MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY (MIST)

SYLLABUS OF

BACHELOR OF SCIENCE IN INDUSTRIAL & PRODUCTION ENGINEERING

DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING (IPE)

JANUARY 2021

CERTIFICATE

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CHAPTER 1

GENERAL INFORMATION

1.1. Introduction to MIST

The necessity of establishing a technical institute for the Bangladesh Armed Forces was felt in the late eighties. In the absence of such an institution, officers of Bangladesh Armed Forces had been graduating from Bangladesh University of Engineering and Technology (BUET), Bangladesh Institute of Technology (BIT), and other foreign institutions of science and technology. With a view to meet the increasing demand for the development and dissemination of engineering and technological knowledge, Bangladesh Armed Forces established the Military Institute of Science and Technology (MIST) on 19 April 1998. Upholding the motto – "Technology for Advancement", MIST promises to provide facilities for higher technical education both for the officers of Bangladesh Armed Forces as well as for civil students from home and abroad. MIST started its journey on 31 January 1999 by offering a four-year bachelor degree in Civil Engineering (CE). Bachelor degree in Computer Science and Engineering (CSE) course started on 2001**.** Bachelor degree in Electrical, Electronic and Communication Engineering (EECE) and Mechanical Engineering (ME) started from 2003. Bachelor degree in Aeronautical Engineering (AE), and Naval Architecture and Marine Engineering (NAME) started from 2008-2009 and 2012-2013, respectively. Besides, four new departments started their academic session from 2014-2015, which are Nuclear Engineering (NE), Biomedical Engineering (BME), Environmental, Water Resources & Coastal Engineering (EWCE) and Architecture (Arch). From 2016 another two new departments named Industrial and Production Engineering (IPE), and Petroleum and Mining Engineering (PME) have started their journey to fulfill the motto of MIST.

1.2 Vision and Mission of MIST

Vision: To be a center of excellence for providing quality education in the field of science, engineering and technology and conduct research to meet the national and global challenges.

Mission: MIST is working on following missions:

a. Develop as a Centre of Excellence for providing comprehensive education and conduct research in diverse disciplines of science, engineering, technology, and engineering management.

b. Produce technologically advanced intellectual leaders and professionals with high moral and ethical values to meet the socio-economic development of Bangladesh and global needs.

c. Conduct collaborative research activities with national and international communities for continuous interaction with academia and industry.

d. Provide consultancy, advisory, testing, and other related services to government, non-government and autonomous organization including personal for widening practical knowledge and to contribute in sustainable development of the society.

1.3 Motto and Values of MIST

Motto: As an institution without gender biasness, MIST is steadily upholding its motto **"Technology for Advancement"** and remains committed to contributing to the wider spectrum of national educational arena, play a significant role in the development of human resources and gradually pursuing its goal to grow into a '**Centre of Excellence**'.

Values:

a. **Humanity-** MIST not only makes our students graduates but also strives to make them humane.

b. **Discipline-** Discipline remains the corner stone of continuous success stories of MIST.

c. **Morality -** Morality is innate. MIST helps nurture it and develops our students as Quality Engineers with Morality.

d. **Quality -** MIST keeps focusing on quality education with inspiration to life-long learning so that our graduates are recognized in the world and can prove their acquired skills.

1.4 Eligibility of Students for Admission in MIST

The students must fulfill the following requirements:

a. **Bangladeshi Students:** Minimum qualifications to take part in the admission test are as follows:

(1) The applicant must have passed the SSC/Equivalent examination obtaining a minimum GPA of 4.00 (without fourth subject) and HSC/Equivalent examination obtaining minimum total grade point 17 in four subjects (Mathematics, Physics, Chemistry, and English).

(2) The applicant must have passed the GCE 'O' Level obtaining minimum B grade in five subjects including Mathematics, Physics, Chemistry, and English, and GCE 'A' Level obtaining minimum B grade in Mathematics, Physics, and Chemistry.

(3) Applicants who have passed HSC or GCE 'A' Level or Equivalent examination in current year or one year before the notification for admission can apply.

b. **Foreign Students.** Maximum 3% of overall vacancies available will be kept reserved for the foreign students and will be offered to foreign countries through Armed Forces Division (AFD) of the Government of the People's Republic of Bangladesh. Applicants must fulfill the following requirements:

(1) Educational qualifications as applicable for Bangladeshi students or equivalent.

(2) Must have security clearance from respective Embassy/ High Commission in Bangladesh.

In the event of non-availability of foreign students, the vacancies will be filled up by Bangladeshi civil students as per merit.

1.5 Seat Capacity.

Department wise seat allotment for four years Bachelor Degree in Engineering programs (Unit – A) and five years Bachelor Degree of Architecture programs are as follows:

Seat Allocation

Ser	Unit	Department	Seats
1	A	Civil Engineering (CE)	60
2		Computer Science and Engineering (CSE)	60
3		Electrical, Electronic and Communication Engineering (EECE)	60
4		Mechanical Engineering (ME)	60
5		Aeronautical Engineering (AE)	50
6		Naval Architecture and Marine Engineering (NAME)	40
7		Biomedical Engineering (BME)	40
8		Nuclear Engineering (NE)	40
9		Environmental, Water Resources and Coastal Engineering (EWCE)	60
10		Industrial and Production Engineering (IPE)	50
11		Petroleum and Mining Engineering (PME)	25
12	B	Architecture (Arch)	25
	Total		570

The total number is 570. In general, about 50% seats will be allocated to military officers. However, in case of the requirement of military students vacancy is less in any particular year, the deficient vacancy will be filled up by civil students. MIST also maintains quota as mentioned below:

Ser	Quota Allocation	Seats
1	General Candidates	54%
2	Children of Military Personnel	40%
3	Children of Freedom Fighters	2%
4	Tribal Citizen	1%
5	International Students	3%
	Total	100%

1.6 Admission Procedure

1.6.1 **<u>Syllabus for admission test.</u>** Admission test will be conducted on the basis of the syllabus of Mathematics, Physics, Chemistry and English subjects of HSC examination. Admission test will be conducted out of 200 marks and the distribution of marks is given below:

Ser.	Subjects	Marks
a.	Mathematics	80
b.	Physics	60
c.	Chemistry	40
d.	English	20
	Total	**200**

1.6.2 **<u>Final Selection</u>**. Students will be selected on the basis of results of the admission test only. Individual choice for selection of departments will be given preference as far as possible. In case of tie in the result of admission test, difference will be judged on the basis of marks obtained in Mathematics, Physics, Chemistry and English respectively in admission test.

1.6.3 Medical Checkup. Civil candidates selected provisionally are to undergo medical check-up at MIST medical centre. They will have to produce test reports of urine for R/E, blood for HBs Ag and blood grouping before the MIST medical authority. The medical authority will decide on the physical fitness of candidates for admission in MIST.

1.7 Students Withdrawal Policy

1.7.1 For Poor Academic Performance.

The under graduate (B.Sc) Engineering programs for all engineering disciplines are planned for 04 regular levels, comprising of 08 regular terms (for Architecture program it is planned for 5 regular levels, comprising of 10 regular terms). It is expected that all students will earn degree by clearing all the offered courses in the stipulated time. In case of failure the following policies will be adopted:

a. Students failing in any course/subject will have to clear/pass the said course/subject by appearing it in supplementary examination as per examination policy. Students may also retake the failed subject/course in regular term as per the Examination policy.

b. Maximum grading for supplementary examination of failed subjects will be B+ as per examination policy.

c. One student can retake/reappear in a failed subject/course only twice. However, with the Permission of Academic Council of MIST, a student may be allowed for third time as last chance.

d. In case of sickness, which leads to missing of more than 40% classes or miss term final examination (supported by requisite medical documents), students may be allowed to withdraw temporarily from that term and repeat the whole level with the regular level in the next academic session, subject to the approval of Academic Council of MIST. Students may retain sessional courses of that term if applies and approved by Academic council. `VW' as grading of each course to be reflected in concerned tabulation sheet, grade sheet and transcript. However, he/she has to complete the whole undergraduate program within 06 (six) academic years (for Architecture 07 academic years) from the date of his/her registration.

e. Minimum credit requirement for the award of bachelor degree in Engineering (BSc. Engg.) and Architecture (B. Arch) will be decided by the respective department as per the existing rules. However the minimum CGPA requirement for obtaining a bachelor degree in engineering and Architecture is 2.20.

f. Whatever may be the cases, students have to complete the whole undergraduate program within 06 (six) academic years from the date of registration.

g. All other terms and condition of MIST Examination Policy remain valid.

1.7.2 Withdrawal on Disciplinary Ground

a. **Unfair Means.** Adoption of unfair means may result in expulsion of a student from the program and so from the Institution. The Academic Council will authorize such expulsion on the basis of recommendation of the Disciplinary Committee, MIST and as per policy approved by the affiliating university. Following would be considered as unfair means adopted during examinations and other contexts:

(1) Communicating with fellow students for obtaining help in the examination.

(2) Copying from another student’s script/ report /paper.

(3) Copying from desk or palm of a hand or from other incrimination documents.

(4) Possession of any incriminating document whether used or not.

c. **Influencing Grades.** Academic Council may expel/withdraw any student for approaching directly or indirectly in any form to influence a teacher or MIST authority for grades.

d. **Other Indiscipline Behaviors.** Academic Council may withdraw/expel any student on disciplinary ground if any form of indiscipline or unruly behavior is seen in him/her which may disrupt the academic environment/program or is considered detrimental to MIST's image.

e. **Immediate Action by the Disciplinary Committee of MIST.** The Disciplinary Committee, MIST may take immediate disciplinary action against any student of the Institution. In case of withdrawal/expulsion, the matter will be referred to the Academic Council, MIST for post-facto approval.

1.7.3 Withdrawal on Own Accord.

a. **Permanent Withdrawal.** A student who has already completed some courses and has not performed satisfactorily may apply for a withdrawal.

b. **Temporary Withdrawal.** A student, if he/she applies, may be allowed to withdraw temporarily from the program, subject to approval of Academic Council of MIST, but he/she has to complete the whole program within 06 (six) academic years (for Architecture 07 academic years) from the date of his/her registration.

CHAPTER 2

RULES AND REGULATIONS FOR UNDERGRADUATE PROGRAM AT MIST

Introduction

2.1 MIST has started course system for undergraduate studies from the academic session 2017-18. Therefore, the rules and regulations mentioned in this paper will be applicable to students for administering undergraduate curriculum through the Course System. This policy will be introduced with an aim of creating a continuous, even and consistent workload throughout the term for the students.

The Course System

2.2 The salient features of the Course System are as follows:

a. Number of theory courses will be generally 06 or as per syllabus in each term. However, with the recommendation of course coordinator and Head of the Department, Commandant MIST may allow up to 07 courses in exceptional cases if department can accommodate within 24 cr hr.

b. Students will not face any level repeat for failing.

c. Students will get scope to improve their grading.

d. Introduction of more optional courses to enable the students to select courses according to their individual needs and preferences.

e. Continuous evaluation of students" performance.

f. Promotion of student-teacher interaction and contact.

2.3 Beside the professional courses pertaining to each discipline, the undergraduate curriculum gives a strong emphasis on acquiring thorough knowledge in the basic sciences of mathematics, physics and chemistry. Due importance is also given on the study of several subjects in humanities and social sciences.

2.4 The first two years of bachelor's degree programs generally consist of courses on basic engineering, general science and humanities subjects; while the third and subsequent years focus on specific disciplines.

Number of Terms in a Year

2.5 There will be two terms *Spring Term (Jan-Jun) and Fall Term (Jul-Dec)* in an academic year.

Duration of Terms

2.6 The duration of each of Spring Term and Fall Term (maximum 22 weeks) may be as under:

Ser	Events	Durations
1.	Classes before Mid Term	7 weeks
2.	Mid Term Vacation	1 week
3.	Classes after Mid Term	7 weeks
4.	Makeup Classes and Preparatory leave	2/3 weeks
5.	Term Final Examination	2/3 weeks
6.	Term End Vacation	1/2 week

Course Pattern and Credit Structure

2.7 The undergraduate program is covered by a set of theoretical courses along with a set of laboratory (sessional) courses to support them.

Course Designation System

2.8 Each course is designated by a maximum of three/four letter code identifying the department offering the course followed by a three-digit number having the following interpretation:

a. The first digit corresponds to the year/level in which the course is normally taken by the students.
b. The second digit is reserved for departmental use. It usually identifies a specific area/group of study within the department.
c. The last digit is an odd number for theoretical courses and an even number for sessional courses.

2.9 The course designation system is illustrated as Follows:

IPE 101 **<u>Introduction to Industrial & Production Engineering</u>**

Course Title
Odd digit designates a theoretical course
Reserved for departmental use
Signifies 1^{st} Year/ 1^{st} Level course
Department identification code

IPE 202 **<u>Manufacturing Process I Sessional</u>**

Course Title
Even digit designates a sessional course
Reserved for departmental use
Signifies 2^{nd} Year/ 2^{nd} Level course
Department identification code

Assignment of Credits

2.10 The assignment of credits to a theoretical course follows a different rule from that of a sessional course.

a. Theoretical Courses: One lecture per week per term is equivalent to one credit.
b. Sessional Courses: Credits for sessional courses is half of the class hours per week per term.

Credits are also assigned to project and thesis work taken by the students. The amount of credits assigned to such work varies from one discipline to another.

Types of Courses

2.11 The types of courses included in the undergraduate curricula are divided into the following groups:

a. <u>Core Courses</u>: In each discipline, a number of courses are identified as core courses, which form the nucleus of the respective bachelor's degree program. A student has to complete all the designated core courses of his/her discipline.
b. <u>Prerequisite Courses</u>: Some of the core courses are identified as prerequisite courses for a specific subject.

c. Optional Courses: Apart from the core courses, the students can choose from a set of optional courses. A required number of optional courses from a specified group have to be chosen.

Course Offering and Instruction

2.12 The courses to be offered in a particular term are announced and published in the Course Catalog along with the tentative Term Schedule before the end of the previous term. The courses to be offered in any term will be decided by Board of Undergraduate Studies (BUGS) of the respective department.

2.13 Each course is conducted by a course teacher who is responsible for maintaining the expected standard of the course and for the assessment of students' performance. Depending on the strength of registered students (i.e. on the number of students) enrolled for the course, the teacher concerned might have course associates and Teaching Assistants (TA) to aid in teaching and assessment.

Teacher Student Interaction

2.14 The new course system encourages students to come in close contact with the teachers. For promotion of a high level of teacher-student interaction, each student is assigned to an adviser and the student is free to discuss all academic matters with his/her adviser. Students are also encouraged to meet any time with other teachers for help and guidance in academic matters. However, students are not allowed to interact with teachers after the moderation of questions.

Student Adviser

2.15 One adviser is normally appointed for a group of students by the BUGS of the concerned department. The adviser advises each student about the courses to be taken in each term by discussing the academic program of that particular term with the student.

2.16 However, it is also the student's responsibility to keep regular contact with his/her adviser who will review and eventually approve the student's specific plan of study and monitor subsequent progress of the student.

2.17 For a student of second and subsequent terms, the number and nature of courses for which he/she can register is decided on the basis of academic performance during the previous terms. The adviser may permit the student to drop 1 or more courses based on previous academic performance.

Course Registration

2.18 Any student who uses classroom, laboratory facilities or faculty-time is required to register formally. Upon admission to the MIST, students are assigned to advisers. These advisers guide the students in choosing and registering courses.

2.19 **Registration Procedure.** At the commencement of each term, each student has to register for courses in consultation with and under the guidance of his/her adviser. The date, time and venue of registration are announced in advance by the Registrar's Office. Counseling and advising are accomplished at this time. It is absolutely essential that all the students be present for registration at the specified time.

2.20 **Pre-conditions for Registration.**

a. For first year students, department-wise enrollment/admission is mandatory prior to registration. At the beginning of the first term, an orientation program will be conducted for them where they are handed over with the registration package on submission of the enrolment slip.

b. Any student, other than the new batch, with outstanding dues to the MIST or a hall of residence is not permitted to register. Each student must clear their dues and obtain a clearance certificate, upon production of which, he/she will be given necessary Course Registration Forms to perform course registration.

c. A student is allowed to register in a particular course subject to the class capacity constraints and satisfaction of pre-requisite courses. However, even if a student fails in a pre-requisite course in any term, the concerned department (BUGS) may allow him/her to register for a course which depends upon the pre- requisite course provided that his/her attendance and performance in the continuous assessment of the mentioned pre- requisite course is found to be satisfactory.

2.21 **Registration Deadline**. Each student must register for the courses to be taken before the commencement of each term. Late registration is permitted only during the first week of classes. Late registration after this date will not be accepted unless the student submits a written application to the registrar through the concerned Head of the department explaining the reasons for delay. Acceptable reasons may be medical problems with supporting documents from the Medical Officer of MIST or some other academic commitments that prohibit enrollment prior to the last date of registration.

2.22 **Penalty for Late Registration**. Students who fail to register during the designated dates for registration are charged a late registration fee of Tk. 100.00 (One hundred only) per credit hours. Penalty for late registration will not be waived.

Limits on the Credit Hours to be taken

2.23 A student should be enrolled for at least 15 credit hours and is allowed to take a maximum of 24 credit hours. Relaxation on minimum credit hours may be allowed. A student must enroll for the sessional courses prescribed in a particular term within the allowable credit hour limits.

2.24 In special cases where it is not possible to allot the minimum required 15 credit hours to a student, the concerned department (BUGS) may permit with the approval of the Commandant, a lesser number of credit hours to suit individual requirements. Only graduating students may be allowed to register less than 15 Cr Hr without approval of Commandant. A list of all such cases to be forwarded to the Register Office, ICT Directorate and Controller of Exam Office by the respective Department.

Course Add/Drop

2.25 A student has some limited options to add or drop courses from the registration list. Addition of courses is allowed only within the first two weeks of a regular term. Dropping a course is permitted within the first four weeks of a regular term. Add or drop is not allowed after registration of courses for Supplementary-I and Supplementary-II Examination.

2.26 Any student willing to add or drop courses has to fill up a Course Adjustment Form. This also has to be done in consultation with and under the guidance of the student’s respective adviser. The original copy of the Course Adjustment Form has to be submitted to the Registrar’s Office, where the required numbers of photocopies are to be made for distribution to the concerned adviser, Head, Dean, Controller of Examinations and the student. All changes must be approved by the adviser and the Head of the concerned department. The Course Adjustment Form has to be submitted after being signed by the concerned persons.

Withdrawal from a Term

2.27 If a student is unable to complete the Term Final Examination due to serious illness or serious accident, he/she may apply to the Head of the degree awarding department for total withdrawal from the term before commencement of term final examination. However application may be considered during term final examination in special case. The application must be supported by a medical certificate from the Medical Officer of MIST. The concerned student may opt for retaining the sessional courses of the term. The Academic Council will take the final decision about such applications. However, the total duration for graduation will not exceed 6 academic years.

The Grading System

2.28 The total performance of a student in a given course is based on a scheme of continuous assessment, for theory courses this continuous assessment is made through a set of quizzes, class tests, class evaluation, class participation, homework assignment and a term final examination. The assessments for sessional courses are made by evaluating performance of the student at work during the class, viva- voce during laboratory hours and quizzes. Besides that, at the end there will be a final lab test. Each course has a certain number of credits, which describes its corresponding weightages. A student's performance is measured by the number of credits completed satisfactorily and by the weighted average of the grade points earned. A minimum grade point average (GPA) is essential for satisfactory progress. A minimum number of earned credits also have to be acquired in order to qualify for the degree. Letter grades and corresponding grade points will be given as follows:

Grading System		
Numerical Markings	**Grade**	**Grade Points**
80% and above	A+	4.00
75% to below 80%	A	3.75
70% to below 75%	A-	3.50
65% to below 70%	B+	3.25
60% to below 65%	B	3.00
55% to below 60%	B-	2.75
50% to below 55%	C+	2.50
45% to below 50%	C	2.25
40% to below 45%	D	2.00
below 40%	F*	0.00
	AB	Absent
	DC	Dis-collegiate
	VW	Voluntary Withdrawn
	X	Project/ Thesis Continuation
	E	Expelled
	S	Satisfactory

* Subject in which the student gets F grade shall not be regarded as earned credit hours for the calculation of Grade Point Average (GPA).

Distribution of Marks

2.29 **Theory.** *Forty percent (40%)* of marks of a theoretical course shall be allotted for Continuous Assessment, i.e. assignments, class tests, pop quizzes, observations, projects and mid-term assessment. These marks must be submitted to Office of the Controller of Examinations before commencement of the final exam. The rest of the marks will be allotted to the Term Final Examination. The duration of final examination will be three (03) hours. The scheme of continuous assessment that a particular teacher would follow for a course will be announced on the first day of the classes. Distribution of marks for a given course per credit is as follows:

Class Performance	5%
Class Test/Assignment	20%
Mid-Term Assessment (Exam/Project)	15%
Final Examination (Section A and B)	60%
Total	100%

Note:

a. In final exam, each section can be used for achieving not more than two course outcomes (COs). The remaining COs should be attained from mid-term assessment or class tests. Course teacher has to inform the student the beginning of the terms.

b. Course teacher of a particular course has to inform the department whether he/she wants to assess mid-term through exam or project within first two weeks of beginning of a term. The duration of mid-term examination should not be more than 50 minutes which has to be conducted in between 6^{th} to 9^{th} week of a semester. If mid-term assessment is done through project, then there should be project report and presentation.

c. The weightage of class performance can be assessed through checking attentiveness during classes or arranging unnoticed pop quizzes.

d. The number of class tests shall be n for 3.0 and above credit courses and (n-1) shall be considered for grading where n is the number of credits of the course. However, for courses having credits below 3.0, the considered class tests shall be 2 out of 3.

e. All class test will carry 20 marks each. Exam software system will finally convert these achieved marks into total class test marks as per credit hour i.e. for n=1(20), n=2 (40), n=3 (60), n=4(80), etc.

f. Irrespective of the result of the continuous assessment (class performance, class test, mid-term assessment), a student has to appear in the final examination (where applicable) for qualifying/passing the concern course/ subject.

2.30 **Laboratory/ Sessional/ Practical Examinations.** Laboratory/Sessional courses are designed and conducted by the concerned departments. Examination on laboratory/sessional/practical subjects will be conducted by the respective department before the commencement of term final examination. The date of practical examination will be fixed by the respective department. Students will be evaluated in the laboratory/ sessional courses on the basis of the followings:

Conduct of Lab Tests/Class Performance	25%
Report Writing/Programming	15%
Mid-Term Evaluation (exam/project/assignment)	20%
Final Evaluation (exam/project/assignment)	30%
Viva Voce/Presentation	10%
Total	100%

Note: the above distribution of percentage is a general guideline. Department can rearrange to some extent if required.

2.31 **Sessional Course in English.** The distribution will be as under:

Class performance/observation	10%
Written Assignment	15%
Oral Performance	25%
Listening Skill	10%
Group Presentation	30%
Viva Voce	10%
Total	100%

2.32 **Class attendance.** Class attendance may be considered as a part of continuous assessment. No mark should be allotted for attending classes.

Collegiate and Non-collegiate

2.33 Students having class attendance of 85% or above in individual subject will be treated as collegiate, and less than 85% and up to 70% will be treated as non-collegiate in that subject. The non-collegiate student(s) may be allowed to appear at the examination subject to payment of non-collegiate fee/fine of an amount fixed by MIST/BUP. Students having class attendance below 70% will be treated as dis-collegiate and will not be allowed to appear at the examination and treated as fail. But in a special case such students may be allowed to appear in the examination with the permission of Commandant and it must be approved by the Academic Council.

Calculation of CGPA

2.34 Grade Point Average (GPA) is the weighted average of the grade points obtained of all the courses passed/completed by a student. For example, if a student passes/completes *n* courses in a term having credits of C_1, C_2, ..., C_n and his grade points in these courses are G_1, G_2, ..., G_n, respectively, then

$$GPA = \frac{\sum_i^n C_i G_i}{\sum_i^n C_i}$$

2.35 The Cumulative Grade Point Average (CGPA) is the weighted average of the GPA obtained in all the terms passed/completed by a student. For example, if a student passes/ completes n terms having total credits of TC_1, TC_2, ... , TC_n and his GPA in these terms are GPA_1, GPA_2,... , GPA_n, respectively then

$$CGPA = \frac{\sum_i^n TC_i GPA_i}{\sum_i^n TC_i}$$

Numerical Example

Suppose a student has completed nine courses in a term and obtained the following grades:

Course	Credit C_i	Grade Points	G_i	C_i*G_i
IPE 101	3.00	A	3.75	11.25
EECE 172	0.75	A+	4.00	3.00
MATH 101	3.00	A-	3.50	10.50
PHY 101	3.00	B+	3.25	9.75
GEE 101	3.00	A	3.75	11.25
LANG 102	1.50	A	3.75	5.625
CHEM 101	3.00	A	3.75	11.25
GEBS 101	3.00	A-	3.50	10.50
CHEM 102	1.50	B+	3.25	4.875
Total	**21.75**			**78.00**

GPA = 78/21.75 = 3.59

Suppose a student has completed four terms and obtained the following GPA:

Level	Term	Earned Credit Hours	Earned GPA	TC_i*GPA_i
		Tc_i	GPA_i	
1	I	21.75	3.75	81.5625
1	II	20.75	3.61	74.9075
2	I	19.50	3.21	62.595
2	II	21.00	2.98	62.58
Total		**83.00**		**281.645**

CGPA = 281.645/83 = 3.39

<u>Impacts of Grade Earned</u>

2.36 The courses in which a student has earned a D or a higher grade will be counted as credits earned by him/her. Any course in which a student has obtained an F grade will not be counted towards his/her earned credits or GPA calculation. However, the F grade will remain permanently on the Grade Sheet and the Transcript.

2.37 A student who obtains an F grade in a core course will have to repeat that particular course. However, if a student gets an F in an optional course, he/she may choose to repeat that course or take a substitute course if available. When a student will repeat a course in which he/she has previously obtained an F, he/she will not be eligible to get a grade better than B+ in that repeated course.

2.38 If a student obtains a grade lower than B+ in a particular course he/she will be allowed to repeat the course only **once** for the purpose of grade improvement. However, he/she will not be eligible to get a grade better than „B+' for an improvement course.

2.39 A student will be permitted to repeat for grade improvement purposes a maximum of 6 courses in BSc. Engineering programs and a maximum of 7 courses in B. Arch. Program.

2.40 If a student obtains a B+ or a better grade in any course he/she will not be allowed to repeat the course for the purpose of grade improvement.

Classification of Students

2.41 At MIST, regular students are classified according to the number of credit hours completed/ earned towards a degree. The following classification applies to all the students:

Level	Credit Hours Earned	
	Engineering/URP	Architecture
Level 1	0.0 to 36.0	0.0 to 34.0
Level 2	More than 36.0 to 72.0	More than 34.0 to 72.0
Level 3	More than 72.0 to 108.0	More than 72.0 to 110.0
Level 4	More than 108.0	More than 110.0 to 147.0
Level 5		More than 147.0

2.42 However, before the commencement of each term all students other than new batch are classified into three categories:

a. **Category 1:** This category consists of students who have passed all the courses described for the term. A student belonging to this category will be eligible to register for all courses prescribed for the upcoming term.

b. **Category 2:** This category consists of students who have earned a minimum of 15 credits but do not belong to category 1. A student belonging to this category is advised to take at least one course less since he might have to register for one or more backlog courses as prescribed by his/her adviser.

c. **Category 3:** This category consists of students who have failed to earn the minimum required 15 credits in the previous term. A student belonging to this category is advised to take at least two courses less than a category 1 student subject to the constraint of registering at least 15 credits. However, he will also be required to register for backlog courses as prescribed by the adviser.

2.43 **Definition of Graduating Student**. Graduating students are those students who will have ≤ 24 credit hours for completing the degree requirement.

Performance Evaluation

2.44 The performance of a student will be evaluated in terms of two indices, viz. Term Grade Point Average and Cumulative Grade Point Average which is the grade average for all the terms completed.

2.45 Students will be considered to be making normal progress toward a degree if their Cumulative Grade Point Average (CGPA) for all work attempted is 2.20 or higher. Students who regularly maintain a term GPA of 2.20 or better are making good progress toward the degrees and are in good standing with MIST. Students who fail to maintain this minimum rate of progress will not be in good standing. This can happen when any one of the following conditions exists.

a. The term GPA falls below 2.20.

b. The Cumulative Grade Point Average (CGPA) falls below 2.20.

c. The earned number of credits falls below 15 times the number of terms attended.

2.46 All such students can make up their deficiencies in GPA and credit requirements by completing courses in the subsequent term(s) and supplementary exams, if there are any, with better grades. When the minimum GPA and credit requirements are achieved, the student is again returned to good standing.

Minimum Earned Credit and GPA Requirement for Obtaining Degree

2.47 Minimum credit hour requirements for the award of bachelor's degree in engineering (BSc Engg) and architecture (B. Arch) will be decided by the respective department (BUGS). However, the syllabus of all BSc engineering program must be of minimum 157 credit hours or more, and for architecture program minimum 189 credit hours or more. A student must earn minimum credit hour set in the syllabus by the concerned department for qualifying Bachelor's Degree. The minimum CGPA requirement for obtaining a Bachelor's degree in engineering and architecture is 2.20.

2.48 A student may take additional courses with the consent of his/her Adviser in order to raise CGPA, but he/she may take a maximum of 15 such additional credits in engineering and 18 such additional credits in architecture beyond respective credit-hour requirements for Bachelor's degree during his/her entire period of study.

Application for Graduation and Award of Degree

2.49 A student who has fulfilled all the academic requirements for Bachelor's degree will have to apply to the Controller of Examinations through his/her Adviser for graduation. Provisional Degree will be awarded by BUP on completion of credit and GPA requirements.

Time Limits for Completion of Bachelor's Degree

2.50 A student must complete his studies within a maximum period of **six** years for engineering and seven years for architecture bachelor's degree.

Attendance, Conduct and Discipline

2.51 MIST has strict rules regarding the issues of attendance in class and discipline.

2.52 **Attendance**. All students are expected to attend classes regularly. The university believes that attendance is necessary for effective learning. The first responsibility of a student is to attend classes regularly and one is required to attend the classes as per MIST rules.

2.53 **Conduct and Discipline**. During their stay in MIST, all students are required to abide by the existing rules, regulations and code of conduct. Students are strictly forbidden to form or be members of student organization or political party, club, society etc., other than those set up by MIST authority in order to enhance student's physical, intellectual, moral and ethical development. Zero tolerance in regards of sexual abuse and harassment in any forms and drug abuse and addiction are strictly observed in the campus.

Teacher-Student Interaction

2.54 The academic system in MIST encourages students to come in close contact with the teachers. For promotion of high level of teacher-student's interaction, a course coordinator (CC) is assigned to each course. Students are free to discuss with CC about all academic matters. Students are also encouraged to meet other teachers any time for help and guidance for academic matters. Heads of the departments, Director of Administration, Director of Students Welfare (DSW), Dean and Commandant address the students at some intervals. More so, monthly Commandant's Parade is organized in MIST where all faculty members, staff and students are formed up, thereby increasing teacher-student interaction.

Absence during a Term

2.55 A student should not be absent from quizzes, tests, etc. during the term. Such absence will naturally lead to reduction in points/marks, which count towards the final grade. Absence in the Term Final Examination will result in an „F" grade in the corresponding course. A student who has been absent for short periods, up to a maximum of three weeks due to illness, should approach the course teacher(s) or the course coordinator(s) for make-up quizzes or assignments immediately upon return to classes. Such request has to be supported by medical certificate from competent authority (e.g. CMH/MIST Medical Officer).

Recognition of Performance

2.56 As recognition of performance and ensure continued studies MIST awards medals, scholarships and stipends as per existing rules and practices.

Types of Different Examination

2.57 Following different types of final examinations will be conducted in MIST to evaluate the students of Undergraduate Programs:

a. **Term Final Examination:** At the end of each normal term (after 22week or so), Term Final Examination will be held. Students will appear in the Term Final Examination for all the theory courses they have taken in the Term.

b. **Supplementary Examination:** It will take place twice in a year. Supplementary-I is defined as provision of giving exam in the first week of Spring Term (Jan-Jun)/Fall Term (Jul-Dec) end break and Supplementary-II in the first week of Fall Term (Jul-Dec)/ Spring Term (Jan-Jun) end break, respectively. Students will be allowed to register for a maximum of **two** theory courses (Failed/ Improvement) in Supplementary-I and maximum of one theory course (Failed/ Improvement) in Supplementary-II.

c. **Improvement Examination:** It will be taken during Supplementary-I and Supplementary-II Examination. Questions will be same as the question of the regular examination of that Supplementary Examination (if any). Student can take maximum two subjects at a time (two subjects in Supplementary-I and one subject in Supplementary-II) and maximum 6 subjects in the whole academic duration. If a student obtains a grade lower than „B+' in a course, he/she will be allowed to repeat the course only once for grade improvement. However, he/she will not be eligible to get a grade better than „B+' for an improvement course. Among the previous result and improvement examination result, best one will be considered as final result for an individual student. However, performance of all examination i.e. previous to improvement examination, shall be reflected in the transcript.

Rules of Different Examinations

2.58 **Term Final Examination.** Following rules to be followed:

a. Registration to be completed before commencement of the Term. A student has to register his desired courses paying registration, examination fee and other related fees.
b. Late registration will be allowed without penalty within first two weeks of the term.
c. Within 1st two weeks of a term a student can Add/Drop course/courses. To add a course, in the 3rd week, one has to register the course by paying additional fees. To drop a course, one has to apply within three weeks and paid fees will be adjusted/ refunded. If anyone wants to drop a course after three weeks and within 4 weeks, that will be permitted but paid fees will not be refunded in that case.

d. Registrar office will finalize registration of all courses within 7 (seven) weeks, issue registration slip and that will be followed by issuing Admit Card.
e. Term Final Examination to be conducted in the 18-20th week of the term as per approved Academic Calendar.

2.59 **Supplementary Examination.** Following rules to be followed:

a. Supplementary-I is defined as provision of giving exam in the first week of Spring Term (Jan-Jun) /Fall Term (Jul-Dec) end break and Supplementary-II in the first week of Fall Term (Jul-Dec) / Spring Term (Jan-Jun) end break, respectively.
b. Students will be allowed to register for a maximum of two theory courses (Failed/ Improvement) in Supplementary-I and maximum of one theory course (Failed/ Improvement) in Supplementary-II.
c. No class will be conducted.
d. 40% marks will be considered from the previous exams.
e. Maximum grading in Supplementary Exam will be B+.
f. No Sessional Exam will be conducted.
g. Examination will be taken on 60% marks like Term Final Examination.
h. If a student fails in a course more than once in regular terms, then for calculating 40% marks, the best one of all continuous assessment marks will be counted.
j. If anyone fails in the Laboratory/ Sessional course, that course cannot be taken in the supplementary examination.
k. If any student fails in a course, he can clear the course retaking it second time or, he can clear the examination appearing at the Supplementary Examination as well. Anyone fails twice in a course, can only retake it in the regular term for appearing third time. But anyone fails even after appearing third time, he/she has to take approval of Academic Council of MIST for appearing 4th (last) time in a course and need to pay extra financial penalty. If any student fails even 4th time in a course, will not be allowed to appear anymore in this same course.
l. Registration of Supplementary-I Exam to be done within 5th week after completion of fall Term (Jul-Dec) and registration of Supplementary-II Exam to be done within the mid- term break of Spring Term (Jan-Jun), paying all the required fees.
m. There will be no provision for add/drop courses after registration.
n. **Thesis:** if a student cannot complete thesis in two consecutive terms, with the recommendation of the supervisor, he/she may continue for next one/two term within six academic years.

2.60 **Improvement Examination.** Following rules to be followed:

a. Improvement Examination is to be taken during the Supplementary-I and II examinations.
b. For Improvement Examination, registration is to be done during the registration of Supplementary-I and Supplementary-II Examinations by paying all the fees.
c. Question Setting, Moderation and Result Publication to be done with courses of Supplementary-I and Supplementary-II Examinations.
d. Any student gets a grading below „B+' and desires to improve that course, he will be allowed to appear the Improvement Examination for that particular course.
e. Highest grade of Improvement Examination will be B+.
f. One student is allowed to appear at Improvement Exam in 6 (six) courses in his whole graduation period taking maximum two courses at a time (two courses at Supplementary-I and one course at Supplementary-II).

Irregular Graduation

2.61 If any graduating student clears his/her failed course in Spring Term /Fall Term/

Supplementary Examinations and his graduation requirements are fulfilled, his graduation will be effective from the result publication date of Spring Term /Fall Term / Supplementary Examinations and that student will be allowed to apply for provisional certificate.

Minimum Earned Credit and CGPA Requirement for Obtaining Degree

2.62 The requirements for award of engineering degree are as follows:

a. Completion of the courses for the minimum required credits of 157 (or as specified in a particular department) in a maximum period of six academic years.

b. Appearing at the final examination in all the required courses as per syllabus of the program.

c. Scoring a CGPA of 2.2 or above.

Consequences of Failing in Sessional Courses

2.63 Any student failing in any sessional course, must re-take that sessional course when offered by the department in any next Regular Term. No Supplementary exam is allowed for sessional course.

Withdrawal for Poor Performance

2.64 A student to remain in reasonable standing must maintain a minimum CGPA of 2.20. Failure to secure/achieve minimum CGPA of 2.20 in two consecutive levels will also lead to withdrawal of the student. A student who fails to maintain a CGPA of 2.20 at the end of a level, but obtains 2.00 or more, will be placed on probation. Failure by a student placed on probation to raise the CGPA to 2.20 in the next level will lead to his withdrawal from the Program. A student failing to maintain a CGPA of 2.20 at the end of the level-4 shall be allowed to repeat courses of the level-4 in which he earned C grades or below. This opportunity will be given only once. Such a student failing to raise CGPA to 2.2 after repeating the courses will be withdrawn from the Program (For further detail MIST Withdrawal Policy' may be consulted).

2.65 Voluntary withdrawal for Sickness. In case of sickness which leads to missing of more than 40% class or miss term final examination (supported by requisite medical documents), students may be allowed to withdraw from that term subject to the approval of the Academic Council of MIST. Students may retain sessional courses of that term if applies and approved by Academic council. VW as grading of each course to be reflected in concerned tabulation sheet, grade sheet and transcript.

2.66 Class Tests. The number of class tests shall be n for 3.0 and above credit courses and (n-1) shall be considered for grading where n is the number of credits of the course. However, for courses having credits below 3.0, the considered class tests shall be 2 out of 3. Class test will be conducted by the subject teacher. Duration of class test should not be more than 30 minutes. Course teacher must announce results within 10 days of holding the examination. Checked script will be shown to the students. If a student misses the class test for acceptable reason the course teacher my take the test of the student.

2.67 MIST is committed in conferring degrees to the students in time which plays a very vital role in steering all the academic activities in any university/ institute. At the beginning MIST conducted all its examinations under the examination section of the University of Dhaka. In June 2008, MIST got affiliation with BUP. Since then MIST has been conducting all its examinations under the control and authority of BUP. For the need of time, former MIST examination policy was reviewed several times. Present review committee has made necessary amendment/ addition/ deletion to suit the proposed course system. This policy may be reviewed every after 05 (five) years or as and when felt necessary by the authority of MIST.

2.68 SUMMARY OF MIST EXAMINATION POLICY-2020

<table>
<tr><th>Serial</th><th>Examination Type</th><th>Session</th><th>Number of Theory Courses</th><th>Maximum Grading</th><th>Assessment Percentage</th><th>Examination Schedule</th><th>Courses</th><th>Registration Schedule</th></tr>
<tr><td>1</td><td>Regular</td><td>Spring Term (Jan-Jun) and Fall Term (Jul-Dec)</td><td rowspan="2">Maximum 6 Theory Courses</td><td>A+</td><td rowspan="2">Assessment on 100%</td><td rowspan="2">Regular Examination</td><td rowspan="2">Regular</td><td rowspan="2">Regular</td></tr>
<tr><td>2</td><td>Retake</td><td>Spring Term (Jan-Jun) and Fall Term (Jul-Dec)</td><td>B+</td></tr>
<tr><td>3</td><td>Supplementary-I (Fail/Improvement)</td><td>Spring Term (Jan-Jun)</td><td>Maximum 2 Theory</td><td>B+</td><td>Assessment on 60%</td><td>1st week of Spring Term (Jan-Jun)/ Fall Term (Jul-Dec) End Break</td><td>Courses of immediate past terms included</td><td>5th week after completion of Fall Term (Previous Year)</td></tr>
<tr><td>4</td><td>Supplementary-II (Fail/Improvement)</td><td>Fall Term (Jul-Dec)</td><td>Maximum 1 Theory</td><td>B+</td><td>Assessment on 60%</td><td>1st week of Fall Term (Jul-Dec)/ Spring Term (Jan-Jun) End Break</td><td>Courses of immediate past terms not included</td><td>Mid-Term Break of Spring (Jan-Jun) Term (March)</td></tr>
</table>

1. Maximum 24 credit hour in one regular term (excluding Supplementary Exams).
2. Students may register maximum up to 7 (seven) theory courses in exceptional case, if department can accommodate within 24 credit hour.
3. Students can register maximum 6 (six) theory courses for improvement in his whole academic period.
4. Supplementary-I Exam to be considered as part of previous Academic Year.
5. Student appearing in Supplementary-I shall not be included in current graduation ceremony.

CHAPTER 3

DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING (IPE)

3.1 Introduction to the program

Industrial and production Engineering (IPE) department was established in 2016 under the faculty of Mechanical Engineering to develop much needed professionals required for the growth of modern industries. The focus of undergraduate program in IPE is on manufacturing and quality, process design and productivity improvement, management and host of core subjects to meet the emerging technological needs of the industry. The curriculum has been prepared keeping view with the basic requirements of modern industries, manufacturing factories and in line with the changing trends in this field.

The syllabus is prepared based on BAETE manual -2017 and focused on Outcome Based Education (OBE) conforming to the Washington accord (WA). Whether Industrial and Production engineers are manufacturing superior automobiles, shortening a roller coaster line, streamlining an operating room, or distributing products worldwide, these challenges concentrate on the common goal of saving companies' money and increasing efficiencies. Education in IPE is very much leaned to practical situations and it is not possible to acquire proper knowledge in this field without sufficient exposure to industrial environment. The relationship of the department with the industries will be strengthened through their involvement in curriculum development and various programs such as seminars, visits and student projects. The students will be encouraged to develop themselves through various co- curricular and extra-curricular activities. The department of IPE aims not only to produce efficient engineers, but also well-educated conscientious leaders who can contribute to the development of the country through ameliorating our industries.

A typical under-graduate course on Industrial & Production Engineering emphasizes on manufacturing and improvement of productivity. A student will also learn the trends of dynamics and control and hence will develop a sound knowledge about overall industrial production and management systems. He/she will also learn to analyze the emerging technological trends of the industry.

3.2 Vision and Mission of the Program

Vision: The department of IPE will be globally recognized as a dynamic contributor to the development and dissemination of advanced knowledge in the diverse field of Industrial and Production Engineering.
Mission: IPE department is working on the following missions:

a. To provide comprehensive education in industrial and production engineering and conduct research.

b. To produce technologically advanced graduates and professionals with high moral and ethical values to meet the domestic and global needs in the field of industrial and production engineering.

c. To conduct collaboration and research activities with national and international academia and industry.

d. To provide consultancy, advisory and testing services to public and private organizations including personal in the areas of industrial and production engineering.

3.3 Program Outcomes (PO)

The Bachelor in Industrial and Production Engineering (IPE) program will have the following Program Outcomes (POs):

a. **Engineering knowledge:** Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in K1 to K4 respectively to the solution of complex engineering problems.

b. **Problem analysis:** Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (K1 to K4)

c. **Design/development of solutions:** Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (K5)

d. **Investigation:** Conduct investigations of complex problems using research-based knowledge (K8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

e. **Modern tool usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering problems, with an understanding of the limitations. (K6)

f. **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (K7)

g. **Environment and sustainability:** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (K7)

h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (K7)

i. **Individual work and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. **Project management and finance:** Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

In addition to incorporating the above-listed POs, MIST also included the following Knowledge Profile (K1-K8) as an educational institution: may include additional outcomes in its learning programs. The ranges of Complex Problem Solving (P1 – P7) and Complex Engineering Activities (A1 – A5) that should be addressed in the program are given in Tables 3.2 and 3.3, respectively.

Table 3.1: Knowledge Profile (KP)

	Attribute
K1	A systematic, theory-based understanding of the natural sciences applicable to the discipline
K2	Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline
K3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
K4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
K5	Knowledge that supports engineering design in a practice area
K6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
K7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability
K8	Engagement with selected knowledge in the research literature of the discipline

Table 3.2: Range of Complex Engineering Problem Solving

Attribute	**Complex Engineering Problems** have characteristic P1 and some or all of P2 to P7:
Depth of knowledge required	P1: Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach
Range of conflicting Requirements	P2: Involve wide-ranging or conflicting technical, engineering and other issues
Depth of analysis required	P3: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	P4: Involve infrequently encountered issues
Extent of applicable codes	P5: Are outside problems encompassed by standards and codes of practice for professional engineering
Extent of stakeholder involvement and conflicting Requirements	P6: Involve diverse groups of stakeholders with widely varying needs
Interdependence	P7: Are high level problems including many component parts or sub-problems

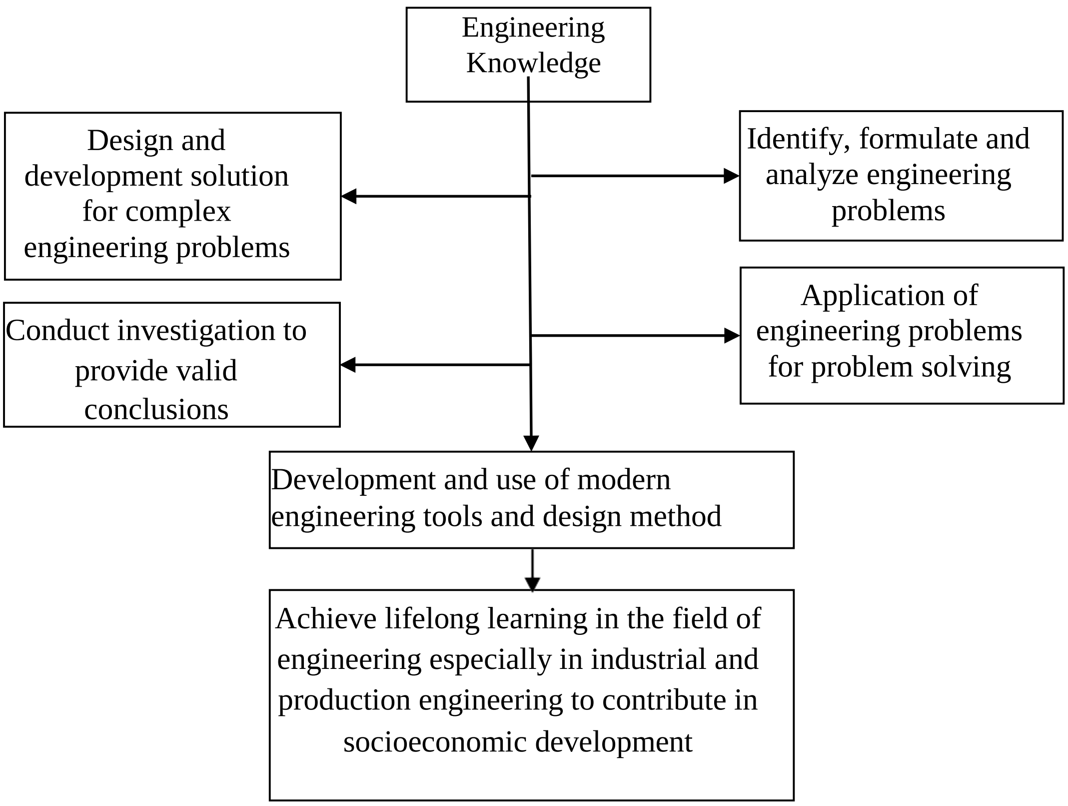
Table 3.3: Range of Complex Engineering Activities

Attribute	**Complex activities** means (engineering) activities or projects that have some or all of the following characteristics:
Range of resources	A1: Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies)
Level of interaction	A2: Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues
Innovation	A3: Involve creative use of engineering principles and research based knowledge in novel ways
Consequences for society and the environment	A4: Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation
Familiarity	A5: Can extend beyond previous experiences by applying principles-based approaches

3.4 Generic Skills

a. Apply the principles and theory of industrial and production engineering knowledge to the requirements, design and development of different industrial and production systems with appropriate understanding.
b. Define and use appropriate research methods and modern tools to conduct a specific project.
c. Learn independently, be self-aware and self-manage their time and workload.
d. Apply critical thinking to solve complex engineering problems.
e. Analyze real time problems and justify the appropriate use of technology.
f. Work effectively with others and exhibit social responsibility.

3.5 Curriculum/ Skill mapping:



CHAPTER 4

COURSE CURRICULUM FOR BACHELOR DEGREE IN IPE

4.1 Introduction

The undergraduate students of the Department of Industrial and Production Engineering have to follow the course schedule given in this chapter. The letter prefix in any course number indicates the department offering the course viz. IPE for Industrial and Production Engineering, ME for Mechanical Engineering, EECE for Electrical & Electronic Engineering, CSE for Computer Science and Engineering, CHEM for Chemistry, PHY for Physics, MATH for Mathematics, GES for General Education Sociology, GEA for General Education Accounting, GEE for General Education Economics, GEBS for General Education Bangladesh Studies, GELM for General Education Leadership and Management, GERM for General Education Research Methodology, GEEM for General Education Engineering Ethics, GESL for General Education Sustainability and Law, LANG for Language, and SHOP for Machine Shop. The first digit in the number indicates the year/level for which the course is intended. Odd number courses are theory courses and even numbered courses are sessional courses.

4.2 Course Schedule

Keeping the above-mentioned program outcome, the course schedule for the undergraduate students of the Department of Industrial and Production Engineering is given below:

Level-Term	**Language Cr Hr**	**General Education Cr Hr**	**Basic Science Cr Hr**	**Mathematics Cr Hr**	**Interdisciplinary Cr Hr**	**Core Courses Cr Hr**	**Elective Cr Hr**	**Total Cr Hr**
1-I	-	2.0+0.0	6.0+3.0	3.0+0.0	0.0+1.00	3.0+0.0	-	18.0
1-II	0.0+1.5	4.0+0.0	-	3.0+0.0	3.0+2.25	3.0+1.5	-	18.25
2-I	0.0+1.5	2.0+0.0	-	3.0+0.0	6.0+2.25	6.0+2.25	-	23.0
2-II	-	-	-	3.0+0.0	-	15.0+3.0	-	21.0
3-I	-	4.0+2.0	-	-	-	13.0+2.25	-	21.25
3-II	-	-	-	-	-	17.0+4.0	-	21.0
4-I	-	-	-	-	-	9.0+6.0	6.0*+0	21.0
4-II	-	-	-	-	-	6.0+4.5	6.0*+0	16.5
Total	0.0+3.0 =3.0	12+2.0=14	6.0+3.0 =9.0	12+0.0= 12.00	9.0+5.5 =14.5	72+23.5 =95.5	12.0+0.0=12.0	160.0
% of total Cr Hr	10.625%		13.125%		9.0625%	59.6875 %	7.5%	

*To be selected from the List of Elective Courses

4.3 Contact Hours and Credit Hours Distribution in Eight Terms

Level-Term	Contact hours for theory courses	Contact hours for sessional courses	Cumulative contact hours	Cumulative credit hours
1-I	14	8	22	18.00
1-II	13	10.5	45.5	36.25
2-I	17	12	84.5	59.25
2-II	18	6	108.5	80.25
3-I	17	8.5	134	101.5
3-II	17	6 + 04 Weeks	157 + 04 Weeks	122.5
4-I	15	12	174 + 04 Weeks	143.5
4-II	12	9	195 + 04 Weeks	160.0
Total	123	72 + 04 Weeks	**195 + 04 Weeks**	**160.0**

4.4 Term-wise Distribution of Courses

Level 1 Term I

Course No.	Course Title	Contact Hour	Credit Hour
IPE 101	Introduction to Industrial and Production Engineering	3	3.00
MATH 101	Differential and Integral Calculus	3	3.00
CHEM 101	Fundamentals of Chemistry	3	3.00
PHY 101	Waves & Oscillations, Optics and Modern Physics	3	3.00
GES 101	Fundamentals of Sociology	2	2.00
Total Theoretical		**14**	**14.00**
PHY 102	Physics Sessional	3	1.50
SHOP 172	Machine Shop Practice	2	1.00
CHEM 102	Chemistry Sessional	3	1.50
Total Sessional		**8**	**4.00**
Grand Term Total		**22.00**	**18.00**

Level 1 Term II

Course No.	Course Title	Contact Hour	Credit Hour
MATH 103	Differential Equations and Matrix	3	3.00
IPE 105	Engineering Materials	3	3.00
EECE 171	Basic Electrical & Electronic Circuit	3	3.00
GEA 101	Principles of Accounting	2	2.00
GEBS 101	Bangladesh Studies	2	2.00
Total Theoretical		**13**	**13.00**
ME 160	Engineering Drawing	3	1.50
LANG 102	Communicative English I	3	1.50
EECE 172	Basic Electrical & Electronic Circuit Sessional	1.50	0.75
IPE 106	Engineering Materials Sessional	3	1.50
Total Sessional		**10.5**	**5.25**
Grand Term Total		**23.5**	**18.25**

Level 2 Term I

Course No.	Course Title	Contact Hour	Credit Hour
MATH 201	Vector Analysis, Laplace Transformation & Co-ordinate Geometry	3	3.00
EECE 271	Electrical Machines and Electronics	3	3.00
CSE 281	Computer Programming	3	3.00
IPE 201	Manufacturing Processes I	3	3.00
GELM 275	Leadership and Management	2	2.00
IPE 207	Engineering Economy	3	3.00
Total Theoretical		**17**	**17.00**
EECE 272	Electrical Machines and Electronics Sessional	1.50	0.75
CSE 282	Computer Programming Sessional	3	1.50
IPE 202	Manufacturing Processes I Sessional	1.5	0.75
IPE 200	Engineering Graphics and CAD Sessional	3	1.50
LANG 202	Communicative English II	3	1.50
Total Sessional		**12.0**	**6.0**
Grand Term Total		**29.0**	**23.00**

Level 2 Term II

Course No.	Course Title	Contact Hour	Credit Hour
IPE 203	Manufacturing Process II	3	3.00
IPE 205	Probability and Statistics	3	3.00
IPE 243	Mechanics of Solids	3	3.00
IPE 251	Thermodynamics and Heat Transfer	3	3.00
MATH 215	Numerical Analysis	3	3.00
IPE 271	Engineering Mechanics and Mechanics of Machinery	3	3.00
Total Theoretical		**18**	**18.00**
IPE 204	Manufacturing Processes II Sessional	1.5	0.75
IPE 206	Probability and Statistics Sessional	1.5	0.75
IPE 244	Mechanics of Solids Sessional	1.5	0.75
IPE 252	Thermodynamics and Heat Transfer Sessional	1.5	0.75
Total Sessional		**6.0**	**3.00**
Grand Term Total		**24.0**	**21.00**

Level 3 Term I

Course No.	Course Title	Contact Hour	Credit Hour
IPE 351	Fluid Mechanics & Machinery	3	3.00
IPE 301	Measurement, Instrumentation and Control	3	3.00
IPE 303	Product Design I	3	3.00
IPE 305	Operations Research	4	4.00
GEEM 343	Engineering Ethics and Moral Philosophy	2	2.00
GESL 313	Environment, Sustainability and Law	2	2.00
Total Theoretical		**17**	**17.00**
IPE 352	Fluid Mechanics & Machinery Sessional	1.5	0.75
IPE 302	Measurement, Instrumentation and Control Sessional	1.5	0.75
IPE 306	Operations Research Sessional	1.5	0.75
GERM 352	Fundamentals of Research Methodology	4	2.00
Total Sessional		**8.5**	**4.25**
Grand Term Total		**25.5**	**21.25**

Level 3 Term II

Course No.	Course Title	Contact Hour	Credit Hour
IPE 309	Material Handling and Maintenance Management	3	3.00
IPE 311	Operations Management	3	3.00
IPE 313	Quality Management	3	3.00
IPE 315	Entrepreneurship Development and Micro Industries	2	2.00
IPE 317	Ergonomics and Safety Management	3	3.00
IPE 307	Product Design II	3	3.00
Total Theoretical		**17**	**17.00**
IPE 308	Product Design Sessional	1.5	0.75
IPE 310	Material Handling and Maintenance Management Sessional	1.5	0.75
IPE 314	Quality Management Sessional	1.5	0.75
IPE 318	Ergonomics and Safety Management	1.5	0.75
IPE 320	Industrial Practice	4 Weeks	1.00
Total Sessional		**6**	**4.00**
Grand Term Total		**23**	**21.00**

Level 4 Term I

Course No.	Course Title	Contact Hour	Credit Hour
IPE 421	Machine Tools	3	3.00
IPE 419	Modeling and Simulation	3	3.00
IPE 415	Project Management	3	3.00
IPE ---	Optional I	3	3.00
IPE ---	Optional II	3	3.00
Total Theoretical		**15**	**15.00**
IPE 400	Final Year Design & Research Project I	6	3.00
IPE 420	Modeling and Simulation Sessional	1.5	0.75
IPE 422	Machine Tools Sessional	3	1.50
IPE 450	Business Communication Seminar	1.5	0.75
Total Sessional		**12**	**6.00**
Grand Term Total		**27**	**21.00**

Level 4 Term II

Course No.	Course Title	Contact Hour	Credit Hour
IPE 405	Supply Chain Management	3	3.00
IPE 411	CAD/CAM	3	3.00
IPE ---	Optional III	3	3.00
IPE ---	Optional IV	3	3.00
Total Theoretical		**12**	**12.00**
IPE 400	Final Year Design & Research Project II	6	3.00
IPE 412	CAD/CAM Sessional	1.5	0.75
IPE 418	Mechatronics and Industrial Automation Sessional	1.5	0.75
Total Sessional		**9**	**4.50**
Grand Term Total		**21**	**16.50**

The grand total credit hours required for the degree of B.Sc. in Industrial and Production Engineering is **160.00**.

4.5 List of Optional Courses

Course No.	Course Title	Contact Hour	Credit Hour
Optional I			
IPE 447	Advanced Material & Process	3	3.00
IPE 425	Marketing Management	3	3.00
IPE 441	Modern Manufacturing Process	3	3.00
IPE 433	Production Planning and Control	3	3.00
IPE 445	Machine Learning	3	3.00
Optional II			
IPE 431	Computer Integrated Manufacturing	3	3.00
IPE 429	Organizational Behavior	3	3.00
IPE 439	Green Manufacturing	3	3.00
IPE 427	Control Engineering	3	3.00
IPE 453	Data Analytics	3	3.00
Optional III			
IPE 417	Industrial Automation	3	3.00
IPE 423	Robotics	3	3.00
CSE 403	Artificial Intelligence	3	3.00
IPE 437	Mechatronics	3	3.00
Optional IV			
IPE 449	Industrial Fire Safety	3	3.00
IPE 451	Micromanufacturing	3	3.00
IPE 435	Metal Cutting	3	3.00
IPE 443	Total Quality Management	3	3.00

4.6 List of Courses Offered to Other Departments

Course No.	Course Title	Contact Hour	Credit Hour
GELM 275	Leadership and Management	2	2.00
IPE 351	Production Process	4	4.00
IPE 352	Production Process Sessional	1.5	0.75
IPE 353	Measurement and Quality Control	3	3.00
IPE 354	Measurement and Quality Control sessional	1.5	0.75
IPE 411	CAD/CAM	3	3.00
IPE 433	Production Planning and control	3	3.00
IPE 435	Metal Cutting Process	3	3.00
IPE 441	Modern Manufacturing Process	3	3.00
IPE 455	Machine Tools & Machining	3	3.00
IPE 456	Machine Tools & Machining Sessional	1.5	0.75
IPE 481	Industrial Management	4	4.00
IPE 485	Operations Research	3	3.00
IPE 487	Material Handling	3	3.00

CHAPTER 5

DESCRIPTION OF IPE COURSES

5.1 Detailed Curriculum of IPE Core Courses

Course Code: IPE 101 **Course Name:** Introduction to Industrial and Production Engineering
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: Level 1/ Term I

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:

This course is designed to impart the core concepts of industrial and production engineering and incorporate inquisition about different fields of works of industrial and production engineers.

Objectives:

1. To acquire knowledge of what industrial engineers do
2. To know how the IP engineers can improve an industrial or a production system
3. To be able to apply basic industrial engineering tools
4. To be able to differentiate among different production processes

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the basic concepts of industrial and production engineering	C4-C5			1	T, Q
CO2	**Outline** how production planning, quality control and supply chain work	C3-C6			1	ASG, T, F
CO3	**Apply** common IE tools to solve real-life problems	C2-C3	1	1	2	ASG, T, F
CO4	**Define** and **describe** the applications of different engineering materials					Q, T, F
CO5	**Describe** and **differentiate** among different production processes and their applications	C3	1	2	1	T, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

a. Main Contents:

Forecasting, Plant layout, Quality engineering, Production planning and control, Statistics, Computer programming, Lean engineering, Work measurement, Manufacturing, Engineering materials, Solidification processes, Particulate processing, Deformation processes, Material removal process, Material handling and management.

b. Detailed Contents:

Introduction to IPE, Career, Input-Process-Output, Efficiency, Life Cycle of Product, **Forecasting** - Simple Moving Average, weighted moving average, exponentially weighted moving average; **Plant Layout:** Line Balancing, cycle time, maximum output, CPM, Locational Economics; **Quality Engineering**: 7 Tools of Quality, Total Quality Management, ISO 9000, Statistical Process Control, Control chart, Control charts for variables and attributes, Process capability assessment, Six Sigma; **Production Planning & Control:** Inventory Control - EOQ, ABC analysis, Value Analysis, Scheduling – forward & backward; **Statistics** - sample & population, sampling, type I, type II error; **Computer Programming:** CAD/CAM, Computer Integrated Manufacturing, **Lean Engineering:** 7 wastes, JIT, 5S, Kaizen, **Work Measurement**: method and time study.

Manufacturing: Definition, Manufacturing industries and products, Manufacturing capabilities, Manufacturing system; **Engineering Materials:** Classification, Selection of materials, Manufacturing Processes classification; **Solidification Processes:** Metal Casting, Shaping processes for plastics and polymer matrix composites; **Particulate Processing:** Pressing and Sintering, Processing of plastics; **Deformation Processes:** Metal forming, Sheet metal working; **Material Removal Process:** Machining and part geometry, Turning and related operations, Drilling and related operations, Milling Operations, Shaping and Planning operations; **Material Handling and Management:** Principles, Unit load, Major Equipment Categories.

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcome**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** the basic concepts of industrial and production engineering **(PO: 1, 2, 4, 5)**	H	M										
CO2	**Outline** how production planning, quality control and supply chain work **(PO: 1, 2, 5)**	M	H										
CO3	**Apply** common IE tools to solve real-life problems **(PO: 3, 5)**			H									
CO4	**Define** and **describe** the applications of different engineering materials **(PO: 1, 4, 5)**	H											
CO5	**Describe** and **differentiate** among different production processes and their applications	H											

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	42
Practical/ Tutorial/ Studio	-
Student-centred learning	-
Self-directed learning	
Non face-to-face learning	18
Revision	21
Assessment preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	106

Teaching methodology:
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	Introduction to IPE, Career, Input-Process-Output	**Class Test 1**
	Lec 2	Efficiency, Life Cycle of Product	
	Lec 3	Simple Moving Average, weighted moving average	
2	Lec 4	Exponentially weighted moving average	
	Lec 5	Line Balancing, cycle time, maximum output	
	Lec 6	CPM	
3	Lec 7	Locational Economics	
	Lec 8	7 Tools of Quality	
	Lec 9	Total Quality Management, ISO 9000	

4	Lec 10	Statistical Process Control, Control chart, Control charts for variables and attributes.	**Class Test 2**
	Lec 11	Process capability assessment, Six Sigma	
	Lec 12	Inventory Control - EOQ, ABC analysis	
5	Lec 13	Value Analysis, Scheduling – forward & backward	
	Lec 14	Sample & population, sampling, type I, type II error	
	Lec 15	CAD/CAM	
6	Lec 16	Computer Integrated Manufacturing	
	Lec 17	7 wastes	
	Lec 18	JIT	
7	Lec 19	5S, Kaizen	
	Lec 20	Method and time study	
	Lec 21	Review class	
8	Lec 22	Manufacturing: Definition, Manufacturing industries and products	**Mid Term / Project**
	Lec 23	Manufacturing capabilities, Manufacturing system	
	Lec 24	Engineering Materials: Classification	
9	Lec 25	Selection of materials	
	Lec 26	Manufacturing Processes classification	
	Lec 27	Metal Casting	
10	Lec 28	Shaping processes for plastics and polymer matrix composites	**Class Test 3**
	Lec 29	Pressing and Sintering	
	Lec 30	Processing of plastics	
11	Lec 31	Metal forming	
	Lec 32	Sheet metal working	
	Lec 33	Machining and part geometry	
12	Lec 34	Turning and related operations	
	Lec 35	Drilling and related operations	
	Lec 36	Milling Operations	
13	Lec 37	Shaping and Planning operations	
	Lec 38	Principles, Unit load	
	Lec 39	Major Equipment Categories	
14	Lec 40	Review class	
	Lec 41		
	Lec 42		

Linkage of Course Outcomes with Assessment Methods and their Weights:

<table>
<tr><th colspan="3">Assessment Strategies</th><th rowspan="2">CO</th><th rowspan="2">Bloom’s Taxonomy</th></tr>
<tr><th colspan="2">Components</th><th>Grading</th></tr>
<tr><td rowspan="3">Continuous Assessment (40%)</td><td>Class test 1-3</td><td>20%</td><td>CO 1-4</td><td>C 1-4, A 1-2, P 1-2</td></tr>
<tr><td>Class Participation</td><td>5%</td><td>CO 1-2</td><td>C 1-4, A 1-2, P 1-2</td></tr>
<tr><td>Mid term</td><td>15%</td><td>CO 1-3</td><td>C 1-6, P 1-4</td></tr>
<tr><td colspan="2">Final Exam</td><td>60%</td><td>CO 1-5</td><td>C 1-6, P 1-4</td></tr>
<tr><td colspan="2">Total Marks</td><td>100%</td><td colspan="2"></td></tr>
</table>

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Industrial Engineering & Management (Ralph M. Barnes)
2. Industrial Engineering & Production Management (Marland T. Telsang)
3. Maynard's Industrial Engineering Handbook (Kjell Zandin, Harold Maynard)
4. Introduction to Industrial and Systems Engineering (Wayne C. Turner, Joe H. Mize, Kenneth E. Case, John W. Nazemtz)

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 105 **Course Title**: Engineering Materials

Credit Hours: 3.00 **Contact Hours:** 3.00

Course Curriculum: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:

To conduct in depth study on atomic structures and bonding, crystallography, phase diagrams, various properties of engineering materials and methods of heat and surface treatments with the objective of laying a strong foundation for core manufacturing courses of program.

Objective:

1. To conduct study on atomic and crystal structure of solids
2. To expose students to phase diagrams of different binary alloys.
3. To conduct study on TTT diagrams to instill understanding of the methods of phase transformation in metallic systems.
4. To conduct study on methods of heat and surface treatments.
5. To apply advanced concepts of engineering materials to the analysis, design and development of materials, components, or processes to meet desired needs of material processing and working condition.

Course Outcomes (CO):

Upon completion of the course, the students will be able to:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** crystal structures and crystalline dislocations in metals	C4-C5		2	1	Pr, R
CO2	**Outline** the properties and applications of various metallic and nonmetallic materials and ceramics	C3-C6	2	2	1	ASG, R
CO3	**Determine** ratios of different phases present binary metallic alloy systems using the respective phase diagrams	C2-C3	1	1	2	ASG
CO4	**Design** cooling rates using TTT diagrams to derive desired combinations of phases in metallic systems	C1-C3			1	T, F
CO5	**Select** and **explain** procedures of different heat and surface treatments operations	C3	2	1,2	1	ASG
CO6	**Estimate** the desired chemical, electrical, magnetic and optical properties of engineering materials	C2			1	T, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Introduction**:** Engineering materials, materials cycle, application and selection criteria of materials.

Structure of solid materials; atomic structure of materials, crystal structure of solids, Miller indices and Bravais space lattices, density, packing factor, defects in crystals and types of defects, solid solutions and dislocations. Amorphous structures: types of solids, poly morphism and allotropy.

Phase diagrams: phase diagrams for Binary metallic system completely soluble in liquid and solid states, Binary metallic system completely soluble in the liquid state but completely insoluble in the solid state; Binary metallic system completely soluble in the liquid state but only partially soluble in the solid state; The Eutectoid Reaction; The Iron-Iron Carbide equilibrium diagram;

Properties of materials: physical, mechanical, chemical, and thermal properties of solids; units and testing.

Engineering materials**:** Structures and properties of metals and alloys, ceramics, polymers, rubber, plastics, semiconductors and magnetic materials.

Heat treatment of Steel: Full Annealing; Spheroidizing; Stress-Relief Annealing; Process Annealing; Normalizing; Hardening; Heating temperatures, holding time and Cooling rates in heat treatments. Case Hardening of Steels: Carburizing; Nitriding; Carburbo-Nitriding; Cyaniding; Flame Hardening and Induction Hardening.

Teaching-learning and Assessment Strategy:

Lectures, class performances, assignments, class tests, mid-term exam and final exam

Linkage of CO with Assessment Methods& their Weights:

Assessment Method	**Mark (%)**
Class Assessment	
Class Participation/Observation//Assignment/Project	05
Class Tests	20
Exams	
Midterm Exam	15
Final exam	60
Total	**100**

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Explain crystal structures and crystalline dislocations in metals	H	H										
CO2	Outline the properties and applications of various metallic and nonmetallic materials and ceramics.	H	H										
CO3	Determine ratios of different phases present binary metallic alloy systems using the respective phase diagrams	H		M									
CO4	Design cooling rates using TTT diagrams to derive desired combinations of phases in metallic systems	H	H										
CO5	Select and explain procedures of different heat and surface treatments operations.	H											
C06	Estimate the desired mechanical and thermal properties of engineering materials	H	M										

Lectures schedule:

Week	Lecture	Topics	Remarks
Week 1	1	Introduction**:** Engineering materials, materials cycle,	CT 1
	2-3	Application and selection criteria of materials.	
Week 2	4	Structure of solid materials; atomic structure of materials, crystal structure of solids	
	5-6	Miller indices and Bravais space lattices	
Week 3	7	Packing factor and density	
	8-9	Defects in Crystals: types of defects, solid solutions, dislocation.	
Week 4	10	Amorphous structures, types of solids, crystal structure, polymorphism and allotropy	
	11-12	**Phase diagrams:** Phase diagrams: phase diagrams for Binary metallic system completely soluble in liquid and solid states,	
Week 5	13	Binary metallic system completely soluble in the liquid state but completely insoluble in the solid state;	
	14-15	Binary metallic system completely soluble in the liquid state but only partially soluble in the solid state; The Eutectoid Reaction;	
Week 6	16	The Iron-Iron Carbide equilibrium diagram;	
	17-18	The Iron-Iron Carbide equilibrium diagram (Continued).	
Week 7	19	Structures and properties of metals and alloys: Ferrous metals – steel	
	20-21	Cast iron	
Week 8	22	Non Ferrous metals and alloys,	Midterm
	23-24	Ceramics	
Week 9	25	Polymers,	CT 3
	26-27	Rubber and plastics	
	28	Semiconductors and magnetic materials.	

Week 10	39-30	Properties of materials: physical and mechanical	
Week 11	31	Properties of materials: Mechanical (Continued)	
	32-33	Thermal properties of solids	
Week 12	34	Chemical properties	
	35-36	Heat treatment of Steel: Full Annealing; Spheroidizing; Stress-Relief Annealing;	
Week 13	37	Heat treatment of Steel: Process Annealing; Normalizing; Hardening; Heating temperatures, holding time and Cooling rates in heat treatments.	
	38-39	Case Hardening of Steels: Carburizing; Nitriding; Carburbo-Nitriding; Cyaniding; Flame Hardening and Induction Hardening.	
Week 14	40	Case Hardening of Steels: Flame Hardening and Induction Hardening.	
	41-42	Course Review	
Referen ce Books		**Text Book:** William D. Callister, ***Materials Science and Engineering an Introduction***, John Wily, 5th Edition. **Reference Books:** **1.** Sidney H Avner, ***Introduction to Physical Metallurgy***, Tata Mc Graw – Hill Edition, 2nd edition.. **2.** Ashby, M. F.; Jones, D. R. H., ***Engineering materials 1: an introduction to properties, applications and design***. Elsevier: 2012; Vol. 1. **3.** Kakani, S., ***Material science. New Age International***: 2006. **4.** Smallman, R. E.; Ngan, A., ***Physical metallurgy and advanced materials.*** Elsevier: 2011.	

Curse Code: IPE 106 **Course Title:** Engineering Materials Sessional
Credit Hour: 1.50 **Contact Hour:** 3.00
Course Curriculum: Outcome Based Education (OBE)
Pre-requisite: None.

Rationale:
Laboratory course to learn basic experimental skills and to introduce basic instruments in materials science and engineering. Use of optical, electrical, thermal and mechanical techniques to investigate composition, structure, thermodynamic and kinetic processes of materials. Communicate laboratory findings through written reports and oral presentation.

Objective:
The overall objective of the course is to provide the students with hands-on experience in (1) basic experimental techniques (2) data analysis and (3) writing journal-quality report. Small groups of about 5 to 6 students work as teams in each laboratory session with the reports prepared independently. The main objectives of the course are

1. To learn the principles of materials science and engineering though lab investigation;
2. To learn the basic skills required to properly use materials scienceinstruments;
3. To learn to organize the lab results into a logic, concise and accurate report;
4. To develop writing and communications skills for a persuasive presentation of technical materials.

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Prepare** formal laboratory reports describing the results of experiments	C4-C5		2	1	Pr, R
CO2	**Operate** basic instruments in materials science and engineering	C3-C6	2	2	1	ASG, R
CO3	**Interpret** the data from the experiments	C2-C3	1	1	2	ASG
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Name of Experiments:

1. Introduction to Metallographic and Metallographic sample specimen preparation.
2. Study of Phase diagram.
3. Microstudy of steels.
4. Study of Heat treatment of Steel-1
5. Study of Heat treatment of Steel-2

6. Study of Microstudy of Cast iron-1
7. Study of Microstudy of Cast iron-2

Teaching-learning and Assessment Strategy:

Class Assessment, Class Participation/ Observation, Class Attendance, Lab Exam, Quiz, Viva

Linkage of CO with Assessment Methods& their Weights:

Assessment Method	**(100%)**
Class Assessment	
Class performance	05
Class Attendance	05
Lab Exam	40
Quiz	40
Viva	10

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Ability to prepare formal laboratory reports describing the results of experiments										M	M	
CO2	Ability to operate basic instruments in materials science and engineering	H			H	M							

CO3	Ability to interpret the data from the experiments		H		M								

Text Books & Ref Books:

1. Lab Manual
2. W.D. Callister, Jr., "Materials Science and Engineering, An Introduction" Wiley
3. Sedney H Avner,“Introduction to Physical Metallurgy”

Course Code: IPE 200 **Course Name:** Engineering Graphics and CAD sessional
Credit Hour: 1.50 **Contact Hour:** 3.00
Level/Term: L-2, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: IPE 160 Engineering Drawing

Synopsis/Rationale:

Rationale:
To help students develop skills in the use of computer aided drawing as a tool for visualizing and communicating design intent of components and items using SolidWorks

Objectives:

1. To help students create 2D and 3D computer drawings and models for manufacturing and prototyping.
2. To develop the skills in students to Evaluate mechanical designs and select the proper access and materials for production.
3. To instill the skills to evaluate computer aided design models and assemblies based on critical thinking and problem-solving skills.
4. To help them apply design principles and rationale in a realistic and original design project.

Course Outcomes (CO):

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Learn** the skills to create and evaluate mechanical designs and select the proper access and materials for production.	C1-C3	2	2	1	Q
CO2	**Evaluate** computer aided design models and assemblies based on critical thinking and problem-solving skills.	C3-C5	2	2	2	ASG, R Pr, Q
CO3	**Apply** design principles and **rationale** in a realistic and original design project.	C3-C6	3	3	3	PR, Pr
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Introduction to CAD: Introduction to SolidWorks, Interface, Navigation

2D Drawings: 2D Sketch**,** 2D Sketch Advanced Options

3D Drawings: 3D Sketch**,** 3D Sketch Advanced Options

Assemblies: Assemblies and different types of mates **,** Advanced Mates

Engineering Drawing: Creating Engineering, Drawings

Design Evaluation: Stress analysis, Design Analysis**,** Animation, Motion analysis**,** Mold Design

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes	Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Lifelong Learning	Project Management and Finance
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**

CO1	**Learn** the skills to create and evaluate mechanical designs and select the proper access and materials for production.	H		**L**		**H**						**M**	
CO2	**Evaluate** computer aided design models and assemblies based on critical thinking and problem-solving skills.	**H**	**H**	**M**	**H**	**H**					**L**	**L**	
CO3	**Apply** design principles and rationale in a realistic and original design project.	**H**	**H**	**H**	**M**	**H**					**H**	**H**	**L**

(H – High, M- Medium, L- Low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	14
Practical/ Tutorial/ Studio	-28
Student-centred learning	-
Self-directed learning	
Non face-to-face learning	0
Revision	30

Assessment preparations	30
Formal Assessment Continuous Assessment Final Examination	 14 3
Total	119

Teaching methodology:

Lecture and Discussion, Practical Sessions, Co-operative and Collaborative Method, Problem Based Method, Project Based Learning

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	Introduction to CAD, Introduction to SolidWorks, Interface, Navigation	**P, Quiz 1**
2	Lec 2	2D Sketch	
3	Lec 3	2D Sketch Advanced Options	
4	Lec 4	3D Sketch	**P, Q**
5	Lec 5	3D Sketch Advanced Options	
6	Lec 6	Assemblies and different types of mates	
7	Lec 7	Advanced Mates	
8	Lec 8	Project Assignment	**Project**
9	Lec 9	Creating Engineering Drawings	

10	Lec 10	Stress analysis, Design Analysis	**Q, P, PR**
11	Lec 11	Animation, Motion analysis	
12	Lec 12	Mold Design	
13	Lec 13	Project Submission and Presentation	
14	Lec 14	Review	

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Quiz 1-2	25%	CO 1	C1-C3, P1
			CO 2	C3-C5, P2-P4
	Class Participation	5%	CO 1	C1-C3, P2, A1
			CO 2	C3-C5, P4, A2
	Project	30%	CO 1	C1-C3, P1
			CO 3	C5-C6, P4-P5
Final Quiz		40%	CO 1	C1-C3, P1
			CO 2	C3-C5, P4-P5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. SolidWorks Manual

2. Mastering SolidWorks- Matt Lombard

Course Code: IPE 201 **Course Name:** Manufacturing Process 1
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-2, T-1
Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

This Outcome Based Education (OBE) based course is designed to make the student conversant with various aspects of different manufacturing process such as casting and welding and enable them to analyze the interaction between manufacturing process concerns and design decisions.

Objectives:

1. To examine the principles associated with basic manufacturing processes involving the casting, press working and welding of engineering materials.
2. To interpret the advantages and limitations of each process and its influence on the properties of the material in the finished component.
3. To analyze and formulate the costs of various manufacturing processes.
4. To describe the main manufacturing steps in a variety of common manufacturing processes (joining, machining and metals manufacturing, glass manufacturing, ceramic manufacturing)
5. To study basic physical and mechanical properties (ceramics and composites), behaviors, and failure modes and their relevance to manufacturing processes.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** how various products are made using traditional, non-traditional, or special manufacturing processes	C1-C4	1		1	T, Mid Term Exam, F
CO2	**Compare** which process is better to produce a given part	C1-C4	1		1	T, Mid Term Exam, F
CO3	**Design** simple process plans for parts and products based on what process is best used for producing some product	C3, C4	2	1	2	T, Mid Term Exam, F
CO4	**Explain** basic materials properties, behaviors, and failure modes and their relevance to manufacturing processes.	C2-C4			1	T, Mid Term Exam, F

CO5	**Solve** any complex geometrical design issue considering proper allowance and pattern design	C2-C4	1			T, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Classification of manufacturing processes, casting processes for ferrous and non-ferrous metals, sand, die, centrifugal, slush, plaster mold, loam mold, precision investment casting etc.
Casting defects, design of molds, riser, gate sprue and core, cost analysis.

Joining methods: soldering, brazing, welding, conventional welding processes: gas, arc, TIG, MIG, thermit, resistance, friction, electro slag etc. Special welding processes: LASER, electron beam, submerged arc etc. Precision and non-precision surface finishing operation, hot and cold extrusion, press working operations etc. Manufacturing of ceramic and glass products, powder metallurgy.

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Explain how various products are made using traditional, non-traditional, or special manufacturing processes	H	L										
CO2	Compare which process is better to produce a given part	**H**	L	L									

CO3	Design simple process plans for parts and products based on what process is best used for producing some product	**H**											
CO4	Explain basic materials properties, behaviors, and failure modes and their relevance to manufacturing processes.	**H**	L										
CO5	Solve any complex geometrical design issue considering proper allowance and pattern design	H	L					M					

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 10 -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	137

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	Assessment
1	Lec 1	Introduction, Engineering materials, Manufacturing Products	
	Lec 2	Classification of manufacturing process, Forging of metals	

	Lec 3	Fundamental of metal casting	
2	Lec 4	Categories of casting process, Sand casting, Sand casting defects	**ASG, Class Test 1, F**
	Lec 5	Sand molding, Shell molding	
	Lec 6	Investment casting, Permanent mold process	
3	Lec 7	Hot chamber and cold chamber die casting, molds for die casting	
	Lec 8	Centrifugal, Slush, Squeeze, Furnace casting	
	Lec 9	Plaster mold, Loam mold casting and heat treatment	
4	Lec 10	Molding sand and properties, Casting defects	**ASG, Class Test 2, F**
	Lec 11	Design for casting, Economics of casting	
	Lec 12	Design of molds, riser, gate, sprue and core	
5	Lec 13	Pattern making, Pattern material, types of pattern	
	Lec 14	Pattern allowance, Fillet and core design	
	Lec 15	Introduction, Classification, Types of weld and weld joints, Different welding process	
6	Lec 16	Arc welding process, TIG, MIG	
	Lec 17	Resistance spot welding, resistance seam welding	
	Lec 18	Friction, Forge, Thermit, electro slag welding	
7	Lec 19	Electron beam, Laser beam welding, Submerged arc	
	Lec 20	Robotic welding, Welding defects, Welding profile	
	Lec 21	Gas welding: OAW, OCW, Gas cutting	
8	Lec 22	Precision and non-precision surface finishing operation	**ASG, Mid Term, F**
	Lec 23	Principle operation, advantage, limitation and application of brazing	
	Lec 24	Principle operation, advantage, limitation and application of soldering	
9	Lec 25	Sheet metal forming: Cutting operations, Shearing, transfer and progressive dies	
	Lec 26	Sheet metal forming: Bending, Stretch Forming, Deep Drawing	
	Lec 27	Tube bending, Tube-Hydroforming, Explosive forming	
10	Lec 28	Bulk deformation process: Hot and cold extrusion	

	Lec 29	Hydrostatic extrusion, Tube drawing	**ASG, Class Test 3, F**
	Lec 30	Design recommendations, Extrusion defects	
11	Lec 31	Rolling of metals: Flat rolling, Defects in flat rolling	
	Lec 32	Shape, Ring, Thread, Tube rolling	
	Lec 33	Roll configuration in rolling mills	
12	Lec 34	Steps in Making Powder-Metallurgy Parts, Powder particles, Atomization	
	Lec 35	Mechanical alloying, Bowl Geometries in Blending Metal Powders, Density Variation in Compacting Metal Powders	
	Lec 36	Press for Compacting Metal Powder, Powder Rolling	
13	Lec 37	Spray Deposition, Mechanisms for Sintering Metal Powders, Design Considerations for P/M	**ASG, F**
	Lec 38	Characteristics of Ceramics Processing, Dry or semi-dry pressing, hydroplastic forming, Slip casting, doctor blade process	
	Lec 39	Extruding and Jiggering, Float method, Glass tubing and manufacturing	
14	Lec 40	Centrifugal casting of glass, Blowing method, Powder-In-Tube Process	
	Lec 41	Glass fiber drawing method, Plate Glass Drawing Method	
	Lec 42	Review	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1-C4
			CO 3	C2-C4
			CO 4	C2

	Class Participation	5%	CO 2	C3, C4
			CO 5	A3
	Mid term	15%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
Final Exam		60%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Manufacturing, Engineering & Technology, Fifth Edition, by Serope Kalpakjian and Steven R. Schmid

2. Fundamentals of Modern Manufacturing, Forth Edition, by Mikell P. Groover

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 202 **Course Name:** Manufacturing Process I Sessional
Credit Hour: 0.75 **Contact Hour:** 1.50
Level/Term: L-2, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: Concurrent with IPE 201 Manufacturing Process I

Synopsis/Rationale:

This Outcome Based Education (OBE) based course is designed to enhance practical knowledge in the field of metal joining and casting methods.

Objectives:

1. To study different components and basic operation of lathe machine
2. To perform various welding operations by changing different parameters.
3. To manufacture a sheet metal job and be introduced with various cold working techniques.
4. To conduct a case study on design of a speed gearbox.
5. To review the basic principles for the design of casting patterns, feeding system and gating system
6. To study metal casting technology and mold making

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Explain** the working principle of lathe machine	C2-C5	1	2	1	T,Q,R,F
CO 2	**Perform** different metal joining and casting process	C4-C6	2	2	1	T,Q,R,F
CO 3	**Explain** the comparison among different joining methods	C3-C5	1	1	2	T,Q,R,F
CO 4	**Investigate** how the accuracy of the job manufactured can be increased	C3	2	1,2	1	T,Q,R,F
CO 5	**Investigate** the main factors affecting the function of pattern design and casting elements	C6, A3	1	1		T,Q,R,F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

1. Study of lathe machine and its operation.
2. Study of TIG and MIG welding operation
3. Study of design and making of pattern for casting.
4. Study of welding joints and welding positions.
5. Mold Making, Casting and Assembly of final product

Mapping of Course Outcomes and Program Outcomes:

	Course Learning Outcomes	Engineering Knowledge **PO1**	Problem Analysis **PO2**	Design / Development of Solutions **PO3**	Investigation **PO4**	Modern Tool Usage **PO5**	The Engineer and Society **PO6**	Environment and **PO7**	Ethics **PO8**	Communication **PO9**	Individual and Team Work **PO10**	Life Long Learning **PO11**	Project Management and **PO12**
CO1	Explain the working principle of lathe machine	H	L										
CO2	Perform different metal joining and casting process	**H**	L										
CO3	Explain the comparison among different joining methods	**H**	L										
CO4	Investigate how the accuracy of the job manufactured can be increased	**H**	L		M								
CO5	Investigate the main factors affecting the function of pattern design and casting elements	H	L		M								

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	16
Practical / Tutorial / Studio	16
Student-Centred Learning	10
Self-Directed Learning	

Non-face-to-face learning Revision Assignment Preparations	40 10 20
Formal Assessment Continuous Assessment Final Examination	 5 1
Total	118

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Exams, Feedback at every step.

Lecture Schedule:

Week 1	**Introduction**
Class 1	Introduction to manufacturing process sessional
Week 2	**Lathe Machine operations**
Class 2	Study of lathe machine and its operation.
Week 3	**TIG and MIG welding operation**
Class 3	Study of TIG and MIG welding operation
Week 4	**Welding Parameters**
Class 4	Study of welding joints and welding positions.
Week 5	**Casting**
Class 5	Study of design and making of pattern for casting.
Week 6	**Casting (contd.)**
Class 6	Mold Making, Casting and Assembly of final product
Week 7	**Conclusion**
Class 7	Review

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (70%)	Weekly Reports	20%	CO 1	C2-C5
			CO 2	C4-C6
			CO 4	C3
		10%	CO 2	C4-C6

	Class Participation		CO 3	C3-C5
	Viva	30%	CO 1	C2-C5
			CO 2	C4-C6
			CO 5	C6, A3
Final Exam		40%	CO 1	C2-C5
			CO 2	C4-C6
			CO 4	C3
			CO 5	C6, A3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Manufacturing, Engineering & Technology, Fifth Edition, by Serope Kalpakjian and Steven R. Schmid

2. Fundamentals of Modern Manufacturing, Forth Edition, by Mikell P. Groover

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 203 **Course Name:** Manufacturing Process II
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-2, T-2

Curriculum Structure: Outcome Based Education (OBE)
Pre-requisites: None

Synopsis/Rationale:

To enable the student to select manufacturing process on the basis of product characteristics.

Objectives:

1. To examine the principles associated with different machining process including turning, drilling, planning, milling, grinding etc.

2. To analyze the advantages and limitations of each process and its influence on the product finishing
3. To interpret the processing sequence for any given product in terms of specification and cost
4. To study design of cutting tool and designation of cutting tool within different standards.
5. To understand the basic features and methods of plastic manufacturing.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** major aspects of conventional and non-conventional machining operations.	C1-C4	1		1	T, Mid Term Exam, F
CO2	**Compare** which machining process is better to produce a given part.	C1-C4	1		1	T, Mid Term Exam, F
CO3	**Select** manufacturing process on the basis of product characteristics and manufacturing economy.	C3, C4	2	1	2	T, Mid Term Exam, F
CO4	**Formulate** chip reduction coefficient and shear strain for various metal removing process.	C2-C4			1	T, Mid Term Exam, F
CO5	**Derive** relationship among different velocities during chip formation, proper allowance and pattern design	C2-C4	1			T, Mid Term Exam, F
CO6	**Analyze** machining economics to achieve maximum production rate.	C2-C4			1	T, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Classification of manufacturing processes, casting processes for ferrous and non-ferrous metals, sand, die, centrifugal, slush, plaster mold, loam mold, precision investment casting etc.
Casting defects, design of molds, riser, gate sprue and core, cost analysis.

Joining methods: soldering, brazing, welding, conventional welding processes: gas, arc, TIG, MIG, thermit, resistance, friction, electro slag etc. Special welding processes: LASER, electron beam, submerged arc etc. Precision and non-precision surface finishing operation, hot and cold extrusion, press working operations etc. Manufacturing of ceramic and glass products, powder metallurgy.

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Explain major aspects of conventional and non-conventional machining operations.	H	L										
CO2	Compare which machining process is better to produce a given part.	**H**	L										
CO3	Select manufacturing process on the basis of product characteristics and manufacturing economy.	**H**	L		**L**								
CO4	Formulate chip reduction coefficient and shear strain for various metal removing process.	**H**	L		**M**								
CO5	Derive relationship among different velocities during chip formation, proper allowance and pattern design	H		L	M								
CO6	Analyze machining economics to achieve maximum production rate.	H			**M**								

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 10 -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	137

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	**Lecture**	**Topics**	**Assessment**
1	Lec 1	Introduction, Engineering materials, Fundamentals of Manufacturing, Classification of Manufacturing Processes	**ASG, Class Test 1, F**
	Lec 2	Introduction to conventional machining, Generating and Forming Shape	
	Lec 3	Basic Turning Operations, Types of lathe, Lathe component, Lathe terminology, CNC Lathe	
2	Lec 4	Reaming, Boring, Broaching Cutting tools for lathe, Lathe centers, Chuck, Collets	
	Lec 5	Drilling and related operations	
	Lec 6	Milling and Related Operations	
3	Lec 7	Shaping and related operations, Quick return mechanism	
	Lec 8	Planning and related operations	

	Lec 9	Grinding and related Operations	
4	Lec 10	Introduction, AJM , WJM, USM	
	Lec 11	ECM, EDM	
	Lec 12	LBM, EBM	
5	Lec 13	Methods of Machining, Cutting Tool Geometry, Tool-in-hand Nomenclature, Single Point Cutting Tool	
	Lec 14	Designation of Cutting Tools, American Standard Association System (ASA), Orthogonal Rake System (ORS)	
	Lec 15	Interconversion Between ASA and ORS	
6	Lec 16	Interconversion Between ASA and ORS (contd.)	
	Lec 17	Chip Formation, Types of Chips, Chip Forms and Classifications, Chip Formation in Metal Machining, Deformation of Uncut Layer	**ASG, Class Test 2, F**
	Lec 18	Chip Reduction Coefficient, Velocity Relationships, Shear angle and shear strain	
7	Lec 19	Mechanics of Metal Cutting, Merchant Circle Diagram, Earnest-Merchant Theory	
	Lec 20	Merchant Theory, Lee and Shaffer Theory, Thermal Aspect of Chip Formation	
	Lec 21	Tool Wear, Mechanism of Tool Wear, Tailor Tool Life Equation	
8	Lec 22	Cutting Tool Materials for Machining, Cutting Fluid	
	Lec 23	Machining economics, Process parameter optimization	
	Lec 24	Processing of plastics, Extrusion, Lamination, Thermoforming	
9	Lec 25	Casting, Blow Molding	
	Lec 26	Compounding, Extrusion, Compression Molding process of plastic manufacturing	**ASG, Mid Term, F**
	Lec 27	Vacuum forming and hand layup	
10	Lec 28	Injection Molding, Press Parameters, Clamping Mechanism Shaping	
	Lec 29	Injection Molding Defects, Common Polymers	
	Lec 30	Shaping Processes for Thermoplastics and Thermosets	

11	Lec 31	Matrix-Reinforced Plastics, Molding Reinforced Plastics	**ASG, Class Test 3, F**
	Lec 32	Selection of Manufacturing Process on the basis of product characteristics	
	Lec 33	Manufacturing of threads and gears	
12	Lec 34	Slip casting, doctor blade process	
	Lec 35	Extruding and Jiggering, Float method, Glass tubing and manufacturing	
	Lec 36	Centrifugal casting of glass, Blowing method, Powder-In-Tube Process	
13	Lec 37	Bulk deformation,	**ASG, F**
	Lec 38	Rolling	
	Lec 39	Sheet metal forging process	
14	Lec 40	Tailor's tool life equation	
	Lec 41	Influence of cutting parameters on tool life	
	Lec 42	Review	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1-C4
			CO 3	C2-C4
			CO 4	C2
	Class Participation	5%	CO 2	C3, C4
			CO 5	A3
	Mid term	15%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
Final Exam		60%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Materials and Processes in Manufacturing- *E.P. Degarmo, J.T. Black & R.A. Kohser*
2. Fundamentals of Modern Manufacturing- *M.P. Groover*
3. Processes and Design for Manufacturing- *S.D.EI Wakil*
4. Manufacturing Processes for Engineering Materials- *S. Kalpakjian & S. R. Schmid*
5. Metal Cutting: Theory & Practice - *A. Bhattacharyya*

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 204 **Course Name:** Manufacturing Process II Sessional
Credit Hour: 0.75 **Contact Hour:** 1.50
Level/Term: L-2, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: Concurrent with IPE 203 Manufacturing Process II

Synopsis/Rationale:

This Outcome Based Education (OBE) based course is designed to enhance practical knowledge in the field of conventional, non-conventional machining and metal cutting.

Objectives:

1. To study different types of chips
2. To study and determine tool wear
3. To operate milling machine to manufacturing a spur and helical gear
4. To conduct a study on different parts and functions of a CNC Milling Machine
5. To study the process of resistance spot welding, EDM, Soldering and Brazing

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Determine** chip reduction co-efficient and temperature (θ) at chip tool interface	C2-C5	1	2	1	T,Q,R,F
CO2	**Examine** causes of tool wear and flank wear with time	C4-C6	2	2	1	T,Q,R,F
CO3	**Develop** G- code for CNC milling operation	C3-C5	1	1	2	T,Q,R,F
CO4	**Investigate** the impact of different parameters on welding joint.	C3	2	1,2	1	T,Q,R,F
CO5	**Determine** material removal rate (MRR) and the Wear ratio	C6, A3	1	1		T,Q,R,F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

1. Study of Chips and Cutting Zone Temperature in Turning Medium Carbon Steel by Uncoated Carbide Insert
2. Study and Determination of Tool Wear
3. Manufacturing of a Spur and Helical Gear on a Column & Knee Type Milling Machine
4. Study of CNC Milling machine.
5. Study of Spot Welding Machine.
6. Study of Electrical-Discharge Machining (EDM) Process
7. Study of Soldering, Brazing operation.

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Determine chip reduction co-efficient and temperature (θ) at chip tool interface	H	L										
CO2	Examine causes of tool wear and flank wear with time	**H**	L										
CO3	Develop G- code for CNC milling operation	**H**		L									
CO4	Investigate the impact of different parameters on welding joint.	**H**	L										
CO5	Determine material removal rate (MRR) and the Wear ratio	H			M	M							

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	16
Practical / Tutorial / Studio	16
Student-Centred Learning	10
Self-Directed Learning	
Non-face-to-face learning	40
Revision	10

Assignment Preparations	20
Formal Assessment Continuous Assessment Final Examination	 5 1
Total	118

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Exams, Feedback at every step.

Lecture Schedule:

Week 1	**Chip and temperature**
Class 1	Study of Chips and Cutting Zone Temperature in Turning Medium Carbon Steel by Uncoated Carbide Insert
Week 2	**Tool wear**
Class 2	Study and Determination of Tool Wear
Week 3	**Gear production in milling machine**
Class 3	Manufacturing of a Spur and Helical Gear on a Column & Knee Type Milling Machine
Week 4	**CNC milling machine**
Class 4	Study of CNC Milling machine.
Week 5	**Spot welding**
Class 5	Study of Spot Welding Machine.
Week 6	**EDM**
Class 6	Study of Electrical-Discharge Machining (EDM) Process
Week 7	**Soldering and Brazing**
Class 7	Study of Soldering, Brazing operation.

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (70%)	Weekly Reports	20%	CO 1	C2-C5
			CO 2	C4-C6
			CO 4	C3
		10%	CO 2	C4-C6

	Class Participation		CO 3	C3-C5
	Viva	30%	CO 1	C2-C5
			CO 2	C4-C6
			CO 5	C6, A3
Final Exam		40%	CO 1	C2-C5
			CO 2	C4-C6
			CO 4	C3
			CO 5	C6, A3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Manufacturing, Engineering & Technology, Fifth Edition, by Serope Kalpakjian and Steven R. Schmid

2. Fundamentals of Modern Manufacturing, Forth Edition, by Mikell P. Groover

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 205 **Course Name:** Probability and Statistics
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: Level 2/ Term II

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:
With probability and statistics, Industrial & Production Engineers make intelligent decisions to develop and manage their processes and businesses by finding optimal solution of real world problems. In this course, students will learn powerful modeling and data analysis techniques for decision-making problems that are used by many successful companies

Objectives:
1. To understand basic laws and distributions of probability.
2. To describe the popular theorems of statistics.

3. To analyze complex data using different data analysis techniques.
4. To compare among different statistical distributions.
5. To implement hypothesis testing to make decision about a process.
6. To solve real-world data-related problems using various tools such as SPSS, MATLAB, Minitab, Python, etc.

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Perform** statistical analysis to explore, visualize and predict situations using data	C4-C5			1	Pr, R
CO2	**Explain** probability distributions and **prepare** data for further analysis	C3-C6	2	2	1	T, ASG, R
CO3	**Outline** mathematical and computational modeling of real decision-making problems, as well as using analytic skills to **evaluate** the problems	C2-C3	1	1	2	T, F, ASG
CO4	**Apply** mathematical software for the **design**, **implementation**, and **analysis** of computational experiments.	C1-C3			1	T, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

a. Main Contents:

Introduction to probability, discrete probability distributions, continuous probability distribution, describing data, sampling, hypothesis testing, analysis of variance, regression analysis, design of experiments, non-parametric methods

b. Detailed Contents:

Introduction to probability: probability, Bayes' rule, random variables, mathematical expectation, variance and covariance of random variables; **Discrete probability distributions:** binomial distribution, multinomial distribution, negative binomial distribution, hypergeometric distribution, Poisson distribution; **Continuous probability distribution:** normal distribution, applications of normal distribution, normal approximation to binomial, gamma and exponential distribution, chi-squared distribution; **Describing data:** graphical presentation, numerical measures, displaying and exploring of data; **Sampling:** sampling methods, sampling errors, sampling distributions, estimates and confidence interval, t-distribution; **Hypothesis testing:** procedures for hypothesis testing, one-sample test of hypothesis, two-sample test of hypothesis; **Analysis of variance:** F-distribution, ANOVA assumptions, ANOVA test, one-way ANOVA, two-way ANOVA; **Regression analysis:** least square principle, simple liner regression, coefficient of correlation and determination, multiple linear regression; **Design of experiments:**

experimental designs, randomized block design, factorial design; **Non-parametric methods:** Chi-square distribution; goodness-of-fit test, equal expected frequencies, unequal expected frequency.

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcome											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Perform** statistical analysis to explore, visualize and predict situations using data **(PO: 1, 2, 4, 5)**	H	M		M	H							
CO2	**Explain** probability distributions and **prepare** data for further analysis **(PO: 1, 2, 5)**	M	H			H							
CO3	**Outline** mathematical and computational modeling of real decision-making problems, as well as using analytic skills to **evaluate** the problems **(PO: 3, 5)**			H		H							
CO4	**Apply** mathematical software for the **design**, **implementation**, and **analysis** of computational experiments **(PO: 1, 4, 5)**	H			M	H							

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	42
Practical/ Tutorial/ Studio	-
Student-centred learning	-
Self-directed learning	
Non face-to-face learning	24

Revision Assessment preparations	24 20
Formal Assessment Continuous Assessment Final Examination	 3 3
Total	116

Teaching methodology:
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	Probability	**Class Test 1**
	Lec 2	Bayes' rule	
	Lec 3	Random variables	
		Mathematical expectation	
2	Lec 4	Variance and covariance of random variables	
	Lec 5 Lec 6	Binomial distribution	
3	Lec 7	Multinomial distribution	
	Lec 8	Negative binomial distribution	
	Lec 9	Poisson distribution	
4	Lec 10	Hypergeometric distribution	**Class Test 2**
	Lec 11 Lec 12	Normal distribution	
		Normal approximation to binomial	
5	Lec 13 Lec 14	Applications of normal distribution	
	Lec 15	Gamma and exponential distribution	
6	Lec 16 Lec 17	Chi-squared distribution	

	Lec 18	Graphical presentation	
7	Lec 19	Numerical measures	
	Lec 20	Displaying and exploring of data	
	Lec 21		
		Sampling methods, Sampling errors	
8	Lec 22	Sampling distributions	**Mid Term / Project**
	Lec 23		
	Lec 24		
		Estimates and confidence interval	
9	Lec 25	t-distribution	
	Lec 26	Procedures for hypothesis testing	
	Lec 27	One-sample test of hypothesis	
10	Lec 28	Two-sample test of hypothesis	**Class Test 3**
	Lec 29		
	Lec 30	F-distribution	
		ANOVA assumptions, ANOVA test	
11	Lec 31	One-way ANOVA	
	Lec 32		
	Lec 33	Two-way ANOVA	
12	Lec 34	Least square principle, simple liner regression	
	Lec 35		
	Lec 36		
		Coefficient of correlation and determination	
13	Lec 37	Multiple linear regression	
	Lec 38	Experimental designs, randomized block design	
	Lec 39	Factorial design	
14	Lec 40	Chi-square distribution,	
	Lec 41	Goodness-of-fit test	
	Lec 42	Equal expected frequencies	
		Unequal expected frequency	

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class test 1-3	20%	CO 1-3	C 1-4, A 1-2, P 1-2
	Class Participation	5%	CO 1-2	C 1-4, A 1-2, P 1-2
	Mid term	15%	CO 1-2	C 1-6, P 1-4
Final Exam		60%	CO 1-4	C 1-6, P 1-4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Reference Books:

1. Probability and Statistics for Engineers & Scientists – Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, and Keying Ye
2. Statistical Techniques in Business & Economics – Douglas A. Lind, William G. Marchal, and Samuel A. Wathen

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 206 **Course Name:** Probability and Statistics Sessional
Credit Hour: 0.75 **Contact Hour:** 1.50
Level/Term: L-2, T-II

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: Concurrent with IPE 205: Probability and Statistics

Synopsis/Rationale:

This sessional course, concurrent with IPE 205: Probability and Statistics, follows the Outcome Based Education (OBE) guidelines. The course is designed to teach the students about the fundamentals of quantitative research, and accustom to strategies for data analysis, hypothesis testing, and statistical inference.

Objectives:

1. To perform exploratory data analysis using IBM SPSS Statistics software
2. To develop and evaluate predictive data analysis models
3. To gain insights of the applied aspects of hypothesis testing

4. To apply knowledge of probability to solve engineering problem

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Visualize** and **interpret** data to make proper engineering decisions	C4-C5		2	1	Pr, R
CO2	**Analyze** data to predict their future patterns with significant level of confidence	C3-C6	2	2	1	ASG, R
CO3	**Implement** the data analysis tools and techniques to test statistical hypothesis	C2-C3	1	1	2	ASG
CO4	**Apply** the knowledge of both discrete and continuous probability distribution to improve reliability of engineering decision	C3	2	1,2	1	ASG
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Name of the experiments:

1. Introduction to IBM SPSS Statistics software
2. Data visualization using SPSS
3. Study of simple linear regression, multiple linear regression, and time series analysis.
4. Study of bivariate statistics- ANOVA, t-test, non-parametric and test.
5. Study of one-sample and two-sample test of hypothesis
6. Study of normal probability distribution

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcome**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Visualize** and **interpret** data to make proper engineering decisions **(PO: 1, 2, 4, 5)**	H	M		M	H							
CO2	**Analyze** data to predict their future patterns with significant level of confidence **(PO: 1, 2, 5)**	M	H			H							
CO3	**Implement** the data analysis tools and techniques to test statistical hypothesis **(PO: 3, 5)**			H		H							

CO4	**Apply** the knowledge of both discrete and continuous probability distribution to improve reliability of engineering decision **(PO: 1, 4, 5)**	H			M	H							

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	-
Practical / Tutorial / Studio	21
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	14
Revision	14
Assignment/Report Preparations	14
Formal Assessment	
Continuous Assessment	3
Final Examination	-
Total	68

Teaching Methodology:

Lectures, class work, weekly reports, Software based, Problem Based Method, Assignments

Lecture Schedule:

Week 1	Introduction to IBM SPSS Statistics software
Week 3	Data visualization using SPSS
Week 5	Study of simple linear regression, multiple linear regression, and time series analysis.
Week 7	Study of bivariate statistics- ANOVA, t-test, non-parametric and test.
Week 9	Study of one-sample and two-sample test of hypothesis
Week 11	Study of normal probability distribution
Week 13	Final Quiz

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Assignment	20%	CO 1	C2-C5
			CO 2	C4-C6
			CO 3	C3
	Class Participation	5%	CO 2	C4-C6
	Mid-term Quiz	15%	CO 1	C2-C5
			CO 2	C4-C6
Final Quiz		60%	CO 1	C2-C5
			CO 2	C4-C6
			CO 3	C3
			CO 4	C6, A3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Probability and Statistics for Engineers & Scientists – Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, and Keying Ye

2. Statistical Techniques in Business & Economics – Douglas A. Lind, William G. Marchal, and Samuel A. Wathen

Reference Site:

https://classroom.google.com/ (To be announced)

IPE 207: Engineering Economy

Contact Hour: 3.00; **Credit Hour:** 3.00

Pre-requisite: None

Rationale:
This course is designed to present engineering students the major concepts and techniques of engineering economic analysis that are needed in the decision making process.

Objective:

i. To prepare engineering students to apply knowledge of mathematics and economics in solving engineering problems.
ii. To make students master the concepts of inflation, depreciation, taxation etc.
iii. To make future engineers able to analyze cash flows in an organization.
iv. To familiarize students with concepts of time value of money
v. To develop the communication skills in students so that they can communicate the results of engineering process to management and non-engineers.

Course Outcomes (CO):

Upon completion of the course, the students will be able to:

1. Apply knowledge of mathematics, economics, and engineering principles to solve engineering problems

2. Comprehend the major capabilities and limitations of cash flow analysis for evaluating proposed capital investments.
3. Recognize, formulate, analyze and solve cash flow models in practical situations and to understand the assumptions underlying these models, and the effects on the modelling process when these assumptions do not hold.

4. Develop the ability to account for time value of money using engineering economy factors and formulas, as well as the implications and importance of considering taxes, depreciation, and inflation

5. Apply engineering economic techniques on solving engineering problems by using computer tools such as spreadsheets.

6. Communicate the results of the modeling process to management and other non-specialist users of engineering analyses in a lucid, informative manner (graphs, tables and/or text)

Course Content:

Introduction to engineering economic decision making common to engineering, cash flow analysis and basic concepts of discounting, cost of capital, required ROR equivalence, business mathematics, investment appraisal criteria for economic decisions, present worth, internal rate of return, social consideration in investment, benefit-cost ratio, decisions involving taxes, depreciation and inflation and sensitivity analysis

Teaching-learning and Assessment Strategy: Lectures, class performances, assignments, class tests, final exam.

Linkage of CO with Assessment Methods& their Weights:

Assessment Method	(100%)
Class Assessment	
Mid term exam	15%
Class Attendance and Performance	05%
Class Tests/Assignment/Presentation	20%
Exam	
Final exam	60%

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Appling knowledge of mathematics, economics, and engineering principles to solve engineering problems	H											
CO2	Understanding the major capabilities and limitations of cash flow analysis for evaluating proposed capital investments		M										
CO3	Recognizing, formulating, analyzing and solving cash flow				H								

	models in practical situations and understanding the assumptions underlying these models, and the effects on the modelling process when these assumptions do not hold												
CO4	Developing the ability to account for time value of money using engineering economy factors and formulas, as well as the implications and importance of considering taxes, depreciation, and inflation		H										
CO5	Applying engineering economic techniques on solving engineering problems by using computer tools such as spreadsheets.					M							
CO6	Communicating the results of the modeling process to management and other non-specialist users of engineering analyses in a lucid, informative manner (graphs, tables and/or text)										H	M	

Lecture schedule:

Week 1	**Introduction to Engineering Economy**	CT 1
Class 1	Economics , Resources, Production Possibility Frontier	
Class 2	Engineering Economy, Origins of Engineering Economy, Principles of Engineering Economy, .	
Class 3	Examples and Problems Related to the Principles of Engineering Economy	
Week 2	**Cost Concepts and Design Economics**	
Class 4	Cost Estimating, Cost Estimating Approaches, Top Down and Bottom Up Approach, Cash Cost and Book Cost, Sunk Cost and Opportunity Cost	
Class 5	Fixed, Variable, and Incremental Costs, Recurring and Nonrecurring Costs, Life-cycle Cost	
Class 6	Phases of the Life Cycle and Their Relative Cost, Direct, Indirect and Overhead Costs, Standard Costs, Consumer and Producer Goods and Services	
Week 3	**Cost Concepts and Design Economics (Contd.)**	
Class 7	Utility, Necessities, Luxuries, and Price Demand, Competition, Cost, Volume, and Breakeven Point Relationships, Economic Breakeven Point	
Class 8	Problems Related to Economic Breakeven Point .	
Class 9	Optimizing a Design with Respect to Cost, A Simplified Cost Function and Examples	
Week 4	**Money-Time Relationships and Equivalence**	CT 2
Class 10	Money, Capital, Types of Capital, Time Value of Money, Origins of Interest, Simple Interest	
Class 11	Compound Interest, Illustration of Simple vs. Compound Interest, Concept of Equivalence, Notation and Cash-Flow Diagrams and Table	
Class 12	Mathematical Problems Related to Cash Flow Diagram.	
Week 5	**Money-Time Relationships and Equivalence (Contd.)**	
Class 13	Arithmetic Calculations with Cash Flows	
Class 14	Arithmetic Calculations with Cash Flows (Contd.)	
Class 15	Deferred Annuities and Mathematical Problems.	
Week 6	**Money-Time Relationships and Equivalence (Contd.)**	
Class 16	Equivalence Calculations Involving Multiple Interest Formulas	
Class 17	Uniform (Arithmetic) Gradient of Cash Flows	
Class 18	Nominal and Effective Interest Rates and Related Mathematical Problems.	
Week 7	**Evaluating a Single Project**	CT 3
Class 19	Introduction, Determining Minimum Attractive Rate of Return (MARR)	
Class 20	Present Worth Method, Assumptions of the PW Method, Bond Value	

Class 21	The Capitalized-Worth Method, Future Worth Method	
Week 8	**Evaluating a Single Project (Contd.)**	
Class 22	Annual Worth Method, Capital Recovery (CR) Amount	
Class 23	Annual Worth Formula, Internal Rate of Return (IRR) Method.	
Class 24	Installment Financing	
Week 9	**Evaluating a Single Project (Contd.)**	
Class 25	Advantages and Disadvantages of IRR method.	
Class 26	External Rate of Return (ERR) Method, Payback (Payout) Period Method	
Class 27	Payback (Payout) Period Method (Contd.).	
Week 10	**Comparison and Selection among Alternatives**	CT 4
Class 28	Introduction, Basic Concepts for Comparing Alternatives, Investment and Cost Alternatives	
Class 29	Investment and Cost Alternatives (Contd.), Ensuring a Comparable Basis, The Study (Analysis) Period	
Class 30	Equivalent-Worth Methods, Rate-of-Return Methods	
Week 11	**Comparison and Selection among Alternatives (Contd.)**	
Class 31	The Inconsistent Ranking Problem, The Incremental Investment Analysis Procedure	
Class 32	The Incremental Investment Analysis Procedure (Contd.),	
Class 33	Mathematical Problems Related to Equivalent Worth Method, Rate-of-Return Analysis	
Week 12	**Depreciation and Income Taxes**	
Class 34	Introduction, Depreciation, Concepts Related to Depreciation	
Class 35	The Classical (Historical) Depreciation Methods	
Class 36	Types of Taxes, Before-Tax and After-Tax MARR, Gain (Loss) on Disposal of a Depreciable Tangible Asset, After-tax Economic Analysis	
Week 13	**Evaluating Projects with the Benefit/Cost ratio method**	
Class 37	Private Versus Public Projects, Benefits, Costs, And Disbenefits, Problems Associated with Multipurpose Projects	
Class 38	Interest Rate Considerations, Benefit / Cost Ratio Method	
Class 39	Criticisms and Shortcomings of Benefit/Cost Ratio Method.	
Week 14	**Review**	
Class 40	Mathematical Problems Related to Concepts of Engineering Economics	
Class 41	Mathematical Problems Related to Concepts of Engineering Economics (Contd.)	

Class 42	Syllabus Review.	

Text and Ref Books:
1. Engineering Economy 16th edition: William G. Sullivan, Elin M. Wicks, C. Patrick Koelling.

Course Code: IPE 243 **Course Name:** Mechanics of Solids
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: Level 2/ Term II
Curriculum Structure: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:
This course will familiarize students with different kinds of loads and the internal reactions in materials (ductile, brittle, composite) due to the loads, the concept of stress as a tensor quantity is introduced along with the relevant materials properties which relate it to strain. In addition, various loading conditions, i.e. axial, tensile, compressive, bending, shear, torsion etc. are explored with pertinent discussions on associated stress and stress distributions. Thermal and centrifugal stresses are also discussed. The importance of shear force and bending moment diagrams in structural analysis along with the use of Mohr's Circle for principal stress/plane determination are elaborated on. An applied component involving computer modeling of common loading problems in engineering concludes the course.

Objectives:
1. Introduction to the calculations concerned with the mechanical properties of materials.
2. To characterize and calculate the magnitude of combined stresses in individual members and complete structures.
3. To analyze various situations involving structural members subjected to combined stresses by application of Mohr’s circle of stress.
4. To calculate and analyze the deflection at any point on a beam subjected to a combination of loads.

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom’s Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Explain** the types of loads and stress in different loaded members and development of skills to determine them	C1-C2			1, 3	T, M, F
CO 2	**Define** the characteristics and calculate the magnitude of minimum safe load and stresses	C1			2, 3	F

	to operate individual members and structures without failure					
CO 3	**Calculate** the deflection at any point on a beam subjected to a combination of loads and clear understanding of shear force and bending moment diagram	C2-C3			2, 3, 4	T, M, F
CO 4	**Analyze** various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress	C4			2, 3,4	T, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; M- Mid; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

a. Main Contents:

Stress and strain introduction; Stress analysis; Modulus of elasticity and rigidity; Pressure vessels; Beams; Deflections of beams; Torsion formula and review of torque; Combined stresses and strains; Columns; Introduction to experimental stress analysis and failure; Problem-based applications.

b. Detailed Contents:

1. Stress and Strain introduction: concept of types of loads and internal reaction forces in resisting materials; tensile, compressive and shear stress; axial stress in composites; concept of strain and deformation; stress-strain concept and their inter-relationship for linearly elastic and isotropic materials, stress-strain diagrams for ductile and brittle materials, elasticity and elastic limits, Young's modulus, material properties from tensile test; introduction to theories of yield;
2. Stress analysis: axially loaded members, statically indeterminate axially loaded members, maximum normal stresses at a cross-section; thermal and centrifugal stresses; concept of stress as tensor quantity, generalized Hooke's Law for 2-D and 3-D stress states and failure under these conditions, graphical representations using stress elements; analysis of elastic behavior of materials under multi-axial loading;
3. Modulus of Elasticity and Rigidity: Definition of important mechanical properties of materials, Poisson's ratio, volumetric strain and bulk modulus; relation between modulus of elasticity and bulk modulus;
4. Pressure Vessels: biaxial stress states due to pressure difference, analysis of bi-axial stresses occurring in thin-walled pressure vessels; stresses in thick walled cylinders and spheres, graphical representation of the distributions of these stresses across vessel's skin thickness; initial yield and plastic collapse in pressure vessels;
5. Beams: types of beam supports (simply supported, cantilevered, fixed ends); pure bending and normal stress, transverse loading and shear stress; mixed loading conditions, shear force and bending moment diagrams; various types of stresses in beams: i.e. bending,

torsion, shear etc.; Flexure formula, stress variation in a rectangular cross-section for positive and negative bending moments; curved beams and hooks, concept of the Neutral Axis (NA);
6. Deflection of beams: integration and area moment methods; shearing stress and deflection in continuous and composite beams, introduction to reinforced concrete beams and slabs;
7. Torsion formula and review of torque; torsional stress, angle of twist of solid and hollow shafts; torsional stiffness and equivalent shaft, modulus of rupture; helical springs;
8. Combined stresses and strains: concept of combined loading, principal stress and principal planes, combined axial and bending stresses, stress at a point, stress on inclined cutting planes, analytical method for the determination of stresses on oblique section; Mohr's Circle and its application in combined loading problems; transformation of strain components, strain rosette;
9. Columns: concept of axial and eccentric loading of columns, introduction to elastic stability, Euler's formula, slenderness ratio and classification of columns, intermediate column formulas, the Secant formula; concept of buckling and bracing; critical load for columns with different end conditions, total maximum stress for a column with initial curvature;
10. Introduction to experimental stress analysis and failure: introduction to techniques; strain energy; stress concentration due to geometric features, brittle fracture, crack growth under repeated or cyclic loading, fatigue, failure theories;
11. Problem-based applications: using basic Finite Element Analysis (FEA) principles of computation for simple FEA model development in aerospace, mechanical, naval and biomedical engineering; results interpretation and validation;

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcome											
		1	2	3	4	5	6	7	8	9	10	11	12
CO 1	**Explain** the types of loads and stress in different loaded members and development of skills to determine them **(PO: 1, 2)**	H	H										
CO 2	**Define** the characteristics and calculate the magnitude of minimum safe load and stresses to operate individual members and structures without failure **(PO: 1, 3, 4)**	H		M		M							
CO 3	**Calculate** the deflection at any point on a beam subjected to a combination of loads and clear understanding of shear force and bending moment diagram **(PO: 1, 2, 3)**	H	H	H									
CO 4	**Define** and **describe** the applications of different engineering materials **(PO: 2, 3)**		H	H									

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	42
Practical/ Tutorial/ Studio	-
Student-centred learning	-
Self-directed learning	
Non face-to-face learning	14
Revision	21
Assessment preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	122

Teaching methodology:
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Lecture Schedule:

Week	Topics
1-2	Stress analysis: statically indeterminate axially loaded member, axially loaded member
3-4	Thermal and centrifugal stresses; Stresses in thin and thick walled cylinders and spheres.
5-6	Beams: Shear force and bending moment diagrams; various types of stresses in beams
7-8	Flexural formula; Deflection of beams: integration and area moment methods; Introduction to reinforced concrete beams and slabs
9-10	Torsion formula; Angle of twist; Modulus of rupture; Helical springs;

11-12	Combined stresses: principal stress, Mohr's Circle; Columns: Euler's formula, intermediate column formulas, the Secant formula;
13-14	Flexure formula of curved beams. Introduction to experimental stress analysis techniques; Strain energy; Failure theories

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class test 1-3	20%	CO 1-4	C 1-4, A 1-2, P 1-2
	Class Participation	5%	CO 1-2	C 1-4, A 1-2, P 1-2
	Mid term	15%	CO 1-3	C 1-6, P 1-4
Final Exam		60%	CO 1-4	C 1-6, P 1-4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Strength of materials (4th edition) William Nash, Publisher Mcgraw-hill International Editions, Schaum's Outline Series
2. Mechanics of material with solved problems A C Mandal & M. Quamrul Islam, published by IUT, OIC, 2011
3. Strength of Materials (4th edition) – Andrew Pytel, Ferdinand L. Singer.
4. Strength of Materials – Beer and Johnston.
5. Mechanics of Materials (10th edition) - R. C. Hibbeler

Reference Site:

Google Classroom (to be announced)

COURSE INFORMATION			
Course Code Course Title	: IPE 244 : Mechanics of Solids Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75
PRE-REQUISITE			
IPE 243			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			

SYNOPSIS/RATIONALE
This is the foundation unit in the study of structures. By applying the knowledge gained in Statics and combining it with the concepts gained in Materials Technology the students are introduced to fundamental theories and techniques required to analyze the state of stress and strain in structural members subjected to external loads. This knowledge will allow students to perform the engineering calculations required to ensure that a structural member meets strength, stiffness and stability requirements.
OBJECTIVE
1. Students will be able to instill a basic knowledge of the statistical aspects of mechanics of materials. 2. Develop the formal theory of solid mechanics: the equilibrium, kinematic, and constitutive equations. 3. Introduce the atomistic mechanisms underlying the mechanical behavior of materials. 4. Establish process - structure - property - performance relationships in materials engineering.
LEARNING OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** the fundamentals of Solid Mechanics.	1	C3			1	R, Q, LT
CO2	**Analyze** the fundamentals of stresses and strains.	1	C4			1	R, Q, LT
CO3	**Identify** and express the principles of Solid Mechanics in obtaining the solutions for applications in real life engineering problems.	2	C3			5	R, Q, LT

CO4	**Identify** and express the principles of Solid Mechanics in design problems.	4	C3			3	R, Q, LT

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, LT – Lab Test, PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

Experiments:

1) **a. Study and calibration of Universal Testing Machine (UTM)**

   b. Tensile Test of mild steel specimens.
2) **Hardness test of metal specimen.**
3) **Impact test of metal specimen.**
4) **Support reaction of a point loaded for a simple supported beam.**
5) **Column test of a mild steel specimen.**

CO-PO MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** the fundamentals of Solid Mechanics	3											
CO2	**Analyze** the fundamentals of stresses and strains.	3											
CO3	**Identify** and express the principles of Solid Mechanics in obtaining the solutions for applications in real life engineering problems.		3										

CO4	**Identify** and express the principles of Solid Mechanics in design problems.				3								

Justification for CO-PO mapping:

Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1	**3**	In order to identify the basics of solid mechanics, the knowledge of engineering fundamental would be required.
CO2-PO1	**3**	In order to perform the experiments, the fundamental knowledge of stress strain would be required
CO3-PO2	**2**	In order to solve the solid mechanics problems, the knowledge of engineering fundamentals is also required.
CO4-PO4	**3**	For performing the experiments, design problems are needed in this laboratory.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical	28
	tal 42

Self-Directed Learning	
Preparation of Lab Reports	10
Preparation of Lab Test	10
Preparation of presentation	5
Preparation of Quiz	10
Engagement in Group Projects	20
Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Total	112

TEACHING METHODOLOGY

Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE

Week-1	Introduction class
Week-3	Exp 1: a. Study and calibration of Universal Testing Machine (UTM) b. Tensile Test of mild steel specimens.
Week-5	Exp 2: Hardness test of metal specimen.
Week-7	Exp 3: Impact test of metal specimen.
Week-9	Exp 4: Support reaction of a point loaded for a simple supported beam.
Week-11	Exp 5: Column test of a mild steel specimen.
Week-13	Quiz/Test, Viva

Components		Grading
Continuous Assessment (60%)	Lab participation and Report	30%
	Labtest-1, Labtest-2	30%
Lab Quiz		40%
Total Marks		100%

REFERENCE BOOKS

1. Strength of materials (4th edition) William Nash, Publisher Mcgraw-hill International Editions, Schaum's Outline Series.

2. Mechanics of material with solved problems A C Mandal & M. Quamrul Islam 2011.

3. Strength of Materials (4th edition) – Andrew Pytel, Ferdinand L. Singer.

4. Strength of Materials – Beer and Johnston.

5. Strength of Materials – E. P. Popov.

6. Mechanics of Solids Laboratory Practice- A.C. Mandal & M.Q. Islam

Course Code: IPE 251 **Course Name:** Thermodynamics and Heat Transfer
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: Level 2/ Term II
Curriculum Structure: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:

An understudy is acclimated with the fundamental concepts and standards of Thermodynamics, as well as the application of mathematical constructs to understand energy flow and conservation. The idea of entropy, and the relationship between work and heat are emphasized with pertinent problems solving approach. The standards and concepts discussed and learned are applied in ensuing courses to address real life related problems in the field of steam cycles, internal combustion engines, air compressors, refrigeration and combustion modeling. This course builds on the fundamental concepts developed in thermodynamics. It examines the different modes of heat transfer with detailed treatment of each mode. Analysis of different heat transfer devices are carried out and associated mathematical concepts emphasized. Analogy is drawn between heat and mass transfer with the prevalent mathematical models and theories discussed. Applications of the concepts developed in practical cases involving cooling towers, heat exchanges, heat pipes etc. further cement the students understanding.

Objectives:

1. Instruct students in analyzing air standard cycles, such as reciprocating piston engines and gas turbine engines, and vapor power cycles, such as those used in power plants and refrigeration units.
2. To make students familiar with fundamental heat transfer concepts: conservation of energy, mechanisms of energy conversion, and mechanisms of heat transfer (conduction, convection, and radiation)
3. To make students familiar with thermal circuit analysis for engineering systems and calculations for conduction, convection, and radiation thermal resistances.

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Explain** the Zeroth, First, Second and Third Laws of thermodynamics, and use the laws of thermodynamics to solve a variety of problems, such as the expansion of gases and the efficiency of heat engines	C1-C2			1, 4, 6, 7	T, M, F
CO 2	**Analyze** efficiency and properties of thermodynamic cycles for heat engines,	C3	1		2, 5	F

	refrigerators and heat pumps and other important mechanical devices.					
CO 3	**Apply** the first and second laws to examine the behavior of internal combustion engines (air–standard cycles), Carnot cycle, Brayton cycle, Ericsson cycle, Rankine power cycles (basic, regeneration, reheat), combined powerplant cycles and Vapor pressure refrigeration cycles	C2-C3	1		4, 6	T, M, F
CO 4	To train students to **identify, formulate, solve** engineering problems, and ability to determine thermal resistance involving conduction heat transfer	C2-C3	1		1, 3,5 ,6, 8	T, M, F, ASG
CO 5	To train students to **identify, formulate, and solve** engineering problems involving forced convection heat transfer, natural convection heat transfer	C2-C3	1		1, 5	T, M, F, ASG
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; M- Mid; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

a. Main Contents:

Introduction to Thermodynamics; First law of thermodynamics; Pure substances; Second law of thermodynamics; Perfect gases; Thermodynamics relations and cycles; Vapor power cycles; Refrigeration cycle; Conductive heat transfer; Convective heat transfer; Radiation heat transfer; Heat exchangers.

b. Detailed Contents:

1. Introduction to Thermodynamics: Definition and the calculus of thermodynamics; Fundamental concepts: thermodynamic system and control volume, classes of systems, thermodynamic properties, flow and non-flow processes, reversible and irreversible processes, constant volume, constant pressure, isothermal, adiabatic, polytrophic and isentropic processes, thermodynamic equilibrium; Zeroth law of thermodynamics;

2. First Law of Thermodynamics: Energy and energy transfer, total energy of a system, concept of temperature and heat, thermodynamic temperature scale; heat and work, modes of work; concept of continuum, macroscopic approach; property, state, path and process; determination of the state of a system from given properties; non-flow energy equation; internal energy, specific heat capacities, relation between specific heats; enthalpy: concept of ideal and real gases; law of conservation of energy; corollaries of first law; application in thermodynamic systems: closed, open and isolated; steady flow energy equation and its applications;

3. Pure Substances: Definition and properties of pure substances; phase changes; single component phase equilibrium (vaporization, melting, sublimation); p-T, p-v, T-s and h-s diagrams; triple point and critical point; tables of thermodynamic properties of steam; Mollier diagram;

4. Second Law of Thermodynamics: Limitation of the first law of thermodynamics; concept of entropy and exergy analysis; Kelvin, Planck and Clausius statements of second law; heat engines and heat pumps; Corollaries of the 2nd law; efficiencies of reversible engines; temperature-entropy diagrams for gases and vapors, entropy changes for a perfect gas for reversible processes; energy analysis: control mass and control volume systems;

5. **Perfect Gases:** Ideal and real gases, equation of the state of a perfect gas; internal energy, enthalpy and specific heat capacities of a perfect gas; coefficient of volume expansion and isothermal compressibility for a perfect gas; reversible processes of perfect gas; perfect gas mixtures; Gibbs-Dalton law; relations involving pressure, volume and composition; internal energy, enthalpy and specific heats of gaseous and gas-vapour mixtures;

6. **Thermodynamics Relations and Cycles:** Carnot cycle; gas power cycles; ideal cycles; Otto cycles, Diesel cycle, Brayton cycle; p-v and T-s diagrams of cycles;

7. **Vapor Power Cycles:** Rankine cycle; Reheat cycle; calculations of cycle efficiency;

8. **Refrigeration Cycle:** Simple vapor compression refrigeration cycle; p-h and T-s diagrams; Actual cycle and its analysis; study of compressor, condenser, expansion device and evaporator in refrigeration systems; efficiency and COP; Psychrometrics;

9. **Conductive heat transfer**: General conduction equation; steady-state conduction, unsteady-state conduction, conduction-convection systems, convection boundary conditions; straight fins of rectangular and triangular profiles;

10. **Convective heat transfer:** Natural convection heat transfer; Heat and momentum transfer associated with laminar and turbulent flows of fluids in forced convection; dimensional analysis of forced and natural convections; Velocity and thermal boundary layer developments over flat plate and through tubes (ducts), Thermal Boundary Layer, Relation Between Fluid Friction and Heat Transfer, Turbulent-Boundary-Layer; General methods for estimation of convective heat transfer coefficient; Reynolds and Nusselt Numbers for heat transfer rate;

11. **Radiation heat transfer:** Laws of radiation heat transfer; blackbody and gray body emissions; radiactive properties of surfaces; radiation shape factor; radiation interchange between two surfaces;

12. **Heat exchangers:** Basic types, Log Mean Temperature Difference (LMTD) of concentric tube heat exchangers, temperature profiles for different configurations and operating parameters of concentric tube heat exchangers; exchanger effectiveness-NTU relations; techniques of heat transfer augmentation; heat exchanger devices;

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcome											
		1	2	3	4	5	6	7	8	9	10	11	12
CO 1	**Explain** the Zeroth, First, Second and Third Laws of thermodynamics, and use the laws of thermodynamics to solve a variety of problems, such as the expansion of gases and the efficiency of heat engines **(PO: 1, 7)**	**H**						**M**					

CO 2	**Analyze** efficiency and properties of thermodynamic cycles for heat engines, refrigerators and heat pumps and other important mechanical devices. **(PO: 1, 2)**	**H**	**H**										
CO 3	**Apply** the first and second laws to examine the behavior of internal combustion engines (air–standard cycles), Carnot cycle, Brayton cycle, Ericsson cycle, Rankine power cycles (basic, regeneration, reheat), combined powerplant cycles and Vapor pressure refrigeration cycles **(PO: 1, 2, 10)**	**H**	**H**								**M**		
CO 4	To train students to **identify, formulate, solve** engineering problems, and ability to determine thermal resistance involving conduction heat transfer **(PO: 1, 2, 3, 4)**	**H**	**H**	**H**	**M**								
CO 5	To train students to **identify, formulate, and solve** engineering problems involving forced convection heat transfer, natural convection heat transfer **(PO: 1, 2, 3)**	**H**	**H**	**H**									

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	42
Practical/ Tutorial/ Studio	-
Student-centred learning	-

Self-directed learning	
Non face-to-face learning	14
Revision	21
Assessment preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	122

Teaching methodology:
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Lecture Schedule:

Week	Topics
1	Definition and the calculus of thermodynamics; Fundamental concepts: thermodynamic system and control volume, classes of systems, thermodynamic properties, flow and non-flow processes, reversible and irreversible processes, constant volume, constant pressure, isothermal, adiabatic, polytrophic and isentropic processes, thermodynamic equilibrium; Zeroth law of thermodynamics
2	Energy and energy transfer, total energy of a system, concept of temperature and heat, thermodynamic temperature scale; heat and work, modes of work; concept of continuum, macroscopic approach; property, state, path and process; determination of the state of a system from given properties; non-flow energy equation; internal energy, specific heat capacities, relation between specific heats;
3	Enthalpy: concept of ideal and real gases; law of conservation of energy; corollaries of first law; application in thermodynamic systems: closed, open and isolated; steady flow energy equation and its applications
4	Definition and properties of pure substances; phase changes; single component phase equilibrium (vaporization, melting, sublimation); p-T, p-v, T-s and h-s diagrams; triple point and critical point; tables of thermodynamic properties of steam; Mollier diagram;
5	Limitation of the first law of thermodynamics; concept of entropy and exergy analysis; Kelvin, Planck and Clausius statements of second law; heat engines and heat pumps
6	Corollaries of the 2nd law; efficiencies of reversible engines; temperature-entropy diagrams for gases and vapors, entropy changes for a perfect gas for

	reversible processes; energy analysis: control mass and control volume systems
7	Ideal and real gases, equation of the state of a perfect gas; internal energy, enthalpy and specific heat capacities of a perfect gas; coefficient of volume expansion and isothermal compressibility for a perfect gas; reversible processes of perfect gas; perfect gas mixtures; Gibbs-Dalton law; relations involving pressure, volume and composition; internal energy, enthalpy and specific heats of gaseous and gas-vapour mixtures
8	Carnot cycle; gas power cycles; ideal cycles; Otto cycles, Diesel cycle, Brayton cycle; p-v and T-s diagrams of cycles;
9	Rankine cycle; Reheat cycle; calculations of cycle efficiency
10	Simple vapor compression refrigeration cycle; p-h and T-s diagrams; Actual cycle and its analysis; study of compressor, condenser, expansion device and evaporator in refrigeration systems; efficiency and COP; Psychrometrics;
11	General conduction equation; steady-state conduction, unsteady-state conduction, conduction-convection systems, convection boundary conditions; straight fins of rectangular and triangular profiles
12	Natural convection heat transfer; Heat and momentum transfer associated with laminar and turbulent flows of fluids in forced convection; dimensional analysis of forced and natural convections; Velocity and thermal boundary layer developments over flat plate and through tubes (ducts), Thermal Boundary Layer, Relation Between Fluid Friction and Heat Transfer, Turbulent-Boundary-Layer; General methods for estimation of convective heat
13	Laws of radiation heat transfer; blackbody and gray body emissions; radiactive properties of surfaces; radiation shape factor; radiation interchange between two surfaces
14	Basic types, Log Mean Temperature Difference (LMTD) of concentric tube heat exchangers, temperature profiles for different configurations and operating parameters of concentric tube heat exchangers; exchanger effectiveness-NTU relations; techniques of heat transfer augmentation; heat exchanger devices;

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom’s Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class test 1-3	20%	CO 1-4	C 1-4, A 1-2, P 1-2
	Class Participation	5%	CO 1-2	C 1-4, A 1-2, P 1-2
	Mid term	15%	CO 1-3	C 1-6, P 1-4

Final Exam	60%	CO 1-5	C 1-6, P 1-4
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Thermodynamics: An Engineering Approach - Yunus A. Cengel, Michael A. Boles
2. Fundamentals of Engineering Thermodynamics- Michael J. Moran & Howard N. Shapiro
3. Thermal Engineering-Mahesh M. Rathore
4. Heat and Mass Transfer, Fundamentals & Applications – Yunus A. Cengel, Afshin J. Ghajar.
5. Fundamental of Heat & Mass Transfer – Frank P. Incropera.
6. Heat Transfer – J. P. Holman

Reference Site:

Google Classroom (to be announced)

COURSE INFORMATION			
Course Code Course Title	: IPE 252 : Thermodynamics & Heat Transfer Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
Thermodynamics sessional deals with the relations between heat and other forms of energy such as mechanical, electrical, or chemical energy. In this course, students will learn and apply a range of thermodynamic laws and principles so that they can analyze a given thermodynamic problem (such as the combustion of fuels to release heat and energy, and the translation of this release of energy into movement) and discuss operational features of various thermodynamic systems and components. This course enables students to apply the understanding of heat transfer mechanisms such as conduction, convection and radiation for understanding the performance of various heat transfer equipment such as heat exchangers, condensers, boilers, evaporators etc. used in almost all industries.			
OBJECTIVE			
1. Students will be able to apply thermodynamic laws and principles to the analysis of processes, cycles and thermodynamic hardware 2. They will explain and investigate the laws and principles of thermodynamics and use to solve problems			

3. They can solve thermodynamics problems by appraising given information, determining which concepts apply, and then provide and verify an appropriate solution
4. They will learn to use basic tools to design process operations involving heat transfer.

LEARNING OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Apply** thermodynamic laws and principles to the analysis of processes, cycles and thermodynamic hardware	1	C3			1	R, Q, LT
CO 2	**Analyze** and investigate the laws and principles of thermodynamics and use to solve problems	1	C4			1	R, Q, LT
CO 3	**Solve** thermodynamics problems by appraising given information, determining which concepts apply, and then provide and verify an appropriate solution	2	C3			5	R, Q, LT
CO 4	**Analyze** heat transfer by conduction, convection and radiation.	1	C4			4	R, Q, LT
CO 5	**Analyze** and calculate heat and mass transfer in complex systems involving several heat transfer mechanisms	2,3	C4			5	R, Q, LT

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, LT – Lab Test, PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

Experiments:

1) **(a) Determination of flash point of liquid gel**

   (b) Study of sling psychrometer

2) **Viscosity test of liquid substance**
3) **Study and calibration of pressure gauge by dead weight tester**
4) **(a)Concept of pressure and pressure sensor behavior**

   (b) Study of different Speed Measuring devices

5) **Determination of thermal conductivity of a metal by steady state method**
6) **Study of heat transfer by radiation and convection**
7) **Study of heat exchanger**

CO-PO MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** thermodynamic laws and principles to the analysis of processes, cycles and thermodynamic hardware	3											
CO2	**Analyze** and investigate the laws and principles of thermodynamics and use to solve problems	3											
CO3	**Solve** thermodynamics problems by appraising given information, determining which concepts apply, and then provide and verify an appropriate solution		3										
CO4	**Analyze** heat transfer by conduction, convection and radiation.		3										
CO5	**Analyze** and calculate heat and mass transfer in complex systems involving several heat transfer mechanisms			2									

Justification for CO-PO mapping:

Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1	**3**	In order to identify the basics of thermodynamic tools and equipment, the knowledge of engineering fundamental would be required.
CO2-PO1	**3**	In order to perform the experiments, the law of thermodynamics knowledge would be required

CO3-PO2	**2**	In order to solve the thermodynamics problems, the knowledge of engineering fundamentals is also required.
CO4-PO2	**3**	In order to analyze heat and mass transfer in complex systems problem analysis skills are required.
CO5-PO3	**2**	To analyze and calculate heat transfer in complex syst ems involving several heat transfer mecl nisms design and development of solutions is required.

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical	28
	Total 42
Self-Directed Learning	
Preparation of Lab Reports	10
Preparation of Lab Test	10
Preparation of presentation	5
Preparation of Quiz	10
Engagement in Group Projects	20
Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Total	112

TEACHING METHODOLOGY
Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE	
Week-1	Expt-01: (a) Determination of flash point of liquid gel (b) Study of sling psychrometer
Week-3	Expt-02: Viscosity test of liquid substance
Week-5	Expt-03: Study and calibration of pressure gauge by dead weight tester
Week-7	Expt-04: (a)Concept of pressure and pressure sensor behavior (b) Study of different Speed Measuring devices
Week-9	Expt-05: Determination of thermal conductivity of a metal by steady state method
Week-11	Expt-06: Study of heat transfer by radiation and convection
Week-13	Expt-07: Study of heat exchanger
Week-14	Quiz Test

Components	**Grading**

<table>
<tr><td rowspan="2">Continuous Assessment (60%)</td><td>Lab participation and Report</td><td>30%</td></tr>
<tr><td>Labtest-1, Labtest-2</td><td>30%</td></tr>
<tr><td colspan="2">Lab Quiz</td><td>40%</td></tr>
<tr><td colspan="2">Total Marks</td><td>100%</td></tr>
</table>

REFERENCE BOOKS
1. Thermodynamics: An Engineering Approach - Yunus A. Cengel, Michael A. Boles 2. Fundamentals of Engineering Thermodynamics- Michael J. Moran &Howard N. Shapiro. 3. Fundamentals of Thermodynamics – R E Sonntag, C. Borgnakke, G J. Van Wylen. 4. Heat and Mass Transfer, Fundamentals & Applications –Yunus A. Cengel, Afshin J. Ghajar. 5. Heat Transfer Laboratory Practice-A.C. Mandal & M.Q. Islam

Course Code: IPE 271 **Course Name:** Engineering Mechanics & Mechanics of Machinery
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: Level 2/ Term II
Curriculum Structure: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:
To familiarize students with the principles of static equilibrium by applying Newton's laws of motion to solve engineering problems. Accentuation is set on drawing free body diagrams. Topics incorporate introduction to forces; 2D equilibrium of particles and rigid bodies; center of gravity and centroids; friction; analysis of truss structures; and moments of inertia. Some of the topics covered are pure kinematics (a mathematical description of motion only), while others are kinetic (determine motion in problems involving the concepts of force and energy). The course is restricted to 2-D (planar) mechanisms. Also, they will understand the basic of mechanism, linkages, gears and gear trains, cams, etc.

Objectives:

1. Introduction to the construction of "Free Body Diagrams" of real-world problems and apply Newton's Laws of motion and vector operations to assess equilibrium of particles and bodies

2. To apply the principles of equilibrium of particles and bodies to analyze the forces in planar truss members and structures.
3. To discuss the concepts of center of gravity, centroids and moment of inertia and apply the concepts to compute their location for bodies of arbitrary shape
4. Explain basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts)
5. Explain and be able to apply other basic dynamics concepts - the Work-Energy principle, Impulse-Momentum principle and the coefficient of restitution
6. To determine the balancing of masses of rotating and reciprocating machine elements
7. To determine the forces and power calculations for brakes, cams, and dynamo-meter

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Explain** the force systems of planar truss members, structures	C1-C2			1, 2, 3	T, M, F
CO 2	**Determine** location of center of gravity, centroids and moment of inertia of bodies of arbitrary shape.	C3	1		1, 2, 3	F
CO 3	**Apply** fundamental concepts of kinematics and kinetics of particles and rigid bodies to the analysis of simple, practical problems.	C2-C3	1		1, 3	T, M, F
CO 4	**Develop** the capacity to predict the effects of force and motion while carrying out the creative design functions of engineering	C2-C3	1		1, 3	T, M, F, ASG
CO 5	Gain knowledge of gears and gear trains and **solve** different problems of gear trains, cams, and dynamometer.	C2-C3	1, 2	2	3, 4, 5	T, M, F, ASG
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; M- Mid; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

a. Main Contents:

Basic concepts of mechanics; Properties of forces; Analysis of structures; Equilibrium of rigid bodies; Statical determinacy; Power transmission; Moments of inertia; Kinematics; Mechanisms; Cams and cam followers.

b. Detailed Contents:

1 **Basic concepts of mechanics:** Free body diagrams; statics of particles and rigid bodies; centroids of lines, areas (planar areas, composite areas) and volumes;
2 **Properties of forces:** Concurrent / coplanar / non-coplanar force systems, resultant of forces, resolution of forces, rectangular and polar components of forces in plane and 3-D space;
3. **Analysis of structures:** Forces in trusses, frames and machines, zero force members; forces in cables; friction;
4. **Equilibrium of rigid bodies:** Conditions for maintaining equilibrium in 2 and 3-D;
5. **Statical determinacy:** Identification of known forces and solution of unknown reactions for a structure, combined loads, application of equilibrium equations for statical determinacy
6. **Power transmission:** By belts and ropes, analysis of slippage (dry friction)
7. **Moments of inertia:** Of areas and masses; moments of force in vector notation; equivalent force system; parallel-axis theorem for determination of rotational inertia about a different axis; polar moments of inertia; couples and resultant of force-couple systems; principal axes and principal moments of inertia;
8. **Kinematics:** Kinematics of particles; Kinetics of particles: Newton's second law; energy and momentum method; System of particles; Kinematics of rigid bodies; Plane motion of rigid bodies: forces and acceleration; Energy and momentum methods; Velocity and acceleration in mechanism.
9. **Mechanisms:** Turning moment: inertia and kinetic energy of reciprocating and rotating parts; Static and dynamic balancing: reciprocating and rotating parts, multi-cylinder in-line and V-engines, radial engines, and opposed-piston engines; Balancing machines.
10. **Study of cams and cam followers**; Clutches and brakes; Dynamometers; Study of gears and gear trains; Gyroscope; Principles and applications.

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcome											
		1	2	3	4	5	6	7	8	9	10	11	12
CO 1	**Explain** the force systems of planar truss members, structures **(PO: 1, 2)**	H	H										
CO 2	**Determine** location of center of gravity, centroids and moment of inertia of bodies of arbitrary shape. **(PO: 1, 2)**	H	H										
CO 3	**Apply** fundamental concepts of kinematics and kinetics of particles and rigid bodies to the analysis of simple, practical problems. **(PO: 1, 2, 3)**	H	H										
CO 4	Develop the capacity to predict the effects of force and motion while	H	H										

	carrying out the creative design functions of engineering **(PO: 1, 2)**												
CO 5	Gain knowledge of gears and gear trains and **solve** different problems of gear trains, cams, and dynamometer. **(PO: 1, 2, 3, 12)**	H	H	H									H

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	42
Practical/ Tutorial/ Studio	-
Student-centred learning	-
Self-directed learning	
Non face-to-face learning	14
Revision	21
Assessment preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	122

Teaching methodology:
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Lecture Schedule:

Week	Topics
1	Free body diagrams; statics of particles and rigid bodies

2	Centroids of lines, areas (planar areas, composite areas) and volumes;
3	Concurrent / coplanar / non-coplanar force systems, resultant of forces, resolution of forces, rectangular and polar components of forces in plane and 3-D space;
4	Forces in trusses, frames and machines, zero force members; forces in cables; friction;
5	Conditions for maintaining equilibrium in 2 and 3-D
6	Identification of known forces and solution of unknown reactions for a structure, combined loads, application of equilibrium equations for statical determinacy
7	Power transmission by belts and ropes, analysis of slippage (dry friction)
8	Moments of inertia of areas and masses; moments of force in vector notation; equivalent force system; parallel-axis theorem for determination of rotational inertia about a different axis;
9	Polar moments of inertia; couples and resultant of force-couple systems; principal axes and principal moments of inertia;
10	Kinematics of particles; Kinetics of particles: Newton's second law; energy and momentum method; System of particles; Kinematics of rigid bodies;
11	Plane motion of rigid bodies: forces and acceleration; Energy and momentum methods; Velocity and acceleration in mechanism.
12	Turning moment: inertia and kinetic energy of reciprocating and rotating parts; Static and dynamic balancing: reciprocating and rotating parts, multi-cylinder in-line and V-engines, radial engines, and opposed-piston engines; Balancing machines.
13	Study of cams and cam followers; Clutches and brakes; Dynamometers;
14	Study of gears and gear trains; Gyroscope; Principles and applications.

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class test 1-3	20%	CO 1-4	C 1-4, A 1-2, P 1-2
	Class Participation	5%	CO 1-2	C 1-4, A 1-2, P 1-2
	Mid term	15%	CO 1-4	C 1-6, P 1-4
Final Exam		60%	CO 1-5	C 1-6, P 1-4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Vector Mechanics for Engineers: Statics– Ferdinand P. Beer, E Russell Johnston, Jr; Publisher – McGraw-Hill Companies, 5th edition 1988.
2. Engineering Mechanics Statics (10th Edition)– R.C. Hibbeler

3. Vector Mechanics for Engineers: Dynamics – Ferdinand P. Beer, E Russell Jr. Johnston Engineering Mechanics, Statics and Dynamics – Joseph F Shelley
4. Engineering Mechanics Dynamics – R.C. Hibbeler.
5. Theory of Machines (S. I. Units) – R. S. Khurmi, J. K. Gupta, Publisher – Eurasia Publishing house (Pvt) Ltd.
6. Mechanics of Machines (Advanced theory and examples) 2nd edition (SI units) – John Hannah and R. C. Stephens.

Reference Site:

Google Classroom (to be announced)

Course Code: IPE 301 **Course Name:** Measurement, Instrumentation and Control
Credit Hour: 3.00 **Contact Hour:** 3.00

Level/Term: L-3, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Rationale:

To develop understanding to collaborate the mechanical instrumentation & control system knowledge with electrical measurement concepts.

Objective:

1. To conduct study on basic system models, control, and measurement system models.
2. To conduct a case study on the development of an accurate model with the model-reference system.
3. To study the methods of calculation and measurement of efficiency level of control system elements.

Course Outcomes (CO):

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods

CO 1	**Design** for Test and Built-in Self Test methodologies, Automatic Test Equipment architectures and operation .	C1-C4	1	2	1	T, Mid Term Exam, F
CO 2	**Implement** the understanding of concepts and applications of test technology.	C1-C4	1	1	1	T, Mid Term Exam, F
CO 3	**Develop** prototype test systems for the given semiconductor devices using specified instrumentation and measurement tools.	C3, C4	2	1	2	T, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

Introduction to fundamentals of engineering measurements, study and use of instrumentation, and control systems. Linear measuring system, instruments limits, fits and gauges: ISO system of limits and fits. Precision dimensional measurement of length and angles, roundness profiles and flatness, surface roughness and texture, wear Taylor's principles on limit gauges, Abbey's principle, measuring threads, gears, measurement, ultrasonic measurement, measurement by light-wave interference, electrical and electronic measurement, digital recording by LASER beam dimension measuring system, opto-electronic, dimensional gauging, non-destructive testing methods (NDT methods), inspection and kinds of inspection, testing and calibration testing of gauges, dynamic measurement.

The characteristics and use of analogue and digital instrumentation applicable to industrial engineering problems, statistical methods for developing system specifications, basic concepts of modern instrumentation.

Concepts and importance of control system, control system description, state variable and transfer function representation, sensitivity, concepts of feedback-the feedback control system, electromechanical controls, digital computer control.

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge **PO1**	Problem Analysis **PO2**	Design / Development of Solutions **PO3**	Investigation **PO4**	Modern Tool Usage **PO5**	The Engineer and Society **PO6**	Environment and Sustainability **PO7**	Ethics **PO8**	Communication **PO9**	Individual and Team Work **PO10**	Life Long Learning **PO11**	Project Management and **PO12**
CO1	**Design** for Test and Built-in Self Test methodologies, Automatic Test Equipment architectures and operation.	H		**M**									
CO2	**Implement** the understanding of concepts and applications of test technology.		**H**			L							
CO3	**Develop** prototype test systems for the given semiconductor devices using specified instrumentation and measurement tools.	**L**		**H**									

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	

Lecture Practical / Tutorial / Studio Student-Centred Learning	42 10 -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	137

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture schedule:

Week 1	**Introduction**	**ASSESSMENT**
Class 1	Introductory concept of Measurement system.	**ASG, Class Test 1, F**
Class 2	Basic concept of the control systems.	

Class 3	Response of a system.	
Week 2	**Sensors and Transducers**	
Class 4	Basic Structures of Sensors and transducers.	
Class 5	Working principles of different types of sensors	
Class 6	Working principles of different types of sensors	
Week 3		
Class 7	Working principles of different types of sensors	
Class 8	Working principles of different types of transducer	**ASG, Class Test 2, F**
Class 9	Working principles of different types of transducer	
Week 4	**Basic System models**	
Class 10	Mathematical modeling of basic system models.	
Class 11	Mathematical modeling of basic system models.	
Class 12	Mathematical modeling of basic system models.	
Week 5		
Class 13	Mechanical and electrical system building blocks	
Class 14	Mechanical and electrical system building blocks	
Class 15	Fluid and Thermal system building blocks	
Week 6	**System models**	
Class 16	Basic engineering system	

Class 17	Basic engineering system.	**ASG, Mid Term, F**
Class 18	Rotational-translational systems.	
Week 7		
Class 19	Rotational-translational systems.	
Class 20	Electromechanical and hydromechanical systems.	
Class 21	Electromechanical and hydromechanical systems.	
Week 8	**Basic system models**	**ASG, Class Test 3, F**
Class 22	Mathematical modeling of basic system models.	
Class 23	Mechanical and electrical system building blocks.	
Class 24	Fluid and Thermal system building blocks.	
Week 9	**Dynamic Response of a system**	
Class 25	Modelling dynamic systems	
Class 26	Modelling dynamic systems	
Class 27	First-order and second-order systems.	
Week 10		
Class 28	First-order and second-order systems.	**ASG, F**
Class 29	Performance measures for second-order systems.	
Class 30	Performance measures for second-order systems.	
Week 11	**System Transfer functions**	

Class 31	Basic knowledge of transfer function.	
Class 32	Designing various system transfer function	
Class 33	Designing various system transfer function	
Week 12	**Programmable Logic Controller**	
Class 34	Basic Pricipal and application of PLC	
Class 35	Basic Stucture of PLC	
Class 36	Basic Stucture of PLC	
Week 13		
Class 37	Programming of PLC	
Class 38	Programming of PLC	
Class 39	Programming of PLC	
Week 14		
Class 40	Review	
Class 41	Review	
Class 42	Review	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
	Test 1-3	20%	CO 1	C1-C4
			CO 3	C2-C4

Continuous Assessment (40%)			CO 2	C2
	Class Participa tion	5%	CO 2	C3, C4
			CO 3	A3
	Mid term	15%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
Final Exam		60%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
			CO 2	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Reference Books:

1. W.Bolton, *Industrial control and instruentation,* Longman Scientific &Technical.
2. J. P. Holman, Publisher, *Experimental Methods for Engineers (6 th edition)*, Mc Graw – Hill Inc.
3. ThomasG.Beckwith, RoyD. Marangoni, John H. Lientar, *Mechanical Measurements (5 th edition).*

Course Code: IPE 302 **Course Name:** Measurements and Instrumentation Sessional
Credit Hour: 0.75 **Contact Hour:** 1.50

Level/Term: L-3, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: Concurrent with IPE 301 Measurements and Instrumentation

Rationale:

To create the opportunity to have the full knowledge of electrical control system and mechanical engineering.

Objective:

1. To expose students to different mechanical and electrical instrumentation system along with their applicability.
2. To conduct detailed study on the applicability of computer based digital control technique, through electronic and electric interfaces, to mechanical engineering problems.
3. To introduce the various tools used in electrical and mechanical machines and their performance.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Differentiate** mechanical and electrical system along with their applicably	C2-C5	1	2	1	T,Q,R,F
CO 2	**Derive** expressions for computer based digital control technique through electronic and electric interfaces, to mechanical engineering problems..	C4-C6	2	2	1	T,Q,R,F
CO 3	**Explain** with reference to tools used in electrical and mechanical machines and their performance.	C3-C5	1	1	2	T,Q,R,F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

Sessional work based on course IPE 301.

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Differentiate mechanical and electrical system along with their applicably	H		L				**M**					
CO2	Derive expressions for computer based digital control technique through electronic and electric interfaces, to mechanical engineering problems..		**H**			L							
CO3	Explain with reference to tools used in electrical and mechanical machines and their performance.	**L**			**H**								

(H – High, M- Medium, L-low)

Teaching-learning and

Assessment Strategy: Lab performances, Lab Report/Assignment/Presentation, Lab Test/ Quiz

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	16
Practical / Tutorial / Studio	16
Student-Centred Learning	10
Self-Directed Learning	
Non-face-to-face learning	40
Revision	10
Assignment Preparations	20
Formal Assessment	
Continuous Assessment	5
Final Examination	1
Total	118

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Exams, Feedback at every step.

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom’s Taxonomy
Components		Grading		
Continuous Assessment (70%)	Weekly Reports	20%	CO 1	C2-C5
			CO 2	C4-C6
	Class Participation	10%	CO 2	C4-C6
			CO 3	C3-C5
	Viva	30%	CO 1	C2-C5
			CO 2	C4-C6
Final Exam		40%	CO 1	C2-C5
			CO 2	C4-C6
			CO 3	C6, A3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text & Reference Books:

1. W.Bolton, Industrial control and instrumentation, Longman Scientific &Technical.
2. J. P. Holman, Publisher, Experimental Methods for Engineers (6 th edition), Mc Graw – Hill Inc.
3. ThomasG.Beckwith, RoyD. Marangoni, John H. Lientar, Mechanical Measurements (5 th edition).

Course Code: IPE 303 **Course Name:** Product Design I
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-3, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites:
(1) IPE 105: Engineering Materials
(2) IPE 207: Engineering Economy
(3) ME 160: Mechanical Engineering Drawing
(4) IPE 243: Mechanics of Solids
(5) IPE 271: Engineering Mechanics and Theory of Machines

Synopsis/Rationale:

This Outcome Based Education (OBE) based course, with its co-requisite laboratory sessional IPE 304, is part of a series of two courses IPE 303 and IPE 307 (Product Design II) designed to introduce students to the systematic engineering approach to developing new/re-designed products of utility. It emphasizes economic, functional, aesthetic, market-demand etc. factors involved in successful product design. In addition environmental and human aspects are highlighted. The unique combination of theory and hands-on sessional work engenders, among the students, the concept of sustainable, ethical and economic design of useful engineering products for societal benefit.

Objectives:

1. To analyze functional characteristics of a product to be designed
2. To design and assess solutions to existent complex problems and societal needs
3. To analyze the societal and environmental impacts of a designed product or service
4. To critically review extant literature and case studies in order to explicate product, process or service failure, and suggest remedies
5. To develop and demonstrate ethical judgment based on moral principles

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Interpret and explain** the functional aspects and characteristics of a product using the basic principles of science and engineering.	C1-C4	1		1	T, Mid Term Exam, F
CO 2	**Propose** optimum design solutions to complex mechanical engineering problems and **assess** their viability in terms of societal, economic and environmental benefits.	C3, C4	1		1	ASG, Mid Term Exam, F
CO 3	**Review and analyze** the impact of engineering products, processes or services on society and environment by applying knowledge of	C2-C4	2	1	2	ASG, Mid Term Exam, F

	engineering, basic economic analysis and environmental science.					
CO 4	**Review** practical engineering case studies from extant literature to **identify** probable effective solutions to posed problems and **explain** reasons of failure in engineering design.	C2			1	T, ASG, R, F
CO 5	**Demonstrate** commitment towards class ethics	A3	1			ASG, PR, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

Course Contents:

Functional Aspects: product functionality, environment and human factors in design, value engineering, design morphology, quality function development, understanding customer needs, establishing product function specification, specification development, concept generation and evaluation.

Industrial Product Development: The process of product development, Product planning, Managing customer and technical specifications, Revision of product concept development materials selection, Product architecture development. Product Rendering techniques: sketching and editing, Applied design with model building, Advanced solid modeling and surface modeling in 3D-CAD and SolidWorks, Simulation of mechanical movement, animation, photo rendering, top-down-design and generating drawings.

Mechanical Design and Failure Analysis: Designing of machine elements: Temporary and Permanent joints; Screw and nut-bolt joints, welding and soldering; Strength analysis of joints, Design and analysis of clamps and fixtures, Design and analysis of power and line shafts, bearings, supports, Design and analysis of power and line shafts, bearings, supports, Keys and coupling design and analysis, Gear and power-train design, Categorization and analysis of failure types: tensile, brittle, fatigue etc., Analysis of product failure and stress concentrations

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcomes (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12

CO1	**Interpret and explain** the functional aspects and characteristics of a product using the basic principles of science and engineering. (**PO: 1**)	H											
CO2	**Propose** optimum design solutions to complex mechanical engineering problems and **assess** their viability in terms of societal, economic and environmental benefits. (**PO: 2, 3, 5, 10**)		H	H		M					M		
CO3	**Review and analyze** the impact of engineering products, processes or services on society and environment by applying knowledge of engineering, basic economic analysis and environmental science. (**PO: 2, 6, 7**)		H				H	H					
CO4	**Review** practical engineering case studies from extant literature to **identify** probable effective solutions to posed problems and **explain** reasons of failure in engineering design. (**PO: 1, 2, 4, 11, 12**)	H	H		H							H	M
CO5	**Demonstrate** commitment towards class ethics (**PO: 8**)								H				

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Revision	20
Assignment Preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	Lec 1 Lec 2 Lec 3	Introduction: Functional aspects of a product, environment and human factors in design, value engineering	**Class Test 1, ASG**
2	Lec 4 Lec 5 Lec 6	Design morphology, quality function development, understanding customer needs	
3	Lec 7 Lec 8 Lec 9	Establishing product function specification, specification development	
4	Lec 10 Lec 11 Lec 12	Concept generation and evaluation	**Class Test 2, ASG, PR**
5	Lec 13 Lec 14 Lec 15	Industrial product development: The process of product development, Product planning, Managing customer and technical specifications	
6	Lec 16 Lec 17 Lec 18	Revision of product concept development and materials selection, Product architecture development. Product Rendering techniques: sketching and editing	
7	Lec 19 Lec 20 Lec 21	Applied design with model building, Advanced solid modeling and surface modeling in 3D-CAD **Review for Mid-term Exam**	
8	Lec 22 Lec 23 Lec 24	Designing of machine elements: Temporary and Permanent joints; Screw and nut-bolt joints, welding and soldering; Strength analysis of joints	**Mid Term**
9	Lec 25 Lec 26 Lec 27	Design and analysis of clamps and fixtures	
10	Lec 31 Lec 32 Lec 33	Design and analysis of power and line shafts, bearings, supports	
11	Lec 28 Lec 29	Keys and coupling design and analysis, Gear and power-train design	

	Lec 30		**Class Test 3, ASG, R, PR, F**
12	Lec 34 Lec 35 Lec 36	Categorization and analysis of failure types: tensile, brittle, fatigue etc.	
13	Lec 37 Lec 38 Lec 39	SolidWorks designing and Simulation of mechanical movement, animation, photo rendering, top-down-design and generating drawings. Analysis of product failure and stress concentrations	
14	Lec 40 Lec 41 Lec 42	Reporting and presentation of preliminary product ideas using multi-media resources and simulation **Review for Final Exam**	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

<table>
<tr><th colspan="3">Assessment Strategies</th><th rowspan="2">CO</th><th rowspan="2">Bloom's Taxonomy</th></tr>
<tr><th colspan="2">Components</th><th>Grading</th></tr>
<tr><td rowspan="8">Continuous Assessment (40%)</td><td rowspan="3">Test 1-3</td><td rowspan="3">20%</td><td>CO 1</td><td>C1-C4</td></tr>
<tr><td>CO 3</td><td>C2-C4</td></tr>
<tr><td>CO 4</td><td>C2</td></tr>
<tr><td rowspan="2">Class Participation</td><td rowspan="2">5%</td><td>CO 2</td><td>C3, C4</td></tr>
<tr><td>CO 5</td><td>A3</td></tr>
<tr><td rowspan="3">Mid term</td><td rowspan="3">15%</td><td>CO 1</td><td>C1-C4</td></tr>
<tr><td>CO 2</td><td>C3, C4</td></tr>
<tr><td>CO 3</td><td>C2-C4</td></tr>
<tr><td colspan="2" rowspan="4">Final Exam</td><td rowspan="4">60%</td><td>CO 1</td><td>C1-C4</td></tr>
<tr><td>CO 2</td><td>C3, C4</td></tr>
<tr><td>CO 3</td><td>C2-C4</td></tr>
<tr><td>CO 4</td><td>C2</td></tr>
<tr><td colspan="2">Total Marks</td><td>100%</td><td colspan="2"></td></tr>
</table>

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

a) Fundamentals of Mechanical Component Design - Kenneth S. Edwards, Robert B. McKee
b) Shigley's Mechanical Engineering Design - Richard Budynas, Keith Nisbett
c) The Mechanical Design Process - David Ullman

Reference Site:

https://classroom.google.com/ (To be announced)

COURSE INFORMATION			
Course Code Course Title	IPE 307 Product Design II	Lecture Contact Hours Credit Hours	3.00 (per week) 3.00
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
RATIONALE			
To conduct in depth study on the process of imagining, creating, and iterating products that solve users' problems or address specific needs in a given market.			
OBJECTIVE			

1. To expose students to the working process of developing a product based on market demand.
2. To explain the procedure of selecting the design criteria and designing a product.
3. To conduct detailed study on house of quality and operating mechanisms of developing a product.
4. To introduce with reverse engineering process.
5. To expose students to prototype designing and designing of engineering systems involving shafts, bearings, linkages, couplings, clutches brakes, gears, power transmission etc.

LEARNING OUTCOMES& GENERIC SKILLS

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Design a product based on market demand.	C1-C3	1		3	T, Mid Term ,F
CO2	Explain the feasibility of a designed product.	C4, P4	3	2		Mid Term Exam,F
CO3	Familiar with different stages of developing a product during mass production.	C1, C4	2	5	3	Mid Term Exam,F
CO4	Derive the most stable process of producing a product.	P4, C4	3	5	1, 3	Mid Term Exam,F
CO5	Define product life cycle of a product based on marketing**.**	P4, C1, C4	3	2	2	Mid Term Exam,F
CO6	Derive the most significant parameters through DOE**.**	C1, C4	2	5	2, 6	Mid Term ,F

(CP- Complex Problems; CA-Complex Activities; KP-Knowledge Profile; T – Test; F – Final Exam)

COURSE CONTENT

Reverse engineering, alternative solutions and their evaluation, designing for assembly and disassembly, reliability, use of standard parts, application of CAD software. DOE and DOP. Product life cycle and cost analysis.

Prototype design, designing of engineering systems involving shafts, bearings, linkages, couplings, clutches brakes, gears, power transmission etc.

SKILL MAPPING

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Design a product based on market demand.	√	√										
CO2	Explain the feasibility of a designed product.	√	√	√									
CO3	Familiar with different stages of developing a product during mass production.	√	√										

CO4	Derive the most stable process of producing a product.	√	√										
CO5	Define product life cycle of a product based on marketing**.**	√											
CO6	Derive the most significant parameters through DOE**.**	√	√										

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	16
Revision	21
Assessment Preparations	22
Formal Assessment	
Continuous Assessment	2
Final Examination	3

Total	106

TEACHING METHODOLOGY

Lectures, class performances, assignments, class tests, final exam.

COURSE SCHEDULE

Week	Lecture	Topics	Remarks
1	1	Introduction and details about Reverse engineering.	CT 1 to be held on these topics
	2	Introduction and details about Reverse engineering. (continued).	
2	1	Alternative solutions and their evaluation.	
	2	Alternative solutions and their evaluation (continued).	
3	1	Designing for assembly and disassembly.	
	2	Designing for assembly and disassembly (continued).	
4	1	Reliability, use of standard parts.	
	2	Reliability, use of standard parts (continued).	
5	1	Application of CAD software.	CT 2 to be held on these topics
	2	Application of CAD software (continued).	
6	1	DOE and DOP.	
	2	DOE and DOP (continued).	
7	1	Product life cycle and cost analysis.	
	2	Product life cycle and cost analysis (continued).	Midterm Exam
8	1	Prototype design.	CT 3 to be held on these topics
	2	Prototype design (continued).	

9	1	Designing of engineering systems involving shafts.	
	2	Designing of engineering systems involving bearings.	
10	1	Designing of engineering systems involving bearings (continued).	
	2	Designing of engineering systems involving linkages.	CT 4 to be held on these topics
11	1	Designing of engineering systems involving couplings.	
	2	Designing of engineering systems involving couplings (continued).	
12	1	Designing of engineering systems involving clutches brakes.	
	2	Designing of engineering systems involving clutches brakes (continued).	
13	1	Designing of engineering systems involving gears.	
	2	Designing of engineering systems involving power transmission.	
14	1	Designing of engineering systems involving power transmission (continued).	
	2	Course Review.	

ASSESSMENT STRATEGY

Components		Grading	CO
Continuous Assessment (40%)	Test 1-3	20%	CO 1
			CO 2
			CO 3
	Class Participation	5%	CO 1
			CO 3

	Mid term	15%	CO 4
			CO 5
Final Exam		60%	CO 4
			CO 5
			CO 6
Total Marks		100%	

REFERENCE BOOKS

1. Fundamentals of Mechanical Component Design - Kenneth S. Edwards, Robert B. McKee.
2. The Mechanical Design Process - David Ullman.
3. Shigley's Mechanical Engineering Design - J. Keith Nisbeth, Richard G. Budynas.

Course Code: IPE 308 **Course Name:** Product Design Sessional
Credit Hour: 1.50 **Contact Hour:** 0.75
Level/Term: L-3, T-2
Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: IPE 303 Product Design I
IPE 307 Product Design II

Synopsis/Rationale:

This sessional course, follows the Outcome Based Education (OBE) guidelines. It is designed to reinforce the concept of systematic engineering approach to developing new/re-designed products and to give hands-on training to students of third year.

The sessional course is aligned with the theory course IPE 303 and builds students' skills in identifying customer requirements through effective questionnaire development and to use concepts such as functional decomposition, house of quality, applied mechanics, aesthetics, and economic viability in order to design a product to meet customer's expectations. Therefore, this course addresses on of the most important challenges an industrial engineer might face in his/her career, i.e. to design and develop new products and services for the marketplace and society.

As all engineering disciplines and outcomes of engineering activities have impact on the society and environment, this course also strives to inculcate moral values and ethical decision making in its systematic product design approach.

Objectives:

1. To analyze and understand functional characteristics and necessary considerations, based on customers' expectation, in the systematic design of a product
2. To model and evaluate probable design options in a systematic manner using physical tests and computer software in order to address customer and societal needs
3. To gain practical experience in the fabrication of products and in the use of materials
4. To develop and inculcate ethical judgment in students pertaining to product design with regards to societal and environmental impacts

Course Outcomes (CO) Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Interpret** and **evaluate** customer requirements and **transform** them into engineering specifications for **determining** required process and materials to realize the specifications using engineering knowledge and computer tools	C2-C5	1	2	1	Pr, R
CO2	**Design** the product by solid modeling and **analyze** its structural performance using Finite Element Analysis (FEA)	C4-C6	2	2	1	ASG, R Pr
CO3	**Apply** cost analysis to select the appropriate material and production process for fabrication in order to meet customer, societal and environmental requirements	C3-C5	1	1	2	ASG
CO4	**Implement** lean manufacturing and other viable existent techniques throughout the design and production process	C3	2	1,2	1	R
CO5	**Function** in group setting to **fabricate** the final product and **communicate** its benefits and limitations to stakeholders; while being	C6, A3	1	1		PR, Pr, R

	cognizant of the product’s environmental impact					
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Name of the sessions:

1. Introduction, Understanding Customer Requirements
2. Quality Function Deployment (QFD), Functional Decomposition
3. Design Analysis
4. Material Selection, Process Selection
5. Finite Element Analysis using Ansys, Ansys Software Practice
6. Cost Analysis
7. Final Presentation & Project Submission

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcome**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Interpret** and **evaluate** customer requirements and **transform** them into engineering specifications for **determining** required process and materials to realize the specifications using engineering knowledge and computer tools **(PO: 1, 2, 5, 9)**	H	H			M				H			
CO2	**Design** the product by solid modeling and **analyze** its structural performance using Finite Element Analysis (FEA) **(PO: 1, 3, 5)**	M		H		H							
CO3	**Apply** cost analysis to select the appropriate material and production process for fabrication in order to meet customer, societal and environmental requirements **(PO: 2, 7)**		M					H					
CO4	**Implement** lean manufacturing and other viable existent techniques throughout the design and production process **(PO: 1, 3, 5)**	M		H		M							
CO5	**Function** in group setting to **fabricate** the final product and **communicate** its benefits and								H	H	H		

	limitations to stakeholders; while being cognizant of the product's environmental impact **(PO: 8-10)**												

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	-
Practical / Tutorial / Studio	28
Student-Centred Learning	10
Self-Directed Learning	
Non-face-to-face learning	40
Revision	10
Assignment/Report Preparations	20
Formal Assessment	
Continuous Assessment	5
Final Examination	-
Total	113

Teaching Methodology:

Lectures, class work, weekly reports, presentation, final report, Problem Based Method, Multi-media Presentation, Visualization using Computer Simulations, Assignments, Feedback at every step.

Lecture Schedule:

Week 1	**Introduction, Understanding Customer Requirements**
	Understanding Customer needs, Gathering & prioritizing needs
We	**Quality Function Deployment (QFD), Functional Decomposition**
	Incorporating the Voice of Customer in product design with Quality Function Deployment (QFD), Functional decomposition, Modular design-Basic Clustering method
Week 5	**Design Analysis**
	Design analysis of a product
Week 7	**Material Selection, Process Selection**
	Alternative material and manufacturing process selection & select best with weighted average method
Week 9	**Finite Element Analysis using Ansys, Ansys Software Practice**
	Finite Element method & introduction to Ansys Software, Other mechanical testing
Week 11	**Cost Analysis**
	Cost Analysis

Week 13	Final Presentation & Project Submission
	Final Presentation, project submission

Linkage of Course Outcomes with Assessment Methods and their Weights:

<table>
<tr><th colspan="3">Assessment Strategies</th><th rowspan="2">CO</th><th rowspan="2">Bloom's Taxonomy</th></tr>
<tr><th colspan="2">Components</th><th>Grading</th></tr>
<tr><td rowspan="8">Continuous Assessment (70%)</td><td rowspan="3">Weekly Reports</td><td rowspan="3">20%</td><td>CO 1</td><td>C2-C5</td></tr>
<tr><td>CO 2</td><td>C4-C6</td></tr>
<tr><td>CO 4</td><td>C3</td></tr>
<tr><td rowspan="2">Class Participation</td><td rowspan="2">10%</td><td>CO 2</td><td>C4-C6</td></tr>
<tr><td>CO 3</td><td>C3-C5</td></tr>
<tr><td rowspan="3">Presentation</td><td rowspan="3">40%</td><td>CO 1</td><td>C2-C5</td></tr>
<tr><td>CO 2</td><td>C4-C6</td></tr>
<tr><td>CO 5</td><td>C6, A3</td></tr>
<tr><td colspan="2" rowspan="4">Final Report</td><td rowspan="4">30%</td><td>CO 1</td><td>C2-C5</td></tr>
<tr><td>CO 2</td><td>C4-C6</td></tr>
<tr><td>CO 4</td><td>C3</td></tr>
<tr><td>CO 5</td><td>C6, A3</td></tr>
<tr><td colspan="2">Total Marks</td><td>100%</td><td colspan="2"></td></tr>
</table>

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Product Design - Kevin Otto & Krinstin wood
2. Product Design - Mike Baxter
3. Mechanical Design Process - David G. Ullmean
4. Mechanical Design - Peter R. N. Childs
5. Shigley's Mechanical Engineering Design - Richard Budynas, Keith Nisbett

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 305 **Course Name:** Operations Research
Credit Hour: 4.00 **Contact Hour:** 4.00
Level/Term: L-3, T-1
Curriculum Structure: Outcome Based Education (OBE)
Pre-requisites: (1) MATH 103: Differential Equation and Matrix

(2) MATH 201: Vector Analysis, Laplace Transformation and Co-ordinate geometry
(3) CSE 281: Computer Programming Techniques
(4) IPE 205: Probability and Statistics

Rationale:

The purpose of this course is to provide students with optimization techniques to get the most out of any engineering endeavors and minimize cost, time, resources and maximize benefits of engineering projects.

Objectives:

1. Be able to define an organization problem including specifying the objectives and parts of the system that must be analyzed before the problem is solved.
2. Be able to collect data to estimate the values of parameters that affects the above problem.
3. Be able to develop a mathematical model of the problem.
4. Given the model, the student will be able to choose the alternative that best meets the objectives.
5. Be able to understand the sensitivity analysis of an optimum solution.
6. Be able to present the results and conclusions to an organization.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Interpret and explain** the fundamental concepts of mathematical optimization	C1-C2	1		1	T, Mid Term Exam, F
CO2	**Review** the mechanics of different optimization models and when to use them	C3-C4	1		1	ASG, Mid Term Exam, F
CO3	**Review and analyze** complex engineering projects mathematically and minimize costs while maximizing benefits	C3-C6	2	1	2	ASG, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Introduction to Operations Research: Origins and Nature of OR Studies, OR Modelling Approach, **Introduction to Linear Programming**: Prototype Example, The Linear Programming Model, Formulating Linear Programming Model

Introduction to Simplex Method: Graphical Method, The Algebra of Simplex Method , Simplex Method in Tabular Form, Post Optimality Analysis, Duality Theory: Introduction to Duality Theory , Primal Dual Relationships ,The Role of Duality Theory , Sensitivity Analysis, Other Algorithms for Linear Programming , Linear Programming Practice

Transportation and Assignment Problem: Introduction to Transportation Problems , Case Studies and Properties Of, Transportation Problem , Transportation Simplex , Methods for BF Solution, Assignment Problem , Case Study and Hungarian Method , Practice Problems , **Network Optimization**: Shortest Path Problem , Minimum Spanning Trees , Maximum Flow Problem

Integer Programming: Introduction to Integer Programming, Prototype Example, The, Branch and Bound Algorithm, Branch and Bound In MIP

Nonlinear Programming: One, Variable Unconstrained Optimization, Multivariable Unconstrained Optimization, Constraint Program , The Karush Kuhn Tucker Condition , Case Studies and Practice

Game Theory: Case Study and Two Person Zero Sum Game, Solving Simple Games, Games with Mixed Strategies

Markov Chains: Introduction to Markov Chains, Stochastic Processes, Chapman-Kolomorogov Equation

Queueing Theory: Introduction to Queuing Theory, The Birth and Death Process , Case Studies and, Practice Problems.

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge PO1	Problem Analysis PO2	Design / Development of Solutions PO3	Investigation PO4	Modern Tool Usage PO5	The Engineer and Society PO6	Environment and Sustainability PO7	Ethics PO8	Communication PO9	Individual and Team Work PO10	Life Long Learning PO11	Project Management and Finance PO12
CO1	**Interpret and explain** the fundamental concepts of mathematical optimization	H			**M**	**M**	**L**					**M**	**L**
CO2	**Review** the mechanics of different optimization models and when to use them	**H**	**M**	**M**	**M**	**H**	**L**	**M**		**L**	**L**	**H**	**L**
CO3	**Review and analyze** complex engineering projects mathematically and minimize costs while maximizing benefits	**H**	**H**	**H**	**H**	**H**	**M**	**M**		**M**	**H**	**H**	**H**

(H – High, M- Medium, L- Low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	56
Practical/ Tutorial/ Studio	-
Student-centred learning	-
Self-directed learning	
Non face-to-face learning	18
Revision	23
Assessment preparations	20
Formal Assessment	
Continuous Assessment	4
Final Examination	3
Total	124

Teaching methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	Introduction to Operations Research	**Class Test 1**
	Lec 2	Origins and Nature of OR Studies	
	Lec 3	OR Modelling Approach	
	Lec 4	OR Modelling Approach (Contd.)	
2	Lec 5	Introduction to Linear Programming	
	Lec 6	Prototype Example	
	Lec 7	The Linear Programming Model	

	Lec 8	Formulating Linear Programming Model	
3	Lec 9	Introduction to Simplex Method	
	Lec 10	Graphical Method	
	Lec 11	The Algebra of Simplex Method	
	Lec 12	Simplex Method in Tabular Form	
4	Lec 13	Simplex Method Continued	**Class Test 2**
	Lec 14	Post Optimality Analysis	
	Lec 15	Introduction to Duality Theory	
	Lec 16	Primal Dual Relationships	
5	Lec 17	The Role of Duality Theory	
	Lec 18	Sensitivity Analysis	
	Lec 19	Other Algorithms for Linear Programming	
	Lec 20	Linear Programming Practice	
6	Lec 21	Introduction to Transportation Problems	
	Lec 22	Case Studies and Properties Of Transportation Problem	
	Lec 23	Transportation Simplex	
	Lec 24	Methods for BF Solution	
7	Lec 25	Transportation Simplex Continued	
	Lec 26	Assignment Problem	
	Lec 27	Case Study and Hungarian Method	
	Lec 28	Practice Problems	
8	Lec 29	Network Optimization	**Mid Term / Project**
	Lec 30	Shortest Path Problem	
	Lec 31	Minimum Spanning Trees	
	Lec 32	Maximum Flow Problem	
9	Lec 33	Introduction to Integer Programming	
	Lec 34	Prototype Example	
	Lec 35	The Branch and Bound Algorithm	
	Lec 36	Branch and Bound In MIP	
10	Lec 37	Nonlinear Programming	**Class Test 3**

	Lec 38	One Variable Unconstrained Optimization	
	Lec 39	Multivariable Unconstrained Optimization	
	Lec 40	Constraint Program	
11	Lec 41	The Karush Kuhn Tucker Condition	
	Lec 42	Case Studies and Practice	
	Lec 43	Game Theory	
	Lec 44	Case Study and Two Person Zero Sum Game	
12	Lec 45	Solving Simple Games	
	Lec 46	Games With Mixed Strategies	
	Lec 47	Introduction to Markov Chains	**Class test 4**
	Lec 48	Stochastic Processes	
13	Lec49	Chapman-Kolomorogov Equation	
	Lec50	Introduction to Queuing Theory	
	Lec51	The Birth and Death Process	
	Lec 52	Case Studies and Practice Problems	
14	Lec 53	Review and Practice	
	Lec 54		
	Lec 55		
	Lec 56		

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class test 1-4	20%	CO 1	C1-C3, P1-P2
			CO 2	C4-C5, P3-P4
	Class Participation	5%	CO 1	C2, P2
			CO 2	C4, P5
	Mid term	15%	CO 1	C1-C3, P1-P2
			CO 2	C4-C5, P3-P4

			CO 3	C5-C6, P5
Final Exam		60%	CO 1	C1-C3, P1-P2
			CO 2	C4-C5, P3-P4
			CO 3	C5-C6, P5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Introduction to Operations Research 8th edition- Hillier Lieberman
2. Operations Research-Hamdy A.Taha

Course Code: IPE 306 **Course Name:** Operations Research Sessional
Credit Hour: 0.75 **Contact Hour:** 1.50
Level/Term: L-3, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: Concurrent with IPE 305 Operations Research

Synopsis/Rationale:

This sessional course, concurrent with IPE 305 Operations Research, follows the Outcome Based Education (OBE) guidelines. The course is intended to give students the skills necessary to implement optimization models and solve those models using various solution techniques. Students will use computer software and programming language to implement the modeling and solving techniques taught in IPE 305 theory course.

Objectives:

1. To achieve the necessary skills to use computer modeling languages.
2. To solve those models using various optimization solvers.
3. To gain practical experience in modelling of a physical process and data collection, analysis, and wrangling

4. To develop the skills in students to interpret the results and implement those results in a practical scenario.

Course Outcomes (CO) Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Analyze** practical business and industry problems to develop mathematical model	C2-C5	1	2	1	PR, Pr, Q
CO 2	**Implement** the models using a computer modelling language	C4-C6	2	2	1	ASG, PR,Q
CO 3	**Apply** a suitable solver software to solve the aforementioned problems	C3-C5	1	1	2	ASG, Q
CO 4	**Analyze** the results of the model and **interpret** their implication in a practical scenario	C3	2	1,2	1	P. PR
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:
Introduction to modelling: Introduction to AMPL and its interface, CPLEX and its functions

Linear Programming: simplex method, duality theory, sensitivity analysis

Integer Programming: Binary programming, mixed integer programming, pure integer programming

Transportation Problems: Transportation simplex, assignment problem, Hungarian method

Network Optimization: Shortest Path Problem , Minimum Spanning Trees , Maximum Flow Problem
Nonlinear Programming: One, Variable Unconstrained Optimization, Multivariable Unconstrained Optimization, Constraint Programming
Game Theory: Two Person Zero Sum Game, Solving Simple Games, Games with Mixed Strategies
Markov Chains: Introduction to Markov Chains, Stochastic Processes, Chapman-Kolomorogov Equation
Queueing Theory: Introduction to Queuing Theory, The Birth and Death Process

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcome											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Analyze** practical business and industry problems to develop mathematical model	H			**M**	**M**	**L**					**M**	**L**
CO2	**Implement** the models using a computer modelling language	**H**	**M**	**M**	**M**	**H**	**L**	**M**		**L**	**L**	**H**	**L**
CO3	**Apply** a suitable solver software to solve the aforementioned problems	**H**	**H**	**H**	**H**	**H**	**M**	**M**		**M**	**H**	**H**	**H**
CO4	**Analyze** the results of the model and **interpret** their implication in a practical scenario	M		H		M				M	H	H	H

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	-
Practical / Tutorial / Studio	14
Student-Centred Learning	5
Self-Directed Learning	
Non-face-to-face learning	20
Revision	5
Assignment/Report Preparations	20
Formal Assessment	
Continuous Assessment	5
Final Examination	-
Total	71

Teaching Methodology:

Lectures, class work, project, presentation, final report, Problem Based Method, Multi-media Presentation, Assignments, Feedback at every step.

Lecture Schedule:

Week 1	Introduction to modelling
Class 1	Introduction to AMPL and its interface, CPLEX and its functions
Week 2	**Linear Programming**
Class 2	simplex method, duality theory, sensitivity analysis
Week 3	**Integer Programming**

Class 3	Binary programming, mixed integer programming, pure integer programming
Week 4	**Transportation Problems**
Class 4	Transportation simplex, assignment problem, Hungarian method
Week 5	**Network Optimization**
Class 5	Shortest Path Problem, Minimum Spanning Trees , Maximum Flow Problem
Week 6	**Nonlinear Programming**
Class 6	One, Variable Unconstrained Optimization, Multivariable Unconstrained Optimization, Constraint Programming
Week 7	**Project Proposal**
Class 7	Project Proposal
Week 8	**Quiz**
Class 8	Quiz
Week 9	**Game Theory**
Class 9	Two Person Zero Sum Game, Solving Simple Games, Games with Mixed Strategies
Week 10	**Markov Chains**
Class 10	Introduction to Markov Chains, Stochastic Processes, Chapman-Kolomorogov Equation
Week 11	**Queueing Theory**
Class 11	Introduction to Queuing Theory, The Birth and Death Process
Week 12	**Review**
Class 12	Review Class
Week 13	**Quiz**
Class 13	Final Quiz
Week 14	**Project submission and Presentation**
Class 14	Final Presentation

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (70%)	Weekly Assignments	15%	CO 1	C1-C3, P1-P2
			CO 2	C4-C5, P3-P4
			CO 4	C2, P2
	Class Participation	5%	CO 2	C4, P5
			CO 3	C1-C3, P1-P2
	Project and Presentation	40%	CO 4	C4-C5, P3-P4
			CO 5	C5-C6, P5
			CO 6	C1-C3, P1-P2
Quiz		40%	CO 1	C2-C5
			CO 2	C4-C6
			CO 3	C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

3. Introduction to Operations Research 8th edition- Hillier Lieberman
4. Operations Research-Hamdy A.Taha

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 309 **Course Name:** Material Handling and Maintenance Management

Credit Hour: 3.00 **Contact Hour:** 3.00

Level/Term: L-3, T-2

Curriculum Structure: Outcome-Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

This Outcome-Based Education (OBE) based course is designed to introduce students to the systematic materials handling approach. It emphasizes a feasible process to conduct an in-depth study on the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption, and disposal, also different types of maintenance and their feasibility.

Objectives:

1. To explain the issues and importance of handling of materials.
2. To expose students to handling processes based on materials.
3. To conduct a detailed study on designing concepts of common handling and transfer equipment.
4. To introduce different types of the maintenance process.
5. To explain the feasibility study of different processes of particular maintenance work.

Course Outcomes (CO) & Generic Skills:

No.	**Course Learning Outcome**	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Familiar with different types of conveyors and their power consumption.	C1-C3	1		3	T, Mid Term, F
CO2	Explain different material handling systems and their efficiency.	C4	3	2	1, 3	T, Mid Term Exam,F
CO3	Design system configuration conforming to various kinds of product features and layout characteristics.	C1, C4	2	5		Mid Term Exam, F
CO4	Design of warehouse facilities appropriate for relevant handling and transfer devices.	P4, C4	3	5	3	Mid Term Exam,F
CO5	Familiar with the concept of maintenance and value of maintenance management.	P4, C1, C4	3	2	2	Mid Term Exam,F
CO6	Implement different maintenance planning.	C1, C4	2	5	2, 6	Mid Term ,F
(CP- Complex Problems; CA-Complex Activities; KP-Knowledge Profile; T-Test; F – Final Exam)						

Course Contents:

Issues and importance of handling materials: analysis of material handling problems, classification of materials, unit load, bulk loads, a study of material handling systems and their efficiency, selection, and classification of material conveying equipment.

Product handling: design system configuration conforming to various kinds of product features and layout characteristics.

Designing concepts of common handling and transfer equipment, different types of conveyors such as belt, screw, chain, flight, bucket elevators, pneumatic hydraulic cranes and forklifts, design of warehouse facilities appropriate for relevant handling and transfer device, automatic packaging devices: testing procedure of packages: vibration test, drop test, performance limits and testing machines, algorithms to design and analyze discrete parts material storage and flow system such as automated storage/retrieval system (ASRS), order picking, automated guided vehicle system (AGVS).

Maintenance management: the concept of maintenance and value of maintenance management, maintenance organization and department structure (resource and administration), types of maintenance, fixed time replacement, condition-based maintenance, preventive and corrective maintenance, replacement strategies, documentation and computer control in maintenance management, Implementation of maintenance planning, plant asset management, human factors in a maintenance environment.

Mapping of Course Outcomes and Program Outcomes:

(H – High, M- Medium, L-low)

Teaching Methodology:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life-Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Familiar with different types of conveyors and their power consumption.	H	H		H								
CO2	Explain different material handling systems and their efficiency.			H		H							
CO3	Design system configuration conforming to various kinds of product features and layout characteristics.		H	H	H							M	
CO4	Design of warehouse facilities appropriate for relevant handling and transfer devices.		H	H								M	H
CO5	Familiar with the concept of maintenance and value of maintenance management.	H	H			H							

CO6	Implement different maintenance planning.				H								H

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multimedia Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	1	Issues and importance of handling of materials: analysis of material handling problems.	
	2	Issues and importance of handling of materials: analysis of material handling problems (continued).	
2	1	Issues and importance of handling of materials: analysis of material handling problems (continued).	
	2	Classification of materials, unit load, bulk loads, a study of material handling systems, and their efficiency.	
3	1	Classification of materials, unit load, bulk loads, a study of material handling systems, and their efficiency (continued).	CT 1 to be held on these topics
	2	Classification of materials, unit load, bulk loads, a study of material handling systems, and their efficiency (continued).	
4	1	Selection and classification of material conveying equipment.	
	2	Selection and classification of material conveying equipment (continued).	
5	1	Selection and classification of material conveying equipment (continued).	
	2	Product handling: design system configuration conforming to various kinds of product features and layout characteristics.	

6	1	Product handling: design system configuration conforming to various kinds of product features and layout characteristics (continued).	CT 2 to be held on these topics, ASG, PR
	2	Product handling: design system configuration conforming to various kinds of product features and layout characteristics (continued).	
7	1	Designing concepts of common handling and transfer equipment, different types of conveyors such as belt, screw, chain, flight, bucket elevators, pneumatic hydraulic cranes, and forklifts.	
	2	Designing concepts of common handling and transfer equipment, different types of conveyors such as belt, screw, chain, flight, bucket elevators, pneumatic hydraulic cranes, and forklifts (continued).	
8	1	Designing concepts of common handling and transfer equipment, different types of conveyors such as belt, screw, chain, flight, bucket elevators, pneumatic hydraulic cranes, and forklifts. (continued).	CT 3 to be held on these topics
	2	Designing concepts of common handling and transfer equipment, different types of conveyors such as belt, screw, chain, flight, bucket elevators, pneumatic hydraulic cranes, and forklifts (continued).	
9	1	Design of warehouse facilities appropriate for relevant handling and transfer device, automatic packaging devices: testing procedure of packages.	
	2	Design of warehouse facilities appropriate for relevant handling and transfer device, automatic packaging devices: testing procedure of packages (continued).	
10	1	Algorithms to design and analyze discrete parts material storage and flow system such as automated storage/retrieval system (ASRS), order picking, automated guided vehicle system (AGVS).	

	2	Maintenance management: the concept of maintenance and value of maintenance management, maintenance organization, and department structure.	
11	1	Maintenance management: the concept of maintenance and value of maintenance management, maintenance organization, and department structure (continued).	CT 4 to be held on these topics, ASG, PR
	2	Types of maintenance, fixed time replacement, condition-based maintenance, preventive and corrective maintenance.	
12	1	Types of maintenance, fixed time replacement, condition-based maintenance, preventive and corrective maintenance (continued).	
	2	Replacement strategies, documentation, and computer control in maintenance management.	
13	1	Replacement strategies, documentation, and computer control in maintenance management (continued).	
	2	Implementation of maintenance planning, plant asset management, human factors in motivation skills in a maintenance environment.	
14	1	Implementation of maintenance planning, plant asset management, human factors in motivation skills in a maintenance environment (continued).	
	2	Course Review.	

(PR – Project; ASG – Assignment)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1 - C4
			CO 3	C2 - C4
			CO 4	C2

	Class Participation	5%	CO 2	C3, C4
			CO 5	C2
	Midterm	15%	CO 2	C1 - C4
			CO 3	C3, C4
Final Exam		60%	CO 1	C1 – C4
			CO 2	C3, C4
			CO 3	C2 – C4
			CO 4	C2
			CO 5	C2 – C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Manufacturing Facilities Design & Material Handling - Fred E. Meyers.
2. Conveyors and Related Equipment - A. SPIVAKOVSKY & V. DYACHKOV.
3. Maintenance, Replacement, and Reliability – A K S Jardine.

Reference Site:

https://classroom.google.com/ (**To be announced**)

Course Code: IPE 310 **Course Name:** Material Handling and Maintenance Management Sessional

Credit Hour: 0.75 **Contact Hour:** 3.00 (per 2 weeks)

Level/Term: L-3, T-2

Curriculum Structure: Outcome-Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

This Outcome-Based Education (OBE) based course is designed to introduce students to the systematic materials handling approach. It emphasizes feasible handling processes to conduct in a study on the control and storage of materials and products throughout manufacturing, warehousing, distribution, consumption, and disposal in an industry.

Objectives:

1. To characterize the properties of materials and explain their impact on the design of storage and conveying systems.
2. To introduce the student with design and select conveyor for designated material handling systems.
3. To expose students to handling processes based on materials.
4. To explain the feasibility study of different processes of particular maintenance work.
5. To familiarize with different types of conveyor.

Course Outcomes (CO) & Generic Skills:

No.	**Course Learning Outcome**	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Familiar with different types of conveyors and their power consumption.	C1-C3	1		3	DW, DR
CO2	Explain different material handling systems and their efficiency.	C4	2	2		DW, DR
CO3	Design system configuration conforming to various kinds of product features and layout characteristics.	C1, C4	3	2	2	DW, DR
CO4	Design of a conveyor for a specific material	C4	2	5	2, 6	PR
CO5	Familiar with the concept of maintenance and their feasibility.	C1, C4	3	5	3	DW, DR
(DW- Daily Work, DR – Daily Report, PR – Project, ASG – Assignment, Pr – Presentation, R – Report)						

Course Contents:

Issues and importance of handling materials: analysis of material handling problems, classification of materials, unit load, bulk loads, a study of material handling systems and their efficiency, selection, and classification of material conveying equipment.

Product handling: design system configuration conforming to various kinds of product features and layout characteristics.

Designing concepts of common handling and transfer equipment, different types of conveyors such as belt, screw, chain, flight, bucket elevators, pneumatic hydraulic cranes and forklifts, design of warehouse facilities appropriate for relevant handling and transfer device, automatic packaging devices: testing procedure of packages: vibration test, drop test, performance limits and testing machines, algorithms to design and analyze discrete parts material storage and flow system such as automated storage/retrieval system (ASRS), order picking, automated guided vehicle system (AGVS).

Maintenance management: the concept of maintenance and value of maintenance management, maintenance organization and department structure (resource and administration), types of maintenance, fixed time replacement, condition-based maintenance, preventive and corrective maintenance, replacement strategies, documentation and computer control in maintenance management, Implementation of maintenance planning, plant asset management, human factors in a maintenance environment.

Mapping of Course Outcomes and Program Outcomes:

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)

Course Learning Outcomes		Engineering Knowledge PO1	Problem Analysis PO2	Design / Development of PO3	Investigation PO4	Modern Tool Usage PO5	The Engineer and Society PO6	Environment and Sustainability PO7	Ethics PO8	Communication PO9	Individual and Team Work PO10	Life-Long Learning PO11	Project Management and PO12
CO1	Familiar with different types of conveyors and their power consumption.	H			H								
CO2	Explain different material handling systems and their efficiency.		H	H		H					H		
CO3	Design system configuration conforming to various kinds of product features and layout characteristics.		H	H	H								
CO4	Design of a conveyor for a specific material			H								M	H
CO5	Familiar with the concept of maintenance and their feasibility.	H	H							M			

Face-to-Face Learning	
Lecture	21

Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	7
Revision	14
Assessment Preparations	7
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	54

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multimedia Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics
1	1	Study and Determination of the Capacity of a Belt Conveyer.

3	3	Study and Determination of the parameters of a bucket conveyor.
5	5	Study and Determination of the Capacity of a screw Conveyer.
7	7	Study and Determination of the parameters of a roller conveyor.
9	9	Maintenance management and control
11	11	Final Assessment & Viva
13	13	Final Quiz

(PR – Project; ASG – Assignment; Pr – Presentation; R- Report)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (70%)	Weekly Reports	20%	CO 1	C2 - C4
			CO 2	C4 – C6
			CO 4	C3
	Class Participation	10%	CO 2	C4 – C6
			CO 3	C3 – C5
	Presentation	40%	CO 1	C2 – C5
			CO 5	C6, A3
Final Report		30%	CO 1	C2- C5
			CO 2	C3, C4
			CO 3	C4 – C6
			CO 4	C3
			CO 5	C6, A3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Manufacturing Facilities Design & Material Handling - Fred E. Meyers.
2. Conveyors and Related Equipment - A. SPIVAKOVSKY & V. DYACHKOV.
3. Maintenance, Replacement, and Reliability – A K S Jardine.

Reference Site:

https://classroom.google.com/ (**To be announced**)

Course Code: IPE 311 **Course Name:** Operations Management
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-3, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Rationale:
To develop an understanding of and an appreciation for the production and operations management function in any organization.

Objective:

1. To be cognizant of the strategic role of operations management in creating and enhancing a firm's competitive advantages
2. To comprehend key concepts and issues of OM in both manufacturing and service organizations
3. To comprehend the interdependence of the operations function with the other key functional areas of a firm
4. To apply analytical skills and problem-solving tools to the analysis of the operations problems

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods

CO1	**Identify** and **evaluate** the processes, tools and principles of operations management to better understand the logistics and supply chain operations.	C1-C5	1		1	T, F
CO2	**Explain** and **evaluate** the quality processes in manufacturing and service sector to improve the operational performance.	C2, C4, C5	1		1	ASG, T, F
CO3	**Identify** future challenges and directions that relate to operations management to effectively and efficiently respond to market changes.	C2	1		1	ASG, Mid Term Exam, F
CO4	**Identify** the processes needed to develop a new product from identifying the customer needs to delivering the final product.	C2	1		1	T, ASG, F
CO5	**Apply** the tasks, tools and underlying principles of operations management in the manufacturing and service sectors to improve organizational performance	C3	1,2,3		2,3	ASG, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

Integrated purchase-production-marketing system, production systems, product/service life cycle, forecasting models, bill of materials, material and inventory management: inventory models, ABC analysis, coding and standardization, aggregate planning, MPS, MRP, capacity planning, operating scheduling.

Work study: MRP II, optimized production technology, group technology, TQC and JIT.

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**Identify** and **evaluate** the processes, tools and principles of operations management to better understand the logistics and supply chain operations.	H											
CO2	**Explain** and **evaluate** the quality processes in manufacturing and service sector to improve the operational performance.	H			**M**	**M**							
CO3	**Identify** future challenges and directions that relate to operations management to effectively and efficiently respond to market changes.	H			M	**M**							

CO4	**Identify** the processes needed to develop a new product from identifying the customer needs to delivering the final product.	H		**H**	**M**	**M**							
CO5	**Apply** the tasks, tools and underlying principles of operations management in the manufacturing and service sectors to improve organizational performance	**H**				**M**						**M**	

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Revision	20
Assignment Preparations	20
Formal Assessment	

Continuous Assessment	2
Final Examination	3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture schedule:

Week 1	**Introduction to Operations Management**	CT 1
Class 1	Concept and definition of Operations Management.	
Class 2	The Scope of Operations Management	
Class 3	Operations Management and Decision Making	
Week 2	**Forecasting**	
Class 4	Features Common to All Forecasts	
Class 5	Steps in the Forecasting Process	
Class 6	Approaches to Forecasting	
Week 3	**Forecasting**	
Class 7	Forecasts Based on Time-Series Data	
Class 8	Associative Forecasting Techniques	
Class 9	Choosing a Forecasting Technique	
Week 4	**Work Design and Measurement**	CT 2
Class 10	Job Design	
Class 11	Motion Study	
Class 12	Work Measurement	
Week 5	**Aggregate Planning and Master Scheduling**	

Class 13	Introduction and Basic Strategies for Meeting Uneven Demand,	
Class 14	Techniques for Aggregate Planning,	
Class 15	Master Scheduling	
Week 6	**MRP**	
Class 16	An Overview of MRP	
Class 17	MRP Inputs, MRP Processing, MRP Outputs	
Class 18	MRP II, Capacity Requirements Planning	
Week 7	**ERP**	CT 3
Class 19	An Overview of MRP	
Class 20	ERP in Services.	
Class 21	An Overview of SAP	
Week 8	**Inventory Management**	
Class 22	An Overview of Inventory Management	
Class 23	Inventory Ordering Policies	
Class 24	How Much to Order: Economic Order Quantity Models	
Week 9	**Inventory Management**	
Class 25	How Much to Order: Fixed-Order-Interval Model,	
Class 26	The Single-Period Model	
Class 27	Operations Strategy	
Week 10	**JIT and Lean Operations**	CT 4
Class 28	Lean Tools	
Class 29	Transitioning to a Lean System	
Class 30	An Overview of JIT	
Week 11	**Scheduling**	
Class 31	Scheduling in Low-Volume Systems,	

Class 32	Scheduling Services	
Class 33	Operations Strategy	
Week 12	**Location Planning and Analysis**	
Class 34	Global Locations	
Class 35	Identifying a Country, Region, Community, and Site	
Class 36	Evaluating Location Alternatives	
Week 13	**Quality Control**	
Class 37	Statistical Process Control	
Class 38	Process Capability	
Class 39	Inspection	
Week 14	**Management of Quality**	
Class 40	The Foundations of Modern Quality Management: The Gurus	
Class 41	1st Review Class	
Class 42	2nd Review Class	

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies	CO	Bloom's Taxonomy

Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1-C5
			CO 2	C2,C4,C5
			CO 4	C2
	Class Participation	5%	CO 2	C3, C4
			CO 5	A3
	Mid term	15%	CO 3	C2
Final Exam		60%	CO 1	C1-C5
			CO 2	C2, C4,C5
			CO 3	C2
			CO 4	C2
			CO 5	C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Reference Books:

Stevenson, W. J., Hojati, M., & Cao, J. (2007). *Operations management* (Vol. 8). Boston: McGraw-Hill/Irwin.

Render, B., & Heizer, J. (1997). *Principles of operations management* (pp. 518-520). Prentice Hall.

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 313 **Course Name:** Quality Management

Credit Hour: 3.00 **Contact Hour:** 3.00

Level/Term: L-3, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: IPE 205 (Probability and Statistics)

Rationale:

The main course's objective is to teach students the fundamentals of quality management system and facilitate professional exposure.

Objective:

1. To describe how quality is quantified in industries and how decisions are taken based upon that.
2. To analyze the critical parameters of a quality control to implement this in practice.
3. To understand the detailed phases of quality management and their long-term control

Course Outcomes (CO) & Generic Skills:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Develop** in-depth knowledge on various tools and techniques of quality control .	C1-C4	1	2	1	T, Mid Term Exam, F
CO 2	**Learn** the applications of quality tools and techniques in both manufacturing and service industry	C1-C4	1	1	1	T, Mid Term Exam, F
CO 3	**Prepare** for Six Sigma Yellow Belt (SSYB) professional certification exam	C3, C4	2	1	2	T, Mid Term Exam, F
CO 4	**Apply** quality engineering knowledge in real world problem; implemented in Minitab statistical software	C2-C4			1	T, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

Emergence of modern concept of quality and its management, Deming’s principle on quality and productivity, quality costs and their interpretation, DMAIC

Methodologies: Six Sigma, Lean Manufacturing, 8D, FMEA, Control Plan, 7 tools for Quality, 7 wastes.

Control and measurement concept of quality: elementary SPC tools-PDCA cycle, Pareto’s law, cause and effect (fishbone), control charts-attribute control charts and variable control charts, design of experiments- identification of key variables for major variations, Acceptance sampling plans

Failure mode and effect analysis, reliability testing. Quality standards and their compliance, ISO 9000 and ISO 14000, foundations of quality revised – total quality management (TQM), application of TQM philosophy, frontiers of quality.

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**Develop** in-depth knowledge on various tools and techniques of quality control	H		**M**									
CO2	**Learn** the applications of quality tools and techniques in both manufacturing and service industry		**H**	**M**	L								
CO3	**Prepare** for Six Sigma Yellow Belt (SSYB) professional certification exam						**L**					**H**	**M**

CO4	**Apply** quality engineering knowledge in real world problem; implemented in Minitab statistical software	**L**		**H**	**M**								

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	10
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Revision	20
Assignment Preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	137

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week 1	**Management & Quality tools**	**ASSESSMENT**
Class 1	DMAIC	
Class 2	Six Sigma	
Class 3	Six Sigma	

Week 2		
Class 4	Lean Manufacturing	
Class 5	Control Plan	**ASG, Class Test 1, F**
Class 6	Control Plan	
Week 3		
Class 7	7 wastes	
Class 8	PDCA	
Class 9	Root cause	
Week 4		**ASG, Mid Term, F**
Class 10	QFD	
Class 11	ISO 9001, ISO 14001	
Class 12	SPC tools – 7 tools of Quality (Pareto law, Fishbone diagram & so on)	
Week 5	**Control Chart**	
Class 13	Attribute & Variable Control Chart	
Class 14	Attribute & Variable Control Chart	
Class 15	Attribute & Variable Control Chart	
Week 6		
Class 16	Special Control Chart	
Class 17	Special Control Chart	
Class 18	Special Control Chart	
Week 7	**Process Capability & Specifications**	**ASG, Class Test 3, F**
Class 19	$\square_{\square}$, $\square_{\square\square}$	
Class 20	Quality of design, conformance and performance, Deming‟s principle on quality and productivity, quality costs and their interpretation	
Class 21	Deming‟s principle on quality and productivity, quality costs and their interpretation	
Week 8	**Sampling Plan**	
Class 22	Acceptance sampling plans: OC curves,	
Class 23	Acceptance sampling plans: OC curves,	
Class 24	Single and double sampling plants	
Week 9		

Class 25	Single and double sampling plants	
Class 26	Sequential and rectifying inspection plans AOQ.	
Class 27	Sequential and rectifying inspection plans AOQ.	
Week 10	**Design of Experiments**	
Class 28	Design of Experiments,	
Class 29	Surplus and waste management ANOVA	
Class 30	Surplus and waste management ANOVA	
Week 11	**Logistics Management**	
Class 31	Regression	
Class 32	Regression	
Class 33	Regression	
Week 12	**Reliability Engineering**	
Class 34	Quality and reliability: failure and survival probability	
Class 35	Hazard rate	
Class 36	Component and system reliability and its prediction	
Week 13	**Material Handling**	
Class 37	Failure mode and fault tree analysis	
Class 38	Failure mode and fault tree analysis	
Class 39	Reliability testing.	
Week 14	**Review**	
Class 40	Reliability testing.	
Class 41	Review	
Class 42	Review	

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1-C4
			CO 3	C2-C4
			CO 2	C2
		5%	CO 2	C3, C4

	Class Participation		CO 3	A3
	Mid term	15%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
Final Exam		60%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
			CO 2	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. *Industrial Engineering: FE Review Manual*, Brightwood Engineering Education
2. Thomas & Paul, *Six Sigma Handbook.*

Course Code: IPE 314 **Course Name:** Quality Management Sessional
Credit Hour: 0.75 **Contact Hour:** 1.50
Level/Term: Level 3/ Term II

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:

This course is concurrent with IPE 313: Quality Management, and its objective is to teach students the methods of analyzing data to make decisions related to quality control processes in industries.

Objectives:

1. To describe different patterns observed in data.
2. To generate visual representation of data.
3. To analyze the critical performance parameters of quality.
4. To make concise decisions on quality control.
5. To apply quality control tools and techniques.

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** how data analysis helps making quality control decisions	C4-C5		1	1	Pr, R
CO2	**Apply** quality control tools to assess production/service industries	C3-C6	1	2	1	Q, ASG, R
CO3	**Outline** and **explain** different methodologies of quality control	C2-C3	1	1	2	Q, ASG
CO4	**Analyze** and **compare** different process options to decide on the best one	C1-C2		1	1	Q, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Name of the experiments:

1. Introduction to Quality Control & Minitab installation
2. Describing distributions – histogram, boxplot, stem plot, time series plot, normal quartile plot, etc.
3. Familiarities with DOE
4. Inference from Regression – fits, ANOVA, correlations
5. Assessing the Quality

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcome**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** how data analysis helps making quality control decisions **(PO: 1, 2, 4, 5)**	H	M		M	H							
CO2	**Apply** quality control tools to assess production/service industries **(PO: 1, 2, 5)**	M	H			H							

CO3	**Outline** and **explain** different methodologies of quality control **(PO: 3, 5)**			H		H							
CO4	**Analyze** and **compare** different process options to decide on the best one **(PO: 1, 4, 5)**	H			M	H							

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	-
Practical/ Tutorial/ Studio	14
Student-centred learning	-
Self-directed learning	
Non face-to-face learning	9
Revision	14
Assessment preparations	18
Formal Assessment	
Continuous Assessment	1.5
Final Examination	1.5
Total	58

Teaching methodology:
Lecture and Discussion, Software Applications Based, Co-operative and Collaborative Method, Problem Based Method

Lecture Schedule:

Week	Topics
1	Experiment 1: Introduction to Quality Control & Minitab installation

3	Experiment 2: Describing distributions – histogram, boxplot, stem plot, time series plot, normal quartile plot, etc.
5	Experiment 3: Familiarities with DOE
7	Mid-term Quiz
9	Experiment 4: Inference from Regression – fits, ANOVA, correlations
11	Experiment 5: Assessing the Quality
13	Final Quiz

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Assignment	20%	CO 1-2	C 3, C 4, P 1, P 2
	Class Participation	5%	CO 2-3	C 1, A 2, P 2
	Mid Term Quiz	15%	CO 3-4	C 3-6, P 3
Final Quiz		60%	CO 3-4	C 3-6, P 3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Quality Control and Management – Ahsan Akhtar Hasin

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 315 **Course Name:** Entrepreneurship Development and Micro Industries
Credit Hour: 2.00 **Contact Hour:** 2.00
Level/Term: L-3, T-2
Curriculum Structure: Outcome Based Education (OBE)
Pre-requisites: None
Synopsis/Rationale:

Entrepreneurship Development and Micro Industries is an interdisciplinary theory course designed to demonstrate students how to think and act entrepreneurial. Students will learn how to start-up and operate a micro industry. The course will build on cross-curricular academic skills, by integrating inquiry-based learning and business tools that will enable students to analyze, create, develop, and pilot small businesses.

Objectives:

6. To understand the basic concepts in the area of entrepreneurship.
7. To recognize the role and significance of entrepreneurship for economic growth.
8. To analyze the societal and environmental impacts of entrepreneurship and micro industries.
9. To realize the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.
10. To develop the mindset of developing micro industry and create job sector for unemployed youth.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Create** the ability of **analyzing** various aspects of entrepreneurship especially of taking over the risk, and the specificities as well as the pattern of entrepreneurship development and, finally, to **contribute** to their entrepreneurial and managerial potentials.	C3, C6	1	1	3	T, Mid Term Exam, F
CO2	**Propose** optimum business solutions to complicated business problems and **evaluate** that problem based on societal and environmental prospects.	C3, C4	1	2	7	ASG, Mid Term Exam, F
CO3	**Establish** their own business as an entrepreneur which can help to reduce the unemployment problem as well as **improve** their risking handling ability.	C3-C5	3	2	6	ASG, Mid Term Exam, F
CO4	**Review and analyses** real life business case studies from external sources and create proper plan for their own business from past data analysis.	C4 - C6	7	5	5	T, ASG, R, F
CO5	**Demonstrate** loyalty in the direction of business ethics.	C3 – C6	4	1	7	ASG, PR, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

Course Contents:

Conceptual definition of entrepreneurs and entrepreneurship, Entrepreneurship in economic theory, Historical development of entrepreneurship, The importance of small business, Type of Entrepreneurship, Entrepreneur and small business, Features and types of businesses and entrepreneurs, Sources of business ideas, The role of entrepreneurship in economic development, Terms of entrepreneurship, Innovation and entrepreneurship, Entrepreneurship and small business, The life cycle of a small company, Small business sector in Bangladesh, Forms of entrepreneurial organization, Analysis on sources of capital, Entrepreneurial process, Entrepreneurial strategies, Starting a new company or buying an existing business decision making, Defining the business concept. Writing a business plan, Basics of Venture Marketing. Fundamentals of entrepreneurial management, Small industries. Business process: product design, operational art, stock management. Technical and technological analysis of entrepreneurial projects. Designing a business investment, Knowledge Economy, Entrepreneur biographies - the actual successes and failures, Business results in SMEs. Fostering the development of entrepreneurship, Entrepreneurship in Bangladesh, Entrepreneurship in transition countries, Strategic guidelines, and objectives for the development of SMEs in Developing Countries like Bangladesh.

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcomes (PO)											
		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team	Life Long Learning	Project Management and Finance
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Create** the ability of **analyzing** various aspects of entrepreneurship especially of taking over the risk, and the specificities as well as		**H**		**M**						**H**		

	the pattern of entrepreneurship development and, finally, to **contribute** to their entrepreneurial and managerial potentials.												
CO2	**Propose** optimum business solutions to complicated business problems and **evaluate** that problem based on societal and environmental prospects.		**H**	**H**	**M**			**H**					
CO3	**Establish** their own business as an entrepreneur which can help to reduce the unemployment problem as well as **improve** their risking handling ability.		**M**	**M**	**H**		**M**						
CO4	**Review and analyses** real life business case studies from external sources and create proper plan for their own business from past data analysis.		**H**	**H**								**H**	
CO5	**Demonstrate** loyalty in the direction of business ethics.								**H**				

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	28
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	20
Revision	10
Assignment Preparations	10

Formal Assessment Continuous Assessment Final Examination	 2 3
Total	118

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	Lec 1 Lec 2	Introduction to entrepreneurs and entrepreneurship, Entrepreneurship in economic theory, Historical development of entrepreneurship	**Class Test 1, ASG, F**
2	Lec 3 Lec 4	The importance of small business, Type of Entrepreneurship, Entrepreneur and small business	
3	Lec 5 Lec 6	Features and types of businesses and entrepreneurs, Sources of business ideas, The role of entrepreneurship in economic development	
4	Lec 7 Lec 8	Terms of entrepreneurship, Innovation and entrepreneurship, Entrepreneurship, and small business, The life cycle of a small company	
5	Lec 9 Lec 10	Small business sector in Bangladesh, Forms of entrepreneurial organization, Analysis on sources of capital,	
6	Lec 11 Lec 12	Entrepreneurial process, Entrepreneurial strategies, Starting a new company or buying an existing business decision making	
7	Lec 13 Lec 14	Defining the business concept. Writing a business plan, Basics of Venture Marketing	**Mid Term, F**
8	Lec 15 Lec 16	Fundamentals of entrepreneurial management, Small industries.	

9	Lec 17 Lec 18	Business process: product design, operational art, stock management, Technical and technological analysis of entrepreneurial projects	
10	Lec 19 Lec 20	Designing a business investment, Knowledge Economy, Entrepreneur biographies - the actual successes and failures	
11	Lec 21 Lec 22	Business results in SMEs. Fostering the development of entrepreneurship,	**Class Test 2, ASG, PR, F**
12	Lec 23 Lec 24	Entrepreneurship in Bangladesh, Entrepreneurship in transition countries	
13	Lec 25 Lec 26	Strategic guidelines, and objectives for the development of SMEs in Developing Countries like Bangladesh.	
14	Lec 27 Lec 28	**Review Classes**	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1, 2	20%	CO 1	C3, C6
			CO 3	C3 – C6
			CO 4	C4 – C6
	Class Participation	5%	CO 1	C3, C6
			CO 2	C3, C4
	Mid term	15%	CO 1	C3, C6
			CO 2	C3, C4
			CO 4	C4 – C6
Final Exam		60%	CO 1	C3, C6
			CO 2	C3, C4
			CO 3	C3 – C6
			CO 4	C4 – C6
			CO 5	C3 – C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

d) Essentials of Entrepreneurship and Small Business management (5/ed.): Thomas W. Zimmerer, and Norman M. Scarborough. PHI
e) Entrepreneurship: Strategies and Resources, 3/E -: Marc Dollinger; Prentice Hall
f) Entrepreneurship in Action, 2/E - Mary Coulter; Prentice Hall

Reference Site:

1. http://ediindia.ac.in/e-policy/ [Entepreneurial Policy India]
2. http://en.wikipedia.org/wiki/List_of_venture_capital_companies_in_India [Venture Capital]
3. indiavca.org/venture-capital-in-india.html [Venture Capital]
4. www.indianangelnetwork.com/ [Angel Investing]
5. www.startbizindia.in/angel_investors_india.php [ANGEL INVESTING]
6. http://www.mensxp.com/work-life/entrepreneurship/21253-51-most-successful-entrepreneurs-ofindia-p1.html [Successful Entrepreneurs]
7. economictimes.indiatimes.com/...of...entrepreneurs/.../20912945.cms [Leadership]
8. http://edition.cnn.com/2013/06/25/tech/innovation/frugal-innovation-india-inventors/ [Innovation]
9. www.bplans.com/ [BUSINESS PLAN]
10. www.entrepreneur.com/businessplan [BUSINESS PLAN]

https://classroom.google.com/ (To be announced)

Course Code: IPE 317 **Course Name:** Ergonomics and Safety Management

Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-3, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

To design and use ergonomic principles for design a better working environment for workers so that they complete their task more effectively and safely.

Objectives:

1. To increase awareness of the need for and role of ergonomics in occupational health
2. To obtain basic knowledge in the application of ergonomic principles to design of industrial workplaces and the prevention of occupational injuries
3. To understand the breadth and scope of occupational ergonomics.
4. To provide students knowledge of safety management concepts and develop students' knowledge to accept and oversee the key components of an SMS, including their implementation.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Identify, explain and evaluate** the impact of various personal attributes (anatomical, physiological, anthropometric and psychological) on proper safe working practice.	C1, C2, C5	1,3	1,2	1,2 ,6	T, Mid Term Exam, F
CO2	**Assess** the effect of physical environment factors on comfort and performance.	C4	1,4	1	2	ASG, Mid Term Exam, F
CO3	**Apply** principles of good ergonomic design of work areas and equipment to a range of occupational settings.	C3-C4	1	3	5	ASG, Mid Term Exam, F
CO4	**Explain** the influence of ergonomic principles on work organization and culture.	C4	1	4	1	T, ASG, R, F
CO5	**Demonstrate** a fundamental knowledge of the science of human factors and ergonomics and ethical responsibility in practice.	C4	2	1,4	2	ASG, PR, R, F
CO6	**Implement** safety principles in any industries.	C3, C6	1,5	1,2	5,6	ASG, PR, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Man-machine-material interfaces in manufacturing: physical and cognitive aspects, comparative advantages of man and machine, physical work and human muscular effort, bio- mechanics and bio-engineering.

Anthropometry, work place design and work place layout, human performance under environment temperature, illumination, vibration, noise, pollution radiation static and dynamic conditions.

Classification and sources of industrial fire, Types of fire detecting devices and extinguisher Fire protective equipment, National and international fire safety standards, Fire safety standards (BNBC, OSHA, NIOSH), Fire risk assessment and control technology.

Evolution of modern safety concepts, industrial hazard, safety and risk management, productivity, worker health and safety, proactive management techniques for safety management, safety standards and regulations for engineering works, case studies.

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcomes (PO)											
		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Identify, explain and evaluate** the impact of various personal attributes (anatomical, physiological, anthropometric and psychological) on proper safe working practice.	**H**	**H**	**H**		**H**					**H**		
CO2	**Assess** the effect of physical environment factors on comfort and performance.			**H**	**H**		**H**	**H**			**H**		
CO3	**Apply** principles of good ergonomic design of work areas			**H**		**H**					**M**		

	and equipment to a range of occupational settings.												
CO4	**Explain** the influence of ergonomic principles on work organization and culture. .	**H**	**M**										
CO5	**Demonstrate** a fundamental knowledge of the science of human factors and ergonomics and ethical responsibility in practice.	**H**							**H**			**L**	
CO6	**Implement** safety principles in any industries.	**H**				**H**		**H**				**M**	

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	Lec 1 Lec 2 Lec 3	Course overview, importance of this course for industrial engineers. Understanding the concept of ergonomics Man machine system and its components	
2	Lec 4 Lec 5 Lec 6	Concepts of anthropometry and its uses. Anthropometry in workstation design. Design of work surfaces and seats.	**Class Test 1, ASG, F**
3	Lec 7 Lec 8 Lec 9	Design of work surfaces and seats. Concepts of stress and strain. Study of metabolisom.	
4	Lec 10 Lec 11 Lec 12	Introduction of physiological functions. Concepts of workload and energy consumption. Biomechanics.	
5	Lec 13 Lec 14 Lec 15	Types of body movements of different body members. Strength and endurance. Speed of movements	
6	Lec 16 Lec 17 Lec 18	Concepts of the terms related to NIOSH lifting Equation. Explanation of NIOSH lifting equation. Lifting index and maximum acceptable weight and forces, application of NIOSH lifting equation.	**Class Test 2, ASG, PR, F**
7	Lec 19 Lec 20 Lec 21	Distal upper extremities risk factors, Starin index. Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA) **Review Class 1**	
8	Lec 22 Lec 23 Lec 24	Introduction to office ergonomics. Importance of study of office ergonomics. Concepts of Visual display terminals (VDT) Design consideration for VDT workstation design. Visual displays in static information, authority, display and controls. Effects of vibration, noise, temperature, and illumination on performance.	**Mid Term, F**
9	Lec 25 Lec 26 Lec 27	Introduction to existing safety codes. Ideas about safety standards. Concepts about accident prevention and control ways. Electrical safety.	

10	Lec 31 Lec 32 Lec 33	Safety in material handling, storage and portable power tools. Introduction to industrial hygiene and General concepts of workers protection. Understanding industrial hygiene. Various hazards in workplace.	
11	Lec 28 Lec 29 Lec 30	Classification and sources of industrial fire, Types of fire detecting devices and extinguisher Fire protective equipment, National and international fire safety standardsfire safety standards (BNBC, OSHA, NIOSH) Fire risk assessment and control technology	**Class Test 3, ASG, R, PR, F**
12	Lec 34 Lec 35 Lec 36	Concepts of personal protective equipment. Types of personal protective equipment. Design standards of personal protective equipment. Selection criteria of personal protective equipment.	
13	Lec 37 Lec 38 Lec 39	Introduction to risk management. Risk management process. The Risk Event Graph Principles of risk management.	
14	Lec 40 Lec 41 Lec 42	Export risk management Insurance and its application as risk distribution. **Review Class 2**	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1, 2	20%	CO 1	C1, C2, C5
			CO 3	C3-C4
			CO 4	C4
	Class Participation	5%	CO 1	C1, C2, C5
			CO 2	C4
	Mid term	15%	CO 1	C1, C2, C5
			CO 2	C4
			CO 4	C4
Final Exam		60%	CO 1	C1, C2, C5
			CO 2	C4

		CO 3	C3-C4
		CO 4	C4
		CO 5	C4
		CO 6	C3, C6
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Helander, M. (2005). A guide to human factors and ergonomics. Crc Press.Elian Stone, Jean A Samples, “Fashion Merchandising”. McGraw Hill Book company, New York, 1985.

2. Salvendy, G. (2012). Handbook of human factors and ergonomics. John Wiley & Sons.

3. Reese, C. D. (2008). Occupational health and safety management: a practical approach. CRC press.

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 318 **Course Name:** Ergonomics and Safety Management Sessional
Credit Hour: 0.75 **Contact Hour:** 1.5
Level/Term: L-3, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: Concurrent with IPE 317

Rationale:
To provide support for both research and teaching activities related to ergonomics, safety and methods engineering.

Objective:

1. To increase awareness of the need for and role of ergonomics in occupational health
2. To obtain basic knowledge in the application of ergonomic principles to design of industrial workplaces and the prevention of occupational injuries
3. To understand the breadth and scope of occupational ergonomics.
4. To provide students knowledge of safety management concepts and develop students' knowledge to accept and oversee the key components of an SMS, including their implementation.

Course Outcomes (CO) Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Design and conduct** experiments, as well as to analyse and interpret data	C3-C6	1	1,3	1,2	R
CO2	**Design** a system, component, or process to meet accepted human factors and workplace ergonomics standards within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	C3-C6	1, 2	1,2	5,6	R
CO3	**Use** the techniques, skills, and modern human factors and workplace ergonomics tools necessary for industrial and systems engineering practice. Apply tools and knowledges for creating the formal letters in career opportunities procedure.	C3-C4	1, 2	1	5,6	ASG,R
CO4	**Implement** safety principles in any industries. .	C4 – C6	1	5	6,7	PR,ASG, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

Measurement of anthropometric data using anthropometer and analysis of dada, Measurement of the ambience noise in road side hospitals or clinics using sound level meter and its consequences., Assessment of luminance in different work places using lux meter and its consequences, Measurement of pinch grip strength s data and their application in product/hand tool design and drafting, Study of industrial safety signs, types and their purposes.

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**Design and conduct** experiments, as well as to analyse and interpret data	**H**	**M**	**M**	**H**	**M**							
CO2	**Design** a system, component, or process to meet accepted human factors and workplace ergonomics standards within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	**M**	**H**	**H**									
CO3	**Use** the techniques, skills, and modern human factors and workplace ergonomics tools necessary for industrial and systems engineering practice.		**H**	**H**								**L**	

	Apply tools and knowledges for creating the formal letters in career opportunities procedure.												
CO4	**Implement** safety principles in any industries.	**H**		**H**				**M**					

(H – High, M- Medium, L-low)

<u>Lecture schedule:</u>

Week No	**Content**	**Remark**
1	Course overview, Group Selection	
3	Measurement of anthropometric data using anthropometer and analysis of dada.	
5	Measurement of the ambience noise in road side hospitals or clinics using sound level meter and its consequences.	Submit Report 1
7	Assessment of luminance in different work places using lux meter and its consequences.	Submit Report 2
9	Measurement of pinch grip strength s data and their application in product/hand tool design and drafting.	Submit Report 3
11	Study of industrial safety signs, types and their purposes.	Submit Report 4
13	**Final Quiz / Presentation**	Submit Report 5 + Final Project Report Submission

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies		CO	Bloom’s Taxonomy
Components	Grading		

Continuous Assessment (70%)	Weekly Reports	20%	CO 1	C3-C6
			CO 2	C3-C6
			CO 3	C3-C4
			CO 4	C4 – C6
	Class Participation	40%	CO 1	C3-C6
	Presentation	10%	CO 1	C3-C6
			CO 2	C3-C6
			CO 3	C3-C4
Final Project Report		30%	CO 1	C3-C6
			CO 2	C3-C6
			CO 3	C3-C4
			CO 4	C4 – C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Helander, M. (1995). A Guide to the Ergonomics of Manufacturing. London: Taylor & Francis.
2. Pheasant, S. (1991). Ergonomics, work and health. Macmillan International Higher Education.

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 320 **Course Name:** Industrial Attachment
Credit Hour: 1.00 **Contact Hour:** 4 weeks

Level/Term: L-3, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

To gain the experience of interrelating theoretical knowledge with practical experiences at industries along with developing lifetime interpersonal skills like communication, leadership, and team management and so on.

Objective:

1. To acquire knowledge of what industrial engineers do
2. To know how the Industrial and Production engineers can improve a production system
3. To be able to apply basic industrial engineering tools
4. To be able to differentiate among different production processes

Course Outcomes (CO) and Genetic Skills:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Implement** industrial and production engineering degree knowledge at industries.	C1-C4	1	2	1	PR, R
CO 2	**Analyze** basic structure of industries and processes in practice.	C1-C4	1	2	1	PR, R
CO 3	**Explain** how production planning, quality control and supply chain system works.	C3, C4	2	1	2	PR, R
CO 4	**Develop** communication, team working and other interpersonal skills.	C2-C4	2	2	1	PR, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Students have to go to different industries by some groups to know the production process and have to submit a report and also have to give an oral presentation both in the industry (if needed) and IPE department (Must). Each group has to find a case in the industry and they have to provide suitable solution to that case.

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**Implement** industrial and production engineering degree knowledge at industries.	H	L					**M**					
CO2	**Analyze** basic structure of industries and processes in practice.			**H**									L
CO3	**Explain** how production planning, quality control and supply chain system works.				**L**		**H**						
CO4	**Develop** communication, team working and other interpersonal skills.									**H**	L	**M**	

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Daily assessment by supervisor at industries	60
Presentation, Interview	3
Assessment of Industrial consulates	14
Report submitting Assessment by supervisor at Department	20 3
Total	100

Teaching Methodology:

Daily assessment by supervisor at industries, Presentation, Interview, Assessment of Industrial consulates, Assessment by supervisor at department, Report submitting.

<u>Attachment schedule:</u>

Week 1	**Introduction**
Week 2	**Individual projects assigned by industrial supervisor**
Week 3	**Individual projects assigned by industrial supervisor**
Week 4	**Presentation, Report Submitting**

Linkage of Course Outcomes with Assessment Methods and their Weights:

<table>
<tr><th colspan="3">Assessment Strategies</th><th rowspan="2">CO</th><th rowspan="2">Bloom's Taxonomy</th></tr>
<tr><th colspan="2">Components</th><th>Grading</th></tr>
<tr><td rowspan="2"></td><td rowspan="2">Daily assessment by supervisor at industries</td><td rowspan="2">20%</td><td>CO 1</td><td>C1-C4</td></tr>
<tr><td>CO 3</td><td>C2-C4</td></tr>
</table>

Continuous Assessment (50%)			CO 4	C2
	Assessment of Industrial consulates	10%	CO 2	C3, C4
			CO 4	A3
	Assessment by supervisor at Department	20%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
Presentation, Interview, Report (50%)		50%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Reference Books

As per requirements from the books suggested to important courses covered in the program.

Course Code: IPE 351 **Course Name:** Fluid Mechanics and Machinery
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: Level 3/ Term I
Curriculum Structure: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:

To introduce the students to different Fluid flow patterns and the fundamental flow cases such as free shear flows, Specific applications of these flow cases are then given through the study of internal flow systems and external flows around air, different fluid power driven machineries and components, Fluid turbo-machinery theory, performance characteristics of centrifugal and axial flow fans, compressors, pumps and turbines, fluid vibrations and sound, water hammer, introduction to fluid power controls and fluid amplifiers, operating principle and design.

Objectives:

1. To familiarize students with the essential ideas of fluid mechanics
2. To familiarize students with the conservation principles governing fluid streams
3. To be able to compute forces on bodies in liquid flows
4. To analyze the familiarity with current practice in fluid and aerodynamic measurement
5. To study the principles to a variety of real-world engineering applications including simple flow networks and pump & turbine design
6. To analyze different practical engineering machineries

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Identify** how properties of fluids change with temperature and their effect on pressure and fluid flow	C1-C2			1, 4, 6	T, M, F
CO 2	**Define** the relationship between pressure and elevation as it relates to manometers, barometers and other pressure measuring devices	C1	1		4, 6	F
CO 3	**Calculate** forces on a plane and buoyancy on a body submerged in a static fluid	C1-C2	1		2, 5, 6	T, M, F
CO 4	**Demonstrate** knowledge on different type of flows and determine sonic velocity in a fluid	C1-C3				T, M, F, ASG
CO 5	**Explain** the different fluid machines such as turbines, pumps etc.	C1-C2	1		4, 6	T, M, F, ASG
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; M- Mid; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

a. Main Contents:

Fundamental concepts; Fluid statics; Hydrostatic forces; Pressure distribution; Continuity, momentum and energy equation; Fluid kinematics; Fluid flow; Turbines; Pumps.

b. Detailed Contents:

1. Fundamental concept: Of fluid as a continuum; Fluid properties: classification of fluid flows (laminar, turbulent, real flows), density and specific gravity, compressibility and bulk modulus, viscosity, surface tension and capillarity;

2. Fluid statics: Basic hydrostatic equation, concept of hydrostatic pressure distributions in static incompressible and compressible fluids, manometry;

3. Hydrostatic forces: On floating and submerged surfaces, buoyant force, Metacenter and metacentric height, stability and buoyancy of floating and submerged bodies; Forces on plane and curved surfaces;

4. Pressure distribution: Of a fluid in a rotating system; relation between system approach and control volume approach;

5. Continuity, momentum and energy equations: special forms of energy and momentum equations and their applications (Bernoulli's equations, limitations and applications);

6. Fluid kinematics: Pressure, velocity and flow measurement devices, Lagrangian and Eulerian descriptions of fluid flow, deformation of fluid elements, Reynolds transport theorem and Reynolds number regimes, one dimensional fluid flow, incompressible and in viscid flow, two dimensional fluid flow, laminar and turbulent flows, developing and developed pipe flows, flow through converging-diverging nozzles, vorticity and rotationality;

7. Fluid flow: fundamental relations of compressible flow; Speed of sound wave; Stagnation states for the flow and ideal gas; Flow through converging – diverging nozzles; Normal shock; Real fluid flow

8. Turbines: Rotodynamic and positive displacement machines; Velocity diagrams and Euler pump/turbine equation; Impulse and reaction turbines; Centrifugal and axial flow pumps; Deep well turbine pumps; Dimensional analysis applied to fluid machinery: specific speed, unit power, unit speed, unit discharge;

9. Pumps: Performance and characteristics of turbines and pumps; Design of pumps; Cavitation; Reciprocating pump, gear and screw pumps

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcome											
		1	2	3	4	5	6	7	8	9	10	11	12
CO 1	**Identify** how properties of fluids change with temperature and their effect on pressure and fluid flow **(PO: 1, 2, 4)**	H	H		M								
CO 2	**Define** the relationship between pressure and elevation as it relates to manometers, barometers and other	H	H		M								

	pressure measuring devices **(PO: 1, 2, 4)**												
CO 3	**Calculate** forces on a plane and buoyancy on a body submerged in a static fluid **(PO: 1, 2, 3)**	H	H	H									
CO 4	**Demonstrate** knowledge on different type of flows and determine sonic velocity in a fluid **(PO: 1, 2)**	H	H										
CO 5	**Explain** the different fluid machines such as turbines, pumps etc. **(PO: 1, 2, 10)**	H	H								M		

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	42
Practical/ Tutorial/ Studio	-
Student-centred learning	-
Self-directed learning	
Non face-to-face learning	14
Revision	21
Assessment preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	122

Teaching methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Lecture Schedule:

Week	**Topics**

1	Of fluid as a continuum; Fluid properties: classification of fluid flows (laminar, turbulent, real flows), density and specific gravity, compressibility and bulk modulus, viscosity, surface tension and capillarity;
2	Basic hydrostatic equation, concept of hydrostatic pressure distributions in static incompressible and compressible fluids, manometry;
3	Hydrostatic forces- on floating and submerged surfaces, buoyant force, Metacenter and metacentric height, stability and buoyancy of floating and submerged bodies;
4	Forces on plane and curved surfaces
5	Pressure distribution - Of a fluid in a rotating system; relation between system approach and control volume approach;
6	Special forms of energy and momentum equations and their applications (Bernoulli's equations, limitations and applications);
7	Pressure, velocity and flow measurement devices
8	Lagrangian and Eulerian descriptions of fluid flow, deformation of fluid elements, Reynolds transport theorem and Reynolds number regimes,
9	One dimensional fluid flow, incompressible and in viscid flow, two dimensional fluid flow, laminar and turbulent flows, developing and developed pipe flows,
10	Flow through converging-diverging nozzles, vorticity and rotationality;
11	Fundamental relations of compressible flow; Speed of sound wave; Stagnation states for the flow and ideal gas;
12	Flow through converging – diverging nozzles; Normal shock; Real fluid flow
13	Rotodynamic and positive displacement machines; Velocity diagrams and Euler pump/turbine equation; Impulse and reaction turbines; Centrifugal and axial flow pumps; Deep well turbine pumps; Dimensional analysis applied to fluid machinery: specific speed, unit power, unit speed, unit discharge;
14	Performance and characteristics of turbines and pumps; Design of pumps; Cavitation; Reciprocating pump, gear and screw pumps

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class test 1-3	20%	CO 1-4	C 1-4, A 1-2, P 1-2
	Class Participation	5%	CO 1-2	C 1-4, A 1-2, P 1-2
	Mid term	15%	CO 1-4	C 1-6, P 1-4
Final Exam		60%	CO 1-5	C 1-6, P 1-4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Fluid Mechanics: Fundamentals and Applications by Yunus A. Cengel, John Cimbala.
2. Mechanics of Fluids by Irving Herman Shames.
3. Fluid Mechanics through Worked out Problems- A.C. Mandal & M.Q. Islam
4. Fluid Mechanics (including Hydraulic Machines) by Jain A.K
5. Hydraulic Machines – Dr. Md. Quamrul Islam

Reference Site:

Google Classroom (to be announced)

COURSE INFORMATION			
Course Code Course Title	: IPE 352 : Fluid Mechanics & Machinery Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
This course provides an introduction to the principles of fluid mechanics of mechanical systems. The focus is to illustrate practical engineering applications of these principles in relation to simple fluid systems. The learning approach is to apply engineering principles to performance analysis and prediction of simple fluid systems. This will provide a basis for understanding how performance can be improved. Student will acquire an understanding of the essential theoretical basis of the fluid mechanic sciences and their application to a range of problems of relevance to practical engineering.			
OBJECTIVE			
1. This course provides an introduction to the principles of fluid mechanics of mechanical systems. 2. The focus is to illustrate practical engineering applications of these principles in relation to simple fluid systems. 3. By the end of this course students should be able to understand the basic principles and analysis of both static and dynamic fluid systems			

LEARNING OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods

CO1	**Identify** how properties of fluids change with temperature and their effect on pressure and fluid flow.	1	C3			1	R, Q, LT
CO2	**Illustrate** practical engineering applications of these principles in relation to simple fluid systems.	1	C2			1	R, Q, LT
CO3	**Evaluate** and design fluid engineering systems	2	C5			5	R, Q, LT
CO4	**Build** simple solutions to a range of problems in basic fluid flows.	4	C3			3	R, Q, LT

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, LT – Lab Test, PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

Experiments:

Expt-01: Verification of Bernoulli's Equation

Expt-02: (a) Calibration of rectangular notch

(b) Calibration of triangular notch (V notch)

Expt-03: Study of flow through an Orifice meter and Venturi Meter (Combined)

Expt-04: Study of Pipe friction (Merged with below two)

(b) Determination of Pressure losses in different types of elbows (Different types of pipe bent)

Expt-05: (a) Introduction to Centrifugal Pump Characteristics (Merged with below three)

(b) Performance test of a single centrifugal pump

(c) Performance test of centrifugal pumps connected in series

(d) Performance test of centrifugal pumps connected in parallel

Expt-06: (a) Study of Propeller Turbine Characteristics

(b) Performance test of a Pelton wheel and Francis Turbine.

Expt-07: Study about, compressor (Single Stage and Multistage) and Blowers

CO-PO MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Identify** how properties of fluids change with temperature and their effect on pressure and fluid flow.	3											
CO2	**Illustrate** practical engineering applications of these principles in relation to simple fluid systems.	3											
CO3	**Evaluate** and design fluid engineering systems		3										
CO4	**Build** simple solutions to a range of problems in basic fluid flows.				3								

Justification for CO-PO mapping:

Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1	**3**	In order to identify the basics of fluid mechanics, the knowledge of engineering fundamental would be required.
CO2-PO1	**3**	In order to perform the experiments, practical engineering applications of these principles in relation to simple fluid systems knowledge would be required
CO3-PO2	**2**	In order to solve and design fluid engineering system, the knowledge of engineering fundamentals is also required.
CO4-PO4	**3**	For performing the experiments, basic simple solutions to a range of problems in basic fluid flows is needed.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical	28
	Total 42
Self-Directed Learning	
Preparation of Lab Reports	10
Preparation of Lab Test	10
Preparation of presentation	5
Preparation of Quiz	10
Engagement in Group Projects	20
Formal Assessment	
Continuous Assessment	14

Final Quiz	1
Total	112

TEACHING METHODOLOGY
Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE	
Week-1	Expt-01: Verification of Bernoulli's Equation
Week-3	Expt-02: (a) Calibration of rectangular notch (b) Calibration of triangular notch (V notch)
Week-5	Expt-03: Study of flow through an Orifice meter and Venturi Meter (Combined)
Week-7	Expt-04: Study of Pipe friction (Merged with below two) (b) Determination of Pressure losses in different types of elbows (Different types of pipe bent)
Week-9	Expt-05: (a) Introduction to Centrifugal Pump Characteristics (Merged with below three) (b) Performance test of a single centrifugal pump (c) Performance test of centrifugal pumps connected in series (d) Performance test of centrifugal pumps connected in parallel
Week-11	Expt-06: (a) Study of Propeller Turbine Characteristics (b) Performance test of a Pelton wheel and Francis Turbine.
Week-13	Expt-07: Study about, compressor (Single Stage and Multistage) and Blowers
Week-14	Quiz Test

Components		**Grading**
Continuous Assessment (60%)	Lab participation and Report	30%
	Labtest-1, Labtest-2	30%
Lab Quiz		40%
Total Marks		100%

REFERENCE BOOKS

1. Fluid Mechanics-1, Victor, L. Streeter.
2. Fluid Mechanics: Fundamentals and Applications by Yunus A. Cengel, John Cimbala.
3. Mechanics of Fluids by Irving Herman Shames.
4. Fluid Mechanics Through Worked out Problems- A.C. Mandal & M.Q. Islam

Course Code: IPE 400 **Course Title:** Final Year Design & Research Project

Credit Hour: 3.00 (6.00 in 2 consecutive semesters in L-4)**; Contact Hour:** 6.00

Course Curriculum: Outcome Based Education (OBE)

Pre-requisites:
(1) IPE 105: Engineering Materials
(2) IPE 207: Engineering Economy
(3) ME 160: Mechanical Engineering Drawing
(4) IPE 243: Mechanics of Solids
(5) IPE 271: Engineering Mechanics and Theory of Machines
(6) IPE 303: Product Design

Synopsis/Rationale:

This course based on Outcome Based Education (OBE) philosophy and spanning two consecutive semesters in the final year (L-4) is the culmination of engineering study and complex engineering activity for IPE students. Students have the option of pursuing a project work, designing and developing a product, or undergraduate research, which leads to a B.Sc. thesis. In both cases, a comprehensive investigation is carried out under the supervision of a qualified faculty member of the department with provisions for co-supervisors from other departments within the faculty of engineering or from a disparate discipline. It provides an opportunity for students to work largely on their own initiative (but under constant supervision), on a topic of interest for Industrial and Production Engineers. The students, in groups of 2 or 3, are challenged with existent complex engineering problems and have to develop a product or research a solution within two (2) semesters of their final academic year. The course is designed to target Blooms higher cognitive domains, especially evaluation and synthesis (C5 and C6). In addition, the engagement of students in laboratory work/research, library research and collaboration in teams means that the psychomotor and affective domains of Blooms taxonomy are also addressed. The 2 semester long project/thesis culminates in oral presentation (defense in front of external examiners), a poster/multi-media display and a written report or thesis.

Objectives:

1. To develop skills in critical review of relevant research literature and gain in-depth understanding of the related work and research findings.
2. To be able to identify gaps in the current knowledge and develop required solutions in the form of project or research findings.
3. To understand the theoretical underpinnings and procedures to be employed for completing project or research thesis.
4. To be able to design and perform experiments and utilize obtained data for research conclusions.
5. To use modern tools for simulation, modeling, experimentation and validation in order to achieve project or research goals.

6. To gain proficiency in technical written communication in order to effectively summarise project results or research findings.
7. To be competent in oral presentations delivered in public presentations and convince the examiners.
8. To develop ethical thinking and judgment, and be able to apply it during the whole project or research endeavor.

Course Outcomes (CO):

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Search** and critically **review** relevant research literature to **retrieve, assess** and **evaluate** existing research outcomes and technologies relevant to the field of research. **Demonstrate** an in-depth understanding of the related work, including an in-depth knowledge of the literature, the important authors, the related terminology, and the research findings (theories, models, structures, designs, principles etc.). (**PO: 4, 12**)	C2-C5	1	2	1	R
CO 2	**Classify, summarize, explain** and **critique** the basic findings of the literature review and **identify** gaps in the current knowledge **to develop** the required problem statements and research questions and **formulate** research hypotheses. (**PO: 1, 2, 3**)	C4-C6	1		1	R, Pr
CO 3	**Demonstrate understanding** of underlying theory, methods and procedures to be employed to complete a project or address research questions for thesis. (**PO: 1**)	C2, C3	2	1	2	R
CO 4	**Apply** proper experimental design, giving consideration to statistical significance and quality of collected data or **analyze** findings for proper project design. Accomplish the work in groups of 2 to 3 students (**PO: 2, 4, 9**)	C3, C4	1	1	1	R
CO 5	**Apply** modern tools with respect to hardware and software (where applicable) by being able **to design, develop, evaluate,** and experimentally **validate** appropriate solutions for the selected research questions. (**PO: 3, 5**)	C3-C6	1	1		R, Pr

CO 6	**Develop** proficiency in engineering / technical writing by being able to generate thesis summarising the research findings. (**PO: 9, 10**)	C6	1	2	1	R
CO 7	**Demonstrate** mastery of oral presentations by being able to deliver public presentation and **demonstrate** to examiners. (**PO: 9, 10**)	C6			1	Pr
CO 8	**Demonstrate** commitment towards ethics in all affairs pertaining to project or thesis (**PO: 8**)	A3	1			R, Pr
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Working in groups of two under the direction and continuing guidance of a project supervisor, the research project/thesis requires independent thought and action. It will simulated professional context where students, as engineers, have to investigate a particular problem in some depth and produce both an analysis of the problem and its innovative solution. The basis of the solution must include a formal thesis and a presentation.

The contents and skills needed to be reviewed or mastered by the students will depend on the type of project or research. Some will focus primarily on laboratory work and can involve substantial liaison with local industry, while others may be more analytical or computational and involve working with research institutes. It must be noted that individual grades are awarded for this research project/thesis based on continuous and formative performance.

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Consultation with Supervisor	42
Practical / Tutorial / Studio	20
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Consultation with collaborators	20
Presentation and Report Preparations	40

Formal Assessment	
Continuous Assessment (mini presentations, preliminary reports)	5
Final Presentations	0.5
Total	167.5

Linkage of Course Outcomes with Assessment Methods and their Weights:

<table>
<tr><th colspan="3">Assessment Strategies</th><th rowspan="2">CO</th><th rowspan="2">Blooms Taxonomy</th></tr>
<tr><th colspan="2">Components</th><th>Grading</th></tr>
<tr><td rowspan="4">Continuous Assessment (40%)</td><td rowspan="4">Presentation</td><td rowspan="4">40%</td><td>CO 2</td><td>C4-C6</td></tr>
<tr><td>CO 5</td><td>C3-C6</td></tr>
<tr><td>CO 7</td><td>C6</td></tr>
<tr><td>CO 8</td><td>A3</td></tr>
<tr><td colspan="2" rowspan="7">Thesis</td><td rowspan="7">60%</td><td>CO 1</td><td>C2-C5</td></tr>
<tr><td>CO 2</td><td>C4-C6</td></tr>
<tr><td>CO 3</td><td>C2, C3</td></tr>
<tr><td>CO 4</td><td>C3, C4</td></tr>
<tr><td>CO5</td><td>C3-C6</td></tr>
<tr><td>CO 6</td><td>C6</td></tr>
<tr><td>CO 8</td><td>A3</td></tr>
<tr><td colspan="2">Total Marks</td><td>100%</td><td colspan="2"></td></tr>
</table>

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Mapping of Course Outcomes and Program Outcomes:

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Course Outcomes (CO) of the Course</th><th colspan="12">Program Outcome</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th></tr>
<tr><td>CO1</td><td>Search and critically review relevant research literature to retrieve, assess and evaluate existing research outcomes and technologies relevant</td><td></td><td></td><td></td><td>H</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>H</td></tr>
</table>

	to the field of research. Demonstrate an in-depth understanding of the related work, including an in-depth knowledge of the literature, the important authors, the related terminology, and the research findings (theories, models, structures, designs, principles etc.). **(PO: 4, 12)**												
CO2	Classify, summarize, explain and critique the basic findings of the literature review and identify gaps in the current knowledge to develop the required problem statements and research questions and formulate research hypotheses. **(PO: 1, 2, 3)**	H	H	M									
CO3	Demonstrate understanding of underlying theory, methods and procedures to be employed to complete a project or address research questions for thesis. **(PO: 1)**	H											
CO4	Apply proper experimental design, giving consideration to statistical significance and quality of collected data or analyze findings for proper project design. Accomplish the work in groups of 2 to 3 students **(PO: 2, 4, 9)**		H		H					H			
CO5	Apply modern tools with respect to hardware and software (where applicable) by being able to design, develop, evaluate, and experimentally validate appropriate solutions for the selected research questions. **(PO: 3, 5)**			H		H							
CO6	Develop proficiency in engineering / technical writing by being able to generate thesis summarising the research findings. **(PO: 9, 10)**									H	H		
CO7	Demonstrate mastery of oral presentations by being able to deliver public presentation and demonstrate to examiners. **(PO: 9, 10)**									H	H		
CO8	Demonstrate commitment towards ethics in all affairs pertaining to project or thesis **(PO: 8)**								H				

(H – High, M- Medium, L-low)

Lecture Schedule:

Week	Consultation with supervisor	Topics	ASSESSMENT
1	Meeting 1	Introductory meeting, norming, group dynamics discussion, guidance	R
2	Meeting 1	Feedback on progress, consultation on problems	
3	Meeting 1	Discussion with collaborators (if any), reviewing and modifying approach	
4	Meeting 1	Feedback	R, Pr
5	Meeting 1	Discussion and consultation	
6	Mock Presentation	Suggestions on improving write-up and presentation	
7	**Mid term Presentation**	**Evaluation of students' performance and feedback on improvement. Guidance if needed.**	
8	Meeting 1	Consultation of project report/thesis writing of relevant chapters	R
9	Meeting 1	Feedback on writing and findings	
10	Meeting 1	Feedback and consultation	
11	Meeting 1	Final adjustments and validation of work	R, Pr
12	Meeting 1	Review of current progress and guidance on meeting the expected deadlines and future work.	
13	Mock Presentation	Consultation for preparation of final report/thesis and final presentation	
14	**Final Review meeting 1**	**Review and feedback of students' performance. Appreciation of goals and targets met. Preparation of final report and presentation**	

(PR – Project; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Teaching Methodology:
Consultation, discussion based on meetings, feedback on presentation and thesis etc.

Text and Ref Books:

g) Research Design: Qualitative, Quantitative and Mixed Methods Approaches, 4th Edition, John W. Creswell
h) Shigley's Mechanical Engineering Design - Richard Budynas, Keith Nisbett
i) The Mechanical Design Process - David Ullman
j) The Research Methods Knowledge Base, 3rd Edition, William M. K. Trochim & James P. Donnelly

Course Code: IPE 405 **Course Name:** Supply Chain Management
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: Level 4/ Term I

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:
The main course's objective is to teach students the fundamentals of a supply chain management system and facilitate professional exposure.

Objectives:

1. To describe how a supply chain work
2. To generate supply chain network base on transportation
3. To analyze the critical performance parameters of a supply chain
4. To compare among suppliers and select the best one
5. To understand the detailed phases of supply chain and their long-term control

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Outline** and **describe** the major areas of supply chain	C4-C5		2	1	Pr, R
CO2	**Apply** the knowledge of fundamentals of supply chain to make procurement decision	C3-C6	2	2	1	ASG, R
CO3	**Explain** and **evaluate** different modes of transportation and design for minimum cost	C2-C3	1	1	2	T, ASG

CO4	**Apply** the inventory analysis knowledge to **prepare** optimum inventory policy	C1-C3	1	1	3	T, F
CO5	**Analyze** from multiple warehousing and material handling options to choose the appropriate one depending on the facility	C3	2	1,2	1	T, F, ASG

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

Course Contents:

a. Main Contents:

Introduction to supply chain management, Materials planning, Procurement management, Inventory systems management, Stores management, Physical distribution

b. Detailed Contents:

Introduction to supply chain management: supply chain, systems approach to management, materials management, major areas of supply chain management, forward and backward linkage; **Materials planning:** role of forecasting, market demand estimation.; **Procurement management:** procurement cycle, materials sourcing, vendor evaluation and selection, make-buy decision, multi-criteria decision making in supplier selection, negotiation, transportation, logistics, incoming materials inspection; **Inventory systems management:** different types of product structures for materials planning, management of raw materials, work-in-process (WIP), finished goods and spare parts inventories, lead time management, cycle time reduction; **Stores management:** stores layout planning, addressing systems, codification systems, traceability, physical verification and counting, surplus and waste management; **Physical distribution:** network planning, packaging, materials handling, carrier systems, distribution inventory, legal aspects and common rules of transportation.

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcome**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Outline** and **describe** the major areas of supply chain **(PO: 1, 2, 4, 5)**	H	M		M	H							
CO2	**Apply** the knowledge of fundamentals of supply chain to make procurement decision **(PO: 1, 2, 5)**	M	H			H							
CO3	**Explain** and **evaluate** different modes of transportation and design for minimum cost **(PO: 3, 5)**			H		H							
CO4	**Apply** the inventory analysis knowledge to **prepare** optimum inventory policy **(PO: 1, 4, 5)**	H			M	H							

CO5	**Analyze** from multiple warehousing and material handling options to choose the appropriate one depending on the facility	H	M	M									

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning Lecture Practical/ Tutorial/ Studio Student-centred learning	 42 - -
Self-directed learning Non face-to-face learning Revision Assessment preparations	 18 21 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	106

Teaching methodology:
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	Supply chain, systems approach to management	
	Lec 2	Materials management	
	Lec 3	Major areas of supply chain management	
2	Lec 4	Forward and backward linkage	

	Lec 5	Role of forecasting, market demand estimation	**Class Test 1**
	Lec 6	Procurement cycle	
3	Lec 7	Materials sourcing	
	Lec 8	Make-buy decision	
	Lec 9	Multi-criteria decision making in supplier selection	
4	Lec 10	Negotiation	**Class Test 2**
	Lec 11	Transportation	
	Lec 12		
5	Lec 13	Logistics	
	Lec 14		
	Lec 15	Incoming materials inspection	
6	Lec 16	Different types of product structures for materials planning	
	Lec 17	Management of raw materials	
	Lec 18	Work-in-process (WIP)	
7	Lec 19	Finished goods and spare parts inventories	
	Lec 20	Cycle time reduction	
	Lec 21		
8	Lec 22	Lead time management	**Mid Term / Project**
	Lec 23		
	Lec 24		
9	Lec 25	Stores layout planning	
	Lec 26		
	Lec 27		
10	Lec 28	Addressing systems	**Class Test 3**
	Lec 29	Codification systems	
	Lec 30	Traceability	
11	Lec 31	Physical verification and counting	
	Lec 32	Surplus and waste management	
	Lec 33		
12	Lec 34	Network planning	
	Lec 35		
	Lec 36		
13	Lec 37	Packaging, materials handling	
	Lec 38	Carrier systems, distribution inventory	
	Lec 39	Legal aspects and common rules of transportation.	
14	Lec 40	Review class	
	Lec 41		
	Lec 42		

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class test 1-3	20%	CO 1-3	C 1-4, A 1-2, P 1-2
	Class Participation	5%	CO 1-2	C 1-4, A 1-2, P 1-2
	Mid term	15%	CO 1-2	C 1-6, P 1-4
Final Exam		60%	CO 1-5	C 1-6, P 1-4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Supply chain Management (Sunil Chopra, Peter Meindl)

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 411 **Course Name:** CAD/CAM
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

To design, analyze and select commonly used robots and implement NC, CNC program based manufacturing using computer controlled machines and rapid tooling techniques.

Objectives:

1. To conduct study on Robot anatomy and drive systems of robots.
2. To expose students to servo drives using voltage, current and direct torque and PID control systems.

3. To introduce different motion control systems using various types of sensors, encoders and methods of integration by using PLCs.
4. To expose students to manual part programming using G and M Codes
5. To introduce machine programming using APT like programming languages
6. To expose students to programming of free form surfaces from CAD-CAM database for machining and rapid prototyping

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** robot anatomy and the degrees of freedom of industrial robots	C1,C2	1	1	1	T, Mid Term Exam, F
CO2	**Explain** strategies for robot motion control under the application of different types of sensor, encoders and methods of integration	C1,C2	1	1	1	ASG, Mid Term Exam, F
CO3	**Program** PLC to Control coordinated motions of robot and **write** manual part program using G and M Codes	C3,C4	3	2	5,6	ASG, Mid Term Exam, F
CO4	**Prepare** part program using programming languages such as APT and **Explain** the morphology of part program development for complex surfaces using CAD-CAM software for machining and rapid prototyping applications	C6	3	3	6,7	T, ASG, R, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Robot: Robot anatomy, Drive systems of robots, Electrical and hydraulic systems, AC and DC drives, Servo drives using voltage control, current control and direct torque control, PID control systems and performance issues. Feedback systems, Single loop and multi-loop, DSP based motion control systems, Sensors for industrial robots, encoders, resolvers, hall-effect sensors, acoustic sensors, ultrasonic and optical/infrared sensors, Elements of robot vision, Integration using PLCs, digital motion planning systems

Computer Control Machines: Introduction, classification, design features and control features of CNC machines; Programming: G and M Code programming, Offline (APT-like) programming; free form surface machining: Isoparametric, Isoplanar and Isoscallop machining strategies.

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcomes (PO)											
		Engineering Knowledge	Problem Analysis	Design / Development of	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** robot anatomy and the degrees of freedom of industrial robots	**H**		**H**		**H**							
CO2	**Explain** strategies for robot motion control under the application of different types of sensor, encoders and methods of integration	**H**		**H**									
CO3	**Program** PLC to Control coordinated motions of robot and **write** manual part program using G and M Codes	**H**		**H**									
CO4	**Prepare** part program using programming languages such as APT and **Explain** the morphology of part program development	**H**		**H**		**M**							

	for complex surfaces using CAD-CAM software for machining and rapid prototyping applications												

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	**Lecture**	**Topics**	**ASSESSMENT**
1	Lec 1 Lec 2 Lec 3	Introduction Robots: types, uses and classification Robot applications	**Class Test 1, ASG, F**
2	Lec 4 Lec 5 Lec 6	Robot anatomy Axes system Grippers	
3	Lec 7 Lec 8 Lec 9	Drive systems of robots: AC and DC drives, Servo drives using voltage control Current control and direct torque control,	

4	Lec 10 Lec 11 Lec 12	PID control systems and performance issues Integration using PLCs Digital motion planning systems	**Class Test 2, ASG, PR, F**
5	Lec 13 Lec 14 Lec 15	Sensors for industrial robots, encoders Resolvers, hall-effect sensors Acoustic sensors, ultrasonic and optical/infrared sensors,	
6	Lec 16 Lec 17 Lec 18	Elements of robot vision	
7	Lec 19 Lec 20 Lec 21	Integration using PLCs Digital motion planning systems	
8	Lec 22 Lec 23 Lec 24	Introduction to Automation, CAD/CAM/CAE: Overview of product life cycle, Essential components of soft automation (CAD and CAM). NC Machine tool: Historical Development, Principle of Numerical Control, Classification of Numerical Control, Numerical Control System. Principle of Numerical Control, Classification of Numerical Control, Numerical Control System.	**Mid Term, F**
9	Lec 25 Lec 26 Lec 27	Coordinate system, NC Program storage media, Symbolic codes NC words, part programming, tool radius compensation. G&M code applications and NC Par Programming examples and problem solving.	
10	Lec 31 Lec 32 Lec 33	APT programming features Definition of Geometry statements Geometry statement (examples)	
11	Lec 28 Lec 29 Lec 30	Definition of Motion statements Definition of Motion statements Motion statement (examples)	**Class Test 3, ASG, R, PR, F**
12	Lec 34 Lec 35 Lec 36	Geometry definition for turning and 21/2 axis milling Tool path generation, simulation and verification free form surface machining	
13	Lec 37 Lec 38 Lec 39	Overview, specific, RP &M process, Application of RP and M, Stereo lithography process, Selective Laser Sintering, 3D Printing, Direct Tooling example	

14	Lec 40 Lec 41 Lec 42	Geometry input, Support Structure, Slice and Merge Software technology for RP&M **Review**	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1,C2
			CO 3	C3,C4
			CO 4	C6
	Class Participation	5%	CO 2	C1,C2
			CO 1	C1,C2
	Mid term	15%	CO 1	C1,C2
			CO 2	C1,C2
			CO 3	C3,C4
Final Exam		60%	CO 1	C1,C2
			CO 2	C1,C2
			CO 3	C3,C4
			CO 4	C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

k) CAD/CAM: Computer-aided Design and Manufacturing - Mikell Groover
l) CAD/CAM theory and practice - Ibrahim Zeid
m) CAD/CAM/CIM - P. Radhakrishnan, S. Subramanyan, and V. Raju

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 412 **Course Name:** CAD / CAM Sessional
Credit Hour: 0.75 **Contact Hour:** 1.5
Level/Term: L-4, T-2
Curriculum Structure: Outcome Based Education (OBE)
Pre-requisites: Concurrent with IPE 411

Rationale:
The main aim is the use of computer systems to aid in the creation, modification, analysis or optimization of a design

Objective:

1. Create 2D and 3D computer drawings and models for manufacturing and prototyping.
2. Evaluate mechanical designs and select the proper access and materials for production.
3. Evaluate computer aided design models and assemblies based on critical thinking and problem-solving skills.
4. Apply design principles and rationale in a realistic and original design project.
5. Develop and present drawings and prototypes to the class.

Course Outcomes (CO) Generic Skills:
Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Create** 2D and 3D computer drawings and **model** for manufacturing and prototyping.	C6	1	1,3	1,2	R
CO2	**Evaluate** mechanical designs and **select** the proper access and materials for production.	C3, C5	1, 2	1,2	5,6	R
CO3	**Evaluate** computer aided design models and assemblies based on critical thinking and problem solving skills.	C5	1, 2	1	5,6	ASG,R
CO4	**Apply** design principles and **rationale** in a realistic and original design project.	C3, C4	1	5	2	ASG, R
CO5	**Develop** and **present** drawings and prototypes to the class.	C4 – C6	1	5	6,7	PR,ASG, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

Introduction to CAD/CAM, Geometric modeling, Computer graphics, Product Design and development using CATIA, Future directions for CAD/CAM, CAD/CAM Programming using MASTERCAM, Solid works CAD/CAM package

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	To **create** 2D and 3D computer drawings and **models** for manufacturing and prototyping.	**H**											
CO2	**Evaluate** mechanical designs and select the proper access and materials for production.		**H**	**H**									
CO3	**Evaluate** computer aided design models and assemblies based on critical thinking and problem solving skills.		**H**	**H**									

CO4	**Apply** design principles and **rationale** in a realistic and original design project.	**H**		**H**									
CO5	**Develop** and **present** drawings and prototypes to the class.			**H**	**H**							**M**	

(H – High, M- Medium, L-low)

<u>Lecture schedule:</u>

Week No	**Content**	**Remark**
1	Intro	
2	CATIA	Assignment (Extra)
3	CATIA	Submit Assignment 1
4	CATIA	Submit Assignment 2
5	CATIA	
6	**Quiz 1**	Submit Assignment 3
7	CATIA	Submit Assignment 4, 5 20% Drawing of the presentation should be completed (will be discussed in class for specific need/struggle you are facing to draw the product assigned)
8	CATIA	Submit Assignment 6, Draft submission of the <u>report</u>
9	CATIA	Submit Assignment 7, **<u>Report</u> submission, report Friday**
10	**Quiz 2**	Submit Assignment 8

11	CATIA	Initial submission of the SolidWorks drawing (Group wise) for the *presentation*. At least 80% of the drawing should be completed by this time
12	CATIA	Submit Assignment 9, Submit an initial Draft of the Presentation
13	**Presentation**	Submit Assignment 10
14	**Viva**	

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (70%)	Weekly Reports	20%	CO 1	C6
			CO 2	C3, C5
			CO 3	C5
			CO 4	C3, C4
			CO 5	C4 – C6
	Class Participation	40%	CO 1	C6
			CO 2	C3, C5
			CO 3	C5
			CO 4	C3, C4
	Presentation	10%	CO 5	C4 – C6
Final Report		30%	CO 1	C6
			CO 2	C3, C5
			CO 3	C5
			CO 4	C3, C4
			CO 5	C4 – C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

l. CAD/CAM Lab Manual Book by Sathish D

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 418 **Course Name:** Mechatronics & Industrial Automation Sessional
Credit Hour: 0.75 **Contact Hour:** 1.50
Level/Term: L-4, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: NA

Rationale:

This sessional course follows the Outcome Based Education (OBE) guidelines. The objective of this course is to instill in students the practical knowledge and skill to automate planning, production, material handling and control in the era of Industry 4.0. This course provides hands on experience on designing and maintaining automation system that have become part and parcel of modern industries.

Objectives:

1. To help students identify the basic components of manufacturing automation and categorize different types of automated production processes
2. Make students understand the performance and dynamic characteristics of industrial robots and the principles of industrial sensors
3. To develop the skills to apply electrical, mechanical and pneumatic actuators, design elementary mechanisms for automated machinery
4. Understand the operation of common industrial controllers (PLCs)

Course Outcomes (CO):

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Knowledge** to **apply** principles of industrial automation to the solution of specific manufacturing challenges	C1-C3	1	2	2	Pr, R, Q
CO 2	**Program** and **operate** an industrial robot, setup and implement pneumatic circuits, **setup and implement** computer vision systems, material handling systems	C4-C6	2	2	1	ASG, R Pr, Q

CO 3	**Integrate** a number of these manufacturing technologies in an automated work cells	C3-C6	2	2	2	ASG, Q
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Industrial robotics: Industrial sensors and switches, PLC, Assembly machines (continuous transfer, intermittent transfer), Industrial control

Automated material handling system: Transportation devices ,Feeding and orientation devices (in-bowl tooling, feed tracks, escapements), Assembly systems , Machine vision system

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Lifelong Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Students will be able to apply principles of industrial automation to the solution of specific manufacturing challenges	H	**H**	**H**	**H**	**H**				**L**	**L**	**H**	

CO2	They will be able to program and operate an industrial robot, setup and implement pneumatic circuits, setup and implement computer vision systems, material handling systems	**H**	**H**	**M**	**M**	**H**					**L**	**M**	
CO3	Integrate a number of these manufacturing technologies in an automated work cells	**H**	**H**	**H**	**H**	**H**						**H**	

(H – High, M- Medium, L- Low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning Lecture Practical/ Tutorial/ Studio Student-centred learning	 7 14 -
Self-directed learning	

Non face-to-face learning Revision Assessment preparations	10 5 7
Formal Assessment Continuous Assessment Final Examination	 3.5 1.5
Total	48

Teaching methodology:

Lecture and Discussion, Practical Sessions, Co-operative and Collaborative Method,

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	Industrial robotics	**Q,P,Pr**
2	Lec 2	Industrial robotics (contd.)	
3	Lec 3	Industrial sensors and switches	
4	Lec 4	PLC	**Q, P, Pr**
5	Lec 5	PLC (contd.)	
6	Lec 6	PLC (contd.)	
7	Lec 7	Assembly machines	
8	Lec 8	Industrial control	**Q, ASG**

9	Lec 9	Transportation devices	
10	Lec 10	Transportation devices (Contd.)	
11	Lec 11	Feeding and orientation devices	
12	Lec 12	Machine vision system	
13	Lec 13	Assembly systems	
14	Lec 14	Review	

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (40%)	Quiz 1-2	50%	CO 1	C1-C3, P1
			CO 2	C3-C5, P2
	Class Participation	10%	CO 1	C1-C3, P1
			CO 2	C3-C5, P2
Final Quiz		40%	CO 2	C1-C3, P2
			CO 3	C3-C6, P4-P5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

5. James A. Rehg, Introduction to Robotics in CIM Systems, 5th edition

Course Code: IPE 419 **Course Name:** Modeling and Simulation

Credit Hour: 3.00 **Contact Hour:** 3.00

Level/Term: L-4, T-2

Curriculum Structure: Outcome-Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

This Outcome-Based Education (OBE) based course is designed to introduce students to the modeling and simulation approach. It emphasizes feasible processes to conduct an in-depth study on the use of models as a basis for simulations to develop data utilized for managerial or technical decision making.

Objectives:

a. To explain the feasible solutions to discrete event problems. T
b. To expose students to various models and their feasibility.
c. To conduct a detailed study of simulation modeling, simulation experimentation, and analysis.
d. To introduce with Monte Carlo simulation.
e. To explain the feasibility study of network system simulation.

Course Outcomes (CO) & Generic Skills:

No.	**Course Learning Outcome**	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Familiar with data analysis.	C1-C3	1		3	T, Mid Term, F
CO2	Derive the simulation modeling using the arena package.	C1, C4	2	2		Mid Term Exam, F, R
CO3	Familiar with different component-based simulation and modeling tools.	P4, C1, C4	2	5		Mid Term Exam, F, PR, Pr
CO4	Derive the most feasible layout of an existing production line.	P4, C4	3	5	3	Mid Term Exam,F

CO5	Define multi-resolution and multi-aspect modeling.	P4, C1, C4	3	2	2	Mid Term Exam,F, T,ASG
CO6	Demonstrate commitment to class ethics.	A3	1			ASG, PR, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, F – Final Exam)						

Course Contents:

Basic concepts of simulation (definitions and types of simulations), Mechanism of discrete event simulation, Random number generation, Input data analysis (input distribution modeling), Simulation modeling using Arena package, Review of probability and statistics, Simulation output analysis, Monte Carlo simulation, Verification and validation of simulation models, Other simulation approaches (Time driven simulations), Component-based simulation and modeling tools, Simulation protocol concepts, designs, and implementations, Simulation experimentation and analysis, Network system simulation modeling, Multiresolution, multi-aspect modeling, Parallel simulation modeling concepts, and methods.

Mapping of Course Outcomes and Program Outcomes:

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Course Learning Outcomes	Engineering Knowledge	Problem Analysis	Design / Development of	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life-Long Learning	Project Management and
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**

CO1	Familiar with data analysis.	H	H		H								
CO2	Derive the simulation modeling using the arena package.			H		H					H		
CO3	Familiar with different component-based simulation and modeling tools.		H		H								M
CO4	Derive the most feasible layout of an existing production line.		H	H								M	H
CO5	Define multi-resolution and multi-aspect modeling.		H			H							
CO6	Demonstrate commitment to class ethics.								H				

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	20
Revision	19
Assessment Preparations	20
Formal Assessment	

Continuous Assessment	2
Final Examination	3
Total	106

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multimedia Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	1	Basic concepts of simulation (definitions and types of simulations).	CT 1 to be held on these topics
	2-3	Mechanism of discrete event simulation.	
2	4	Mechanism of discrete event simulation (continued).	
	5-6	Random number generation.	
3	7	Input data analysis (input distribution modeling).	
	8-9	Input data analysis (input distribution modeling) (continued).	
4	10	Simulation modeling using the Arena package.	
	11-12	Simulation modeling using the Arena package (continued).	
5	13	Simulation modeling using the Arena package (continued).	

	14-15	Review of probability and statistics.	CT 2 to be held on these topics, ASG, PR
6	16	Simulation output analysis.	
	17-18	Simulation output analysis (continued).	
7	19	Monte Carlo simulation.	
	20-21	Monte Carlo simulation (continued).	
8	22	Monte Carlo simulation (continued).	CT 3 to be held on these topics
	23-24	Verification and validation of simulation models.	
9	25	Verification and validation of simulation models (continued).	
	26-27	Time driven simulations.	
10	28	Time driven simulations (continued).	
	29-30	Component-based simulation and modeling tools.	
11	31	Component-based simulation and modeling tools (continued).	ASG, PR
	32-33	Simulation protocol concepts, designs, and implementations.	
12	34	Simulation experimentation and analysis.	
	35-36	Simulation experimentation and analysis (continued).	
13	37	Network system simulation modeling, Multiresolution, multi-aspect modeling.	
	38-39	Network system simulation modeling, Multiresolution, multi-aspect modeling (continued).	
14	40	Parallel simulation modeling concepts and methods.	
	41-42	Parallel simulation modeling concepts and methods (continued) and Course Review.	

(PR – Project; ASG – Assignment)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1 - C4
			CO 2	C2 - C4
			CO 4	C2
	Class Participation	5%	CO 1	C3, C4
			CO 6	A3
	Midterm	15%	CO 3	C1 - C4
			CO 4	C3, C4
Final Exam		60%	CO 1	C1- C4
			CO 2	C3, C4
			CO 3	C2 - C4
			CO 4	C2
			CO 5	C3, C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Theory of Modeling and Simulation - Bernard P. Zeigler, Alexandre Muzy, Ernesto Kofman. Third Edition.
2. Principle of Modeling and Simulation, A multidisciplinary approach – John A. Sokolowski, Catherine M. Banks.

Reference Site:

https://classroom.google.com/ (**To be announced**)

Course Code: IPE 420 **Course Name:** Modeling and Simulation Sessional
Credit Hour: 1.50 **Contact Hour:** 3.00
Level/Term: L-4, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: Concurrent with IPE 419 Modeling and Simulation

Rationale:
The course is intended to develop the necessary skills in students to develop a simulation of a manufacturing or service organization.

Objective:

1. To make students familiar with the concepts and tools of industrial simulation
2. To develop the students' ability to model a complex manufacturing or service process.
3. To make students adept at coding simulation in MALAB
4. To make students proficient at developing complex industrial simulation at ARENA

Course Outcomes (CO) Generic Skills:
Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Explain** the concept of simulation and **develop** and **analyze** a simulation model	C2-C6	1	2	1,3	R
CO 2	**Explain** the logic, structure, components and management of simulation modeling	C2	1	1	1	R
CO 3	**Demonstrate** knowledge of MATLAB and ARENA	C3	1	1	2	ASG,R
CO 4	**Build** a simple simulation model using MATLAB	C6	1	1,2	2	ASG, R
CO 5	**Build** a complex industrial simulation model using ARENA	C6	1,2	1,2, 3	2	PR,ASG, R
CO 6	**Analyze** the output data and **demonstrate** the various findings to management	C3, C4	2	3	1	ASG, R
CO 7	Do reverse calculation and determine the amount of input(s) to generate the required output	C2	2	1	1,2	ASG, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

Basic flow simulation, Random numbers, Modelling methodology, Modelling of complex systems, Different kinds of statistical distributions, Basic queue theory, Single server systems, Parallel server systems, Attributes, Batch/bulk arrival, Modelling of AGV and conveyor belts, Statistical analysis of the results from simulations

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**Explain** the concept of simulation and **develop** and **analyze** a simulation model	**H**											
CO2	**Explain** the logic, structure, components and management of simulation modeling	**H**				**M**							
CO3	**Demonstrate** knowledge of MATLAB and ARENA	**H**	**M**	**H**		**M**							
CO4	**Build** a simple simulation model using MATLAB	**M**	**M**	**H**		**M**							
CO5	**Build** a complex industrial simulation model using ARENA	**H**	**H**	**H**		**H**					**M**		
CO6	**Analyze** the output data and **demonstrate** the various findings to management				**H**	**M**				**M**			

CO7	Do reverse calculation and determine the amount of input(s) to generate the required output			**M**	**M**	**H**							

(H – High, M- Medium, L-low)

<u>Lecture schedule:</u>

Week 1	**Introduction**	
Class 1	Introduction to MATLAB, Discrete Event Simulation	
Week 2	**Fundamental Simulation Concepts**	
Class 2	Simulating Service and Manufacturing Industry using MATLAB	
Week 3	**Quiz 1**	
Class 3	Quiz 1	
Week 4	**Introduction to ARENA**	
Class 4	A guided tour through ARENA simulation software	
Week 5	**Modelling Advanced Operations**	
Class 5	Modelling advanced operations using ARENA	
Week 6	**ARENA Animation**	
Class 6	Animating a simulation model using ARENA	
Week 7	**Course Review and Quiz 2**	
Class 7	A review of the entire course and final quiz	

Linkage of Course Outcomes with Assessment Methods and their Weights:

<table>
<tr><th colspan="3">Assessment Strategies</th><th rowspan="2">CO</th><th rowspan="2">Bloom’s Taxonomy</th></tr>
<tr><th colspan="2">Components</th><th>Grading</th></tr>
<tr><td rowspan="9">Continuous Assessment (70%)</td><td rowspan="7">Weekly Reports</td><td rowspan="7">20%</td><td>CO 1</td><td>C2-C6</td></tr>
<tr><td>CO 2</td><td>C2</td></tr>
<tr><td>CO 3</td><td>C3</td></tr>
<tr><td>CO 4</td><td>C6</td></tr>
<tr><td>CO 5</td><td>C6</td></tr>
<tr><td>CO 6</td><td>C3, C4</td></tr>
<tr><td>CO 7</td><td>C2</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">40%</td><td>CO 1</td><td>C2-C6</td></tr>
<tr><td>CO 2</td><td>C2</td></tr>
</table>

	Class Participation		CO 3	C3
			CO 4	C6
			CO 7	C2
	Presentation	10%	CO 5	C6
Final Report		30%	CO 5	C6
			CO 6	C3, C4
			CO 7	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

l. Kelton, W. David, Sadowski, Randall P., and Swets, Nancy B. (2010).- Simulation with Arena

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 421 **Course Title:** Machine Tools

Contact Hour: 3.00 **Credit Hour:** 3.00

Level/Term: 4/I

Course Curriculum: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:

To conduct in depth of internal kinematic structures of machine tools and develop sound understanding of the basic principles of metal cutting.

Objective:

1. To conduct study on classification and specifications of general purpose conventional machine tools.
2. To expose students to different drive systems, power consumption and important components of machine tools.
3. To conduct detailed case study on kinematic structures speed and feed gear boxes of conventional machine tools.
4. To conduct a case study on design of a speed gearbox.

5. To study the methods of calculation and measurement of cutting forces and temperature generated during metal cutting.
6. To introduce the various cutting tools, cutting fluids used in machining and their performance.

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Classify** machine tools and prepare specifications for machine tools	C4-C5		2	1	Pr, R
CO2	**Explain** working principles of basic mechanical, hydraulic and electrical drive systems.	C3-C6	2	2	1	ASG, R
CO3	**Design** a speed gearbox of a machine tool	C2-C3	1	1	2	ASG
CO4	**Derive** kinematic balance equations to establish relationship between different components of machine tools linked through complex kinematic chains to achieve desired speeds or feeds of operational mechanisms.					
CO5	**Derive** expressions for components of cutting force and cutting temperature in terms of the properties of the work and tool materials, tool geometry and machining parameters.	C3	2	1,2	1	ASG
CO6	**Explain** with reference to tool life the cutting performance of various types of tools under dry and wet machining.					
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

Machine Tools: Concept and definition of machining and machine tools. History of developments of machine tools. Concept of producing geometrical surfaces by generatrix and directrix. Kinematic systems and structures of conventional machine tools. Electromechanical and hydraulic drives and control of machine tools. Machine tool automation. Classification and specification of machine tools. Construction, working principle and application of various semi-automatic and automatic lathes. Flexible automation need, principle and advantages.

Basic constructional features, working principle and application of CNC machine tools, machining center and FMS.

Machining: Tool geometry, mechanism of chip formation. Mechanics of machining. Cutting temperature; causes, effects, estimation, measurement and control. Cutting fluid applications. Failure modes, wear and life of cutting tools. Cutting tool materials. Role of geometrical and process parameters and cutting fluid on machine-ability. Mechanics of grinding. Economy of machining and grinding. Special techniques and advanced technology of machining and grinding.

Teaching-learning and Assessment Strategy:

Lectures, class performances, assignments, class tests, final exam.

Linkage of CO with Assessment Methods& their Weights:

Assessment Method	**(100%)**
Class Assessment	
Class Participation	05
Mid Term	15
Class Tests/Assignment/Presentation	20
Exam	
Final exam	60

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Calculate power consumption and	H	M										

	prepare specifications of machine tools												
CO2	Explain working principles of basic components of machine tools and machine tool drive systems	H	H										
CO3	Design a speed gearbox of a machine tool	H		H									
CO4	Derive kinematic balance equations to establish relationship between different components of machine tools linked through complex kinematic chains to achieve desired speeds or feeds of operational mechanisms.	H	H										
CO5	Derive expressions for components of cutting force and cutting temperature in terms of the properties of the work and tool materials, tool geometry and machining parameters.	H		H	H								
CO6	Explain the mechanism of improvement of machinability due to the application of coolants and lubricants.	H			H								

Lecture schedule:

Week 1	**Machine Tools:** Introduction	
Class 1	Concept and definition of machining and classification of machine tools.	CT 1
Class 2	Elements of machine tools: Slide ways,	

Class 3	Spindles and bearings.	
Week 2	**Drive systems of machine tools**	
Class 4	Mechanical drive systems: Kinematics of machine tool	
Class 5	Determination of transmission ratios, limiting values of transmission ratios, transmission in stepped regulation of speed	
Class 6	Design of speed gear boxes: Construction of structural and speed chart diagrams	
Week 3	**Kinematic structures of machine tools**	
Class 7	Kinematic diagrams of 2, 3, 4 and higher speed gear boxes	
Class 8	Mechanism of variation of speeds in speed in speed gear and feed gear boxes	
Class 9	Calculation of spindle torque and power requirements in machine tools	
Week 4	**Hydraulic drives and pumps.**	CT 2
Class 10	Characteristics of hydraulic drives of machine tools, working principle of Gear pumps	
Class 11	Working principle of Vane pumps	
Class 12	Working principle of Centrifugal pumps	
Week 5	**Electrical drive.**	
Class 13	Speed and torque characteristics of AC motors	
Class 14	Speed and torque characteristics of DC motor	
Class 15	Infinite variation of speed using electrical drive system	
Week 6	**Engine lathes**	
Class 16	Components and specifications of engine lathes.	
Class 17	Kinematics of speed gear boxes of engine lathe.	
Class 18	Kinematics of feed gear boxes of engine lathe.	
Week 7	**Milling machine**	CT 3
Class 19	Classifications and specifications; Kinematics of speed gear boxes of milling machine.	
Class 20	Kinematics of feed gear boxes of milling machine.	
Class 21	Universal Index Head: Simple, differential and helical indexing	

Week 8	**Grinding machines**	
Class 22	Classifications and specifications; Motions in different grinding machines	
Class 23	Kinematics of surface grinding machine	
Class 24	Kinematics of cylindrical grinding machine	
Week 9	**Machining**	
Class 25	Introduction, historical background, essential features of metal cutting, turning: tool point reference system,	
Class 26	Geometry of single point cutting tool,	
Class 27	Mechanism of chip formation, classification of chips.	
Week 10	**Mechanics of machining, and cutting forces**	
Class 28	Chip-tool contact processes	
Class 29	Merchant's cutting force diagram and derivation of cutting force components	
Class 30	Measurement of cutting forces and dynamometry	
Week 11	**Cutting Temperature**	
Class 31	Sources of heat generation in metal cutting	
Class 32	Derivation of formula for estimation of temperature generation in chip	
Class 33	Methods of cutting temperature measurement	
Week 12	**Cutting tool materials, tool wear and tool life**	
Class 34	Cutting tool materials: Carbon steel and high speed tools - their properties, cutting performance and failure modes	
Class 35	Cemented uncoated and coated carbide tools - their properties, cutting performance and failure modes	
Class 36	Ceramic and ultra-high hard tools - their properties, cutting performance cutting performance and failure modes	
Week 13	**Cutting fluid**	
Class 37	Types of cutting fluids, their properties	
Class 38	Conventional application of cutting fluids	

Class 39		
Week 14	**Economy of metal cutting**	
Class 40	Tailor's tool life equation	
Class 41	Influence of cutting parameters on tool life	
Class 42	Review	

Text and Reference Books:

Krar, S.F., (1998), *Technology of Machine Tools*, McGraw Hill Book Co.

Acherkan, N., Push, V., Ignatyev, N., et al.,, (1982), *Machine Tool Design,* Vol 1-4, Mir Publishers.

Basu, S.K. and Pal, D.K., (1989), *Design of Machine Tools*, Oxford and IBH Publishing Co.

Chernov, N., (1979), *Machine Tools,* Mir Publishers.

Kibbe, R.R., Neely, J.E., Meyer, R.O., et. al., (1999), *Machine Tool Practices*, Prentice Hall.

Course Code: IPE 422 **Course Name:** Machine Tools Sessional
Credit Hour: 1.50 **Contact Hour:** 3.00
Level/Term: L-4, T-1
Curriculum Structure: Outcome Based Education (OBE)
Pre-requisites: Concurrent with IPE 421 Machine Tools

Synopsis/Rationale:

This Outcome Based Education (OBE) based course is designed to enhance practical knowledge of internal kinematic structures of machine tools.

Objectives:

1. To study basic components of an Engine Lathe and their working principles
2. To study the kinematic diagram of an Engine Lathe
3. To conduct a study on different parts and functions of a CNC Milling Machine
4. To study the operation and components of a Shaper Machine
5. To study the indexing and manufacturing of a spur and helical gear

6. To study basic components of a Grinding Lathe and their working principles

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Explain** working principles of basic components of Engine Lathe	C2-C5	1	2	1	T,Q,R,F
CO 2	**Draw** and **explain** kinematic diagram of Engine Lathe	C4-C6	2	2	1	T,Q,R,F
CO 3	**Develop** G- code for CNC milling operation	C3-C5	1	1	2	T,Q,R,F
CO 4	**Explain** operations of Shaper Machine	C3	2	1,2	1	T,Q,R,F
CO 5	**Set up** different types of indexing in milling machine	C6, A3	1	1		T,Q,R,F
CO 6	**Explain** working principles of basic components of Grinding Lathe	C3	2	1,2	1	T,Q,R,F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:
Name of the experiments:

1. (a) Study of Engine Lathes
(b) Study the Kinematic Diagram of an Engine Lathe
2. Study of CNC Milling machine.
3. Study of Shaper Machine.
4. Study of Milling Machine and Dividing Head
5. Study and Operation of Surface Grinding Machine.

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge **PO1**	Problem Analysis **PO2**	Design / Development of Solutions **PO3**	Investigation **PO4**	Modern Tool Usage **PO5**	The Engineer and Society **PO6**	Environment and **PO7**	Ethics **PO8**	Communication **PO9**	Individual and Team Work **PO10**	Life Long Learning **PO11**	Project Management and **PO12**
CO1	Explain working principles of basic components of Engine Lathe	H	L										
CO2	Draw and explain kinematic diagram of Engine Lathe	**H**	L										
CO3	Develop G- code for CNC milling operation	**H**	L	L									
CO4	Explain operations of Shaper Machine	**H**											
CO5	Set up different types of indexing in milling machine	H	L										
CO6	Explain working principles of basic components of Grinding Lathe	H											

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	16
Practical / Tutorial / Studio	16
Student-Centred Learning	10
Self-Directed Learning	
Non-face-to-face learning	40
Revision	10

Assignment Preparations	20
Formal Assessment Continuous Assessment Final Examination	 5 1
Total	118

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Exams, Feedback at every step.

Lecture Schedule:

Week 1	**Introduction**
Class 1	Introduction to machine tools sessional
Week 2	**Engine Lathe**
Class 2	Study of Engine Lathes
Week 3	**Engine Lathe (contd.)**
Class 3	Study of Engine Lathes
Week 4	**Kinematic Diagram**
Class 4	Study the Kinematic Diagram of an Engine Lathe
Week 5	**Kinematic Diagram (contd.)**
Class 5	Study the Kinematic Diagram of an Engine Lathe
Week 6	**CNC Milling machine**
Class 6	Study of CNC Milling machine.
Week 7	**CNC Milling machine (contd.)**
Class 7	Study of CNC Milling machine.
Week 8	**Shaper Machine**
Class 8	Study of Shaper Machine.
Week 9	**Shaper Machine (contd.)**
Class 9	Study of Shaper Machine.
Week 10	**Milling Machine and Dividing Head**
Class 10	Study of Milling Machine and Dividing Head
Week 11	**Milling Machine and Dividing Head (contd.)**
Class 11	Study of Milling Machine and Dividing Head
Week 12	**Surface Grinding Machine**
Class 12	Study and Operation of Surface Grinding Machine.
Week 13	**Surface Grinding Machine (contd.)**
Class 13	Study and Operation of Surface Grinding Machine.
Week 14	**Final Exam**

Class 14	Final Quiz

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (70%)	Weekly Reports	20%	CO 1	C2-C5
			CO 2	C4-C6
			CO 4	C3
	Class Participation	10%	CO 2	C4-C6
			CO 3	C3-C5
	Viva	30%	CO 1	C2-C5
			CO 2	C4-C6
			CO 5	C6, A3
Final Exam		40%	CO 1	C2-C5
			CO 2	C4-C6
			CO 4	C3
			CO 5	C6, A3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Krar, S.F., (1998), *Technology of Machine Tools*, McGraw Hill Book Co.
2. Chernov, N., (1979), *Machine Tools*, Mir Publishers.
3. Kibbe, R.R., Neely, J.E., Meyer, R.O., et. al., (1999), *Machine Tool Practices*, Prentice Hall.
4. Boothroyd, G., & Knight W.A. *Fundamentals of Machining and Machine Tools*. 2nd Edition, Marcel Dekker Inc.

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 450 **Course Name:** Business Communication Seminar
Credit Hour: 0.75 **Contact Hour:** 1.5
Level/Term: Level 4/ Term II

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisite: None

Rationale:

The course is designed to develop in students interpersonal and communication skills required for their professional life.

Objectives:

1. To learn how to prepare and present business presentation and job interviews.
2. To learn how to prepare professional CV, resume, and cover letter.
2. To develop business writing skills while communicating via letters.
3. To create entrepreneurship skills by innovating business ideas.

Course Outcomes (CO) & Generic Skills:

	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Develop** the verbal communication skills while presenting a business presentation, or appearing in debate competition and job interviews	C4-C5		2	1	Pr, R
CO2	**Prepare** business letters, curriculum vitae, resume and cover letters	C3-C6	2	2	1	ASG, R
CO3	**Analyze** and **evaluate** business proposals and **create** new endeavors of entrepreneurship	C2-C3	1	1	2	F, ASG
CO4	**Prepare** themselves for effective communication in any business-world setting	C3			3	Pr
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Name of the sessions:

1. Preparing CV, resume, and cover letter.
2. Preparing business letters.
3. How to present a business presentation.
4. How to prepare for job interview.
5. Preparing business proposals.

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)

Face-to-face learning Lecture Practical/ Tutorial/ Studio Student-centred learning	 - 28 -
Self-directed learning Non face-to-face learning Revision Assessment preparations	 9 14 18
Formal Assessment Continuous Assessment Final Examination	 1.5 1.5
Total	72

Teaching methodology:

Lecture and Discussion, Formal Presentation, Formal Interview, Co-operative and Collaborative Method, Problem Based Method

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcome**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Develop** the verbal communication skills while presenting a business presentation, or appearing in debate competition and job interviews **(PO: 1, 2, 4, 5)**	H	M		M	H							
CO2	**Prepare** business letters, curriculum vitae, resume and cover letters **(PO: 1, 2, 5)**	M	H			H							
CO3	**Analyze** and **evaluate** business proposals and **create** new endeavors of entrepreneurship **(PO: 3, 5)**			H		H							
CO4	**Prepare** themselves for effective communication in anybusiness-world setting **(PO: 1, 4, 5)**	H			M	H							

Lecture Schedule:

Week	Topics
1	Preparing CV, resume, and cover letter.
3	Preparing business letters.
5	How to prepare for job interview.
7	Mock Interview
9	How to present a business presentation.
11	Preparing business proposals.
13	Final Interview

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Assignment	20%	CO 1-2	C 3, C 4, P 1, P 2
	Class Participation	5%	CO 2-3	C 1, A 2, P 2
	Mock Presentation & Interview	15%	CO 3-4	C 6, A 3, P 4, P 5
Final Presentation and Interview		60%	CO 3-4	C 6, A 3, P 4, P 5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Essentials of Business Communication - Mary Ellen Guffey
2. Excellence in Business Communication - Courtland L Bovee
3. Business Presentations - Anne Freitag-Lawrence

Reference Site:

https://classroom.google.com/ (To be announced)

5.2 Detailed Curriculum of IPE Optional Courses

Course Code: IPE 417 **Course Name:** Industrial Automation
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: IPE 411 (CAD/CAM)

Synopsis/Rationale:

Provides the students with basic knowledge of industrial automation systems designs, installation, modifications, maintenance, and repair.

Objectives:

1. To provide the student with basic skills useful in identifying the concepts of automated machines and equipment and describe the terms and phrases associated with industrial automation.
2. To introduce preventative maintenance, identify or solve problems in machines, and other technologies.
3. To demonstrate competence in maintaining and troubleshooting technology includes identifying, understanding, and performing routine preventative maintenance and service on technology.
4. To introduce different motion control systems using various types of sensors, encoders, and methods of integration by using PLCs.
5. To expose students to data acquisition and control system.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the general function of industrial automation and **identify** safety in industrial automation.	C1,C2	1	1	1	T, Mid Term Exam, F
CO2	**Identify** practical programmable logic controller applications as well as **recognize** fundamentals of programming.	C1,C2	3	1	3,5	ASG, Mid Term Exam, F

CO3	**Use** arithmetic and advanced instructions in industrial automation including common arithmetic instructions, add, subtract, multiply, divide, and compare function, logical, operators, average, standard deviation, trigonometric, numbering system conversion sequencers and shift register prepare part program using programming languages such as APT.	C3	3	3	6	ASG, Mid Term Exam, F
CO4	**Explain** fundamentals of process control including process and control, proportional, integral, derivative (PID) control and tuning.	C1	1	1	1,2	T, ASG, R, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Robot: Robot anatomy, Drive systems of robots, Electrical and hydraulic systems, AC and DC drives, Servo drives using voltage control, current control and direct torque control, PID control systems and performance issues. Feedback systems, Single loop and multi-loop, DSP based motion control systems, Sensors for industrial robots, encoders, resolvers, hall-effect sensors, acoustic sensors, ultrasonic and optical/infrared sensors, Elements of robot vision, Integration using PLCs, digital motion planning systems

Computer Control Machines: Introduction, classification, design features and control features of CNC machines; Programming: G and M Code programming, Offline (APT-like) programming; free form surface machining: Isoparametric, Isoplanar and Isoscallop machining strategies.

Mapping of Course Outcomes and Program Outcomes:

No.	Course Outcomes (CO) of the Course	Program Outcomes (PO)											
		Engineering Knowledge	Problem Analysis	Design / Development of	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** the general function of industrial automation and **identify** safety in industrial automation.	**H**	**H**	**H**		**M**							
CO2	**Identify** practical programmable logic controller applications as well as **recognize** fundamentals of programming.	**H**	**M**	**H**									
CO3	**Use** arithmetic and advanced instructions in industrial automation including common arithmetic instructions, add, subtract, multiply, divide, and compare function, logical, operators, average, standard deviation, trigonometric, numbering system conversion sequencers and shift register prepare part program using programming languages such as APT.	**H**		**H**							**M**		

CO4	**Explain** fundamentals of process control including process and control, proportional, integral, derivative (PID) control and tuning.	**H**		**H**									

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	**Lecture**	**Topics**	**ASSESSMENT**
1	Lec 1 Lec 2 Lec 3	Introduction Automation system utilized in manufacturing industries Basic control systems: in pressure, flow, level, temperature etc	**Class Test 1, ASG, F**
2	Lec 4 Lec 5 Lec 6	Pumps, valves, indicators, Switches, recorders. transmitters Signal conditioners, drives etc.	
3	Lec 7 Lec 8	Drive systems of robots: AC and DC drives,	

	Lec 9	Typical electronic controls used to position pneumatic found in many mechanical processes, actuators, servo valves etc. Typical electronic controls used to hydraulic cylinders found in many mechanical processes, actuators, servo valves etc.	
4	Lec 10 Lec 11 Lec 12	Introduction to system sensors Use of sensor in automation image and vision processing Web-based manufacturing monitoring system	**Class Test 2, ASG, PR, F**
5	Lec 13 Lec 14 Lec 15	Sensors for industrial robots, encoders Resolvers, hall-effect sensors Acoustic sensors, ultrasonic and optical/infrared sensors,	
6	Lec 16 Lec 17 Lec 18	Basic principles of operation and programming of PLC/PID Computer-based PLC simulation and real plcs for programming practice PLC programming and control knowledge in typical industrial operation	
7	Lec 19 Lec 20 Lec 21	Integration using PLCs Digital motion planning systems **Review Class 1**	
8	Lec 22 Lec 23 Lec 24	Introduction to Data acquisition Control system Multiple Human Machine Interface	**Mid Term, F**
9	Lec 25 Lec 26 Lec 27	Computer software programs Computer software programs and today’s industry Modern Uses of Software	
10	Lec 31 Lec 32 Lec 33	PC hardware interfacing PC communications data acquisition	
11	Lec 28 Lec 29 Lec 30	Data acquisition (Cntd) Data acquisition and display	**Class Test 3, ASG, R, PR, F**
12	Lec 34 Lec 35 Lec 36	Introduction to Supervisory Control and Data Acquisition (SCADA) Supervisory Control and Data Acquisition (SCADA)Techniques	
13	Lec 37 Lec 38 Lec 39	Introduction to Distributed Control System (DCS) Control System (DCS) and data highways	
14	Lec 40 Lec 41 Lec 42	Presentation **Review Class 2**	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

<table>
<tr><th colspan="3">Assessment Strategies</th><th rowspan="2">CO</th><th rowspan="2">Bloom’s Taxonomy</th></tr>
<tr><th colspan="2">Components</th><th>Grading</th></tr>
<tr><td rowspan="9">Continuous Assessment (40%)</td><td rowspan="3">Test 1-3</td><td rowspan="3">20%</td><td>CO 1</td><td>C1,C2</td></tr>
<tr><td>CO 3</td><td>C3</td></tr>
<tr><td>CO 4</td><td>C1</td></tr>
<tr><td rowspan="2">Class Participation</td><td rowspan="2">5%</td><td>CO 2</td><td>C1,C2</td></tr>
<tr><td>CO 1</td><td>C1,C2</td></tr>
<tr><td rowspan="3">Mid term</td><td rowspan="3">15%</td><td>CO 1</td><td>C1,C2</td></tr>
<tr><td>CO 2</td><td>C1,C2</td></tr>
<tr><td>CO 3</td><td>C3</td></tr>
<tr><td colspan="2" rowspan="4">Final Exam</td><td rowspan="4">60%</td><td>CO 1</td><td>C1,C2</td></tr>
<tr><td>CO 2</td><td>C1,C2</td></tr>
<tr><td>CO 3</td><td>C3</td></tr>
<tr><td>CO 4</td><td>C1</td></tr>
<tr><td colspan="2">Total Marks</td><td>100%</td><td colspan="2"></td></tr>
</table>

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Industrial Control Electronics Devices, Systems, & Applications - Terry Bartlet
2. Industrial Automation: Hands On - Frank Lamb

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 423 **Course Name:** Robotics
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: (1) CSE 281: Computer Programming Techniques
(2) IPE 271: Engineering Mechanics and Theory of Machines
(3) CSE 282: Computer Programming Techniques Sessional
(4) IPE 243: Mechanics of Solids
(5) IPE 301: Measurement, Instrumentation and Control
(6) IPE 302: Measurement, Instrumentation and Control Sessional

Synopsis/Rationale:

This Outcome Based Education (OBE) based course, is designed to introduce the concepts of Robotic system, its components and instrumentation and control related to robotics and to prepare the students to be able to recognize the suitability and implications of applying the robotics technology to specific industrial applications. This curricular unit aims to provide the students with the necessary tools so they can be able to understand, characterize, specify and use of robotic manipulators, as well as to program and operate industrial robotic manipulators.

Objectives:

i. To develop the student's knowledge in various robot structures and their workspace
ii. To develop student's skills in performing spatial transformations associated with rigid body motions
iii. To develop student's skills in perform kinematics analysis of robot systems
iv. To provide the student with knowledge of the singularity issues associated with the operation of robotic systems
v. To provide the student with some knowledge and analysis skills associated with trajectory planning
vi. To provide the student with some knowledge and skills associated with robot control

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Define** and **describe** the fundamentals of robotics and its components, kinematics and dynamics of robotics and **explain** the need and implementation of related instrumentation & control in robotics.	C1,C2	1		1	T, Mid Term Exam, F
CO 2	**Discuss, model and solve** the math and computational methods related to kinematic problems involving robot manipulators and mobile robots.	C2-C6	1		1,2	T, ASG, F

CO 3	**Appraise** the computational challenges inherent in fundamental mobile robotic tasks (e.g. localization, mapping, motion planning)**.**	C2-C5	1		2,3	T, F
CO 4	**Use** robot inputs and outputs to control operation sequence and create, modify, and **execute** different robot programs.	C3,C4	1		1,3	T, Mid Term Exam, ASG, F
CO 5	**Develop** simple robot control systems integrating perception, planning, and action.	C6	1,3	1,2	3	ASG, Pr, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Basic Concepts in Robotics: Automation and robotics, Robot anatomy, Basic structure of robots Resolution, Accuracy and repeatability, and Classification and Structure of robots, Point to point and continuous path systems.

Robotic System and Control Systems: Components of robotic system, Hydraulic systems, DC servo motors, Basic control systems concepts and models, Control system analysis, Robot activation and feedback components, Positional and velocity sensors, actuators. Power transmission systems

Robot arm Kinematics and Dynamics: Robot joints, The direct kinematics problem, The inverse kinematics solution, Lagrange-Euler formation, Generalized D'Alembert equations of motion, Denavit-Hartenberg convention and its applications

Sensors and Instrumentation in robotics: Tactile sensors, proximity and range sensors, Force and torque sensors, Uses of sensors in robotics, Vision equipment, Image processing, Concept of low level and high level vision

Robot control: Decoupling of nonlinear systems, feed forward and feedback control, control models and strategies, position control and simple feedback synthesis, adaptive control and force control

Computer based Robotics: Method of robots programming, GUI based robotic arm control, Introduction to Artificial Intelligence, Interfacing with computer, communication and data processing

Mobile robots kinematics: Path planning and control, Research in robotics, Future of robotics

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO**	**PO**	**PO 10**	**PO 11**	**PO 12**
CO1	**Define** and **describe** the fundamentals of robotics and its components, kinematics and dynamics of robotics and **explain** the need and implementation of related instrumentation & control in robotics.	**H**											
CO2	**Discuss, model and solve** the math and computational methods related to kinematic problems involving robot manipulators and mobile robots.	**H**	**M**										
CO3	**Appraise** the computational challenges inherent in fundamental mobile robotic tasks (e.g. localization, mapping, motion planning)**.**	**H**			**M**								
CO4	**Use** robot inputs and outputs to control operation sequence and create, modify, and	**H**		**H**									

	execute different robot programs.												
CO5	**Develop** simple robot control systems integrating perception, planning, and action.	**H**	**H**	**H**							**H**		

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	**Lecture**	**Topics**	**ASSESSMENT**
1	Lec 1 Lec 2 Lec 3	Basic Concepts in Robotics: Automation and robotics, Robot anatomy, Basic structure of robots	

2	Lec 4 Lec 5 Lec 6	Resolution, Accuracy and repeatability, and Classification and Structure of robots, Point to point and continuous path systems.	**Class Test 1**
3	Lec 7 Lec 8 Lec 9	Robotic System and Control Systems: Components of robotic system, Hydraulic systems, DC servo motors	
4	Lec 10 Lec 11 Lec 12	Basic control systems concepts and models Control system analysis, Robot activation and feedback components	
5	Lec 13 Lec 14 Lec 15	Positional and velocity sensors, actuators. Power transmission systems	
6	Lec 16 Lec 17 Lec 18	Robot arm Kinematics and Dynamics: Robot joints, The direct kinematics problem, The inverse kinematics solution	**Class Test 2**
7	Lec 19 Lec 20 Lec 21	Lagrange-Euler formation, Generalized D'Alembert equations of motion, Denavit-Hartenberg convention and its applications.	
8	Lec 22 Lec 23 Lec 24	Sensors and Instrumentation in robotics: Tactile sensors, proximity and range sensors, Force and torque sensors, Uses of sensors in robotics.	
9	Lec 25 Lec 26 Lec 27	Vision equipment, Image processing, Concept of low level and high level vision.	
10	Lec 31 Lec 32 Lec 33	Robot control: decoupling of nonlinear systems, feed forward and feedback control, control models and strategies, position control and simple feedback synthesis, adaptive control and force control.	**Mid Term Exam**
11	Lec 28 Lec 29 Lec 30	Computer based Robotics: Method of robots programming	
12	Lec 34 Lec 35 Lec 36	GUI based robotic arm control, Introduction to Artificial Intelligence	
13	Lec 37 Lec 38 Lec 39	Interfacing with computer, communication and data processing	**Class Test 3, ASG, R, F**
14	Lec 40 Lec 41 Lec 42	Mobile robots kinematics, path planning and control, Research in robotics, Future of robotics **Review for Final Exam**	

(PR – Project; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1,C2
			CO 2	C2-C6
			CO 3	C2-C5
	Class Participation	5%	CO 2	C2-C6
			CO4	C3,C4
	Mid term	15%	CO 1	C1,C2
			CO 4	C3,C4
Final Exam		60%	CO 1	C1,C2
			CO 2	C2-C6
			CO 3	C2-C5
			CO 4	C3,C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

n) CAD/CAM principles of application - P.N. Rao
o) Robot Manipulators, Mathematics, Programming and Control - Richard Paul
p) Introduction to Robotics - John J. Craig

Reference Site:
https://classroom.google.com/ (To be announced)

Course Code: IPE 425 **Course Name:** Marketing Management
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: (1) IPE 207: Engineering Economy

Synopsis/Rationale:

This Outcome Based Education (OBE) based course, which introduces students to concepts of marketing. This course focuses on various marketing strategies, including segmentation, targeting, positioning, and marketing mix (product, price, place and promotion) strategies and to explore how those strategies contribute to the company's competitive advantage in the marketplace.

Objectives:

1. The overall objective of the course is to provide students with the basic understanding of marketing concepts and theories
2. To give students the basic knowledge of the marketing discipline.
3. To cover the major topics of classical marketing.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Outline** the key marketing concepts and fields of their application	C1-C4			1	T, Mid Term Exam, F
CO 2	**Develop** marketing mix for different markets (b2b, b2c, services)	C3, C4	1	1	1	ASG, Mid Term Exam, F
CO 3	**Apply** marketing theories and approaches during class discussions and work on group projects	C2-C4	2	2	2	ASG, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

The role and understanding of marketing: Course introduction, Defining marketing, What is marketing/marketing process, Marketing principles

Different types of markets (consumer markets – b2c, industrial markets – b2b, service markets)

Market analysis: The marketing environment and markets, B2C markets and consumer buying behavior, B2B markets and services, Marketing research and marketing information systems, Strategic marketing, Segmentation, Targeting and Positioning (STP),

Operational marketing: Marketing Mix, The product mix, The price mix, The distribution mix, The communication mix, The Marketing mix principle, Products, services and branding decisions, Price decisions, Channel management and retailing

Marketing communications: tools and techniques. Managing marketing communications

Marketing organization and controlling: Marketing implementation and control, Marketing Metrics

Marketing management in Emerging markets: The impact of Emerging markets on marketing development, Contemporary marketing practices. Principles of relational marketing

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Outline** the key marketing concepts and fields of their application	H				**M**						**M**	**H**
CO2	**Develop** marketing mix for different markets (b2b, b2c, services)		**M**						**L**	**H**	**H**	**M**	**H**
CO3	**Apply** marketing theories and approaches during class discussions and work on group projects		**H**		**L**					**H**		**M**	**H**

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	18
Revision	21
Assignment Preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	106

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	**The role and understanding of marketing:** Course introduction.	ASG, Class Test 1
	Lec 2	Presentation of main course topics. Explanation of learning outcomes	
	Lec 3	Defining marketing. What is marketing / marketing process?	
2	Lec 4	Marketing principles	
	Lec 5	**Different types of markets**	
	Lec 6	**Market analysis**	
3	Lec 7	The marketing environment and markets	
	Lec 8	B2c markets and consumer buying behavior	
	Lec 9	B2B markets and services	
4	Lec 10	Marketing research and marketing information systems	ASG, Class Test 2
	Lec 11	**Strategic marketing**	
	Lec 12	Segmentation, Targeting and Positioning (STP)	
5	Lec 13	Marketing strategy	
	Lec 14	Marketing strategy (Contd.)	
	Lec 15	Marketing strategy (Contd.)	
6	Lec 16	Segmentation	
	Lec 17	Targeting and Positioning (STP)	
	Lec 18	**Operational marketing**	
7	Lec 19	Marketing Mix	
	Lec 20	Marketing Mix (Contd.)	
	Lec 21	Marketing Mix (Contd.)	
8	Lec 22	The product mix	
	Lec 23	The product mix (Contd.)	

	Lec 24	The product mix (Contd.)	**Mid Term**
9	Lec 25	The price mix	
	Lec 26	The price mix	
	Lec 27	The distribution mix	
10	Lec 28	The communication mix	**ASG, Class Test 3**
	Lec 29	The communication mix	
	Lec 30	The Marketing mix principle	
11	Lec 31	The Marketing mix principle	
	Lec 32	The Marketing mix principle	
	Lec 33	Products, services and branding decisions	
12	Lec 34	Price decisions	
	Lec 35	Channel management and retailing	
	Lec 36	Marketing communications	
13	Lec 37	Managing marketing communications	**ASG,F**
	Lec 38	Marketing implementation and control	
	Lec 39	Marketing implementation and control, Marketing Metrics	
14	Lec 40	The impact of Emerging markets on marketing development	
	Lec 41	Contemporary marketing practices	
	Lec 42	Principles of relational marketing	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (40%)	Class test 1-3	20%	CO 1	C1-C3
			CO 2	C4, P4
			CO 3	P4,C1,C4
		5%	CO 1	C1-C3, A2

	Class Participation		CO 2	C4, P4
	Mid term	15%	CO 1	C1-C3
			CO 2	C4, P4
Final Exam		60%	CO 1	C1-C3
			CO 2	C4, P4
			CO 3	P4, C1, C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

i. Marshall & Johnston, Marketing Management, McGraw Hill
ii. Kotler & Keller, 14th ed., Marketing Management, Prentice Hall
iii. Chernev & Kotler, 5th ed., Strategic Marketing Management, Brightstar Media

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 427 **Course Title:** Control Engineering
Credit Hour: 3.00 **Contact Hour:** 3.00 (Lecture)
Course Curriculum: Outcome Based Education (OBE)

Pre-requisites:
(1) IPE 301: Measurement, Instrumentation and Control
(2) MATH-201: Differential Equations and Laplace Transform
(3) CSE 281: Computer Programming Techniques
(4) EECE 171: Basic Electrical and Electronic Circuit
(5) IPE 271: Engineering Mechanics and Theory of Machines

Synopsis/Rationale

This course follows the Outcome Based Education (OBE) approach and introduces students to the concept of dynamic systems modeling and control systems design. Mathematical representations of control systems by different equations and Laplace transformations, block diagrams and transfer functions are emphasized as well as visualization using MATLAB programming. Salient aspects of control systems such system input and response (time and frequency domain), control action, system types, Lead-Lag compensators etc. are analyzed analytically. Analogues of control systems (mechanical, fluids, thermal and electrical) as well as orientation with electro-hydro-pneumatic and electromechanical controls help students understand the scope of the subject and its real world applications. Concurrent with the theory, some physical demonstrations and computer simulations in MATLAB aid in cementing students' grasp of the subject matter. Finally, digital and robust control systems are introduced which are the current approaches to control and automation in the industry.

Objectives:

i. To understand the application of physical laws and differential equations in order to create mathematical models of dynamic systems
ii. To apply concepts of transfer function and Laplace transforms in order to analyze system response
iii. To analyze control system stability and to evaluate robustness of comparable systems under standard inputs
iv. To apply PLC and PID based control protocols to design simulated control systems of real world applications
v. To evaluate the performance of digital and robust systems using time and frequency domain outputs and simulation in MATLAB

Course Outcomes (CO):

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Explain** the basics of mathematical modeling of systems, apply relevant physical and engineering principles and develop suitable models. (**PO: 1, 2, 3, 9**)	C2-C6	1,2	2	1	Group ASG, Mid-Term Exam, F
CO 2	**Outline** the fundamental tenets of linearization and Laplace transformation, apply transformations and complex frequency 's' variables to analyze and visualize responses of dynamic systems to standard inputs: impulse, step, ramp and parabolic. (**PO: 1, 2, 5, 9**)	C2-C4	1	1, 2	1	ASG, T, Mid Term Exam

CO 3	**Apply** the analytical tools and MATLAB simulation to analyze stability of control systems and use it to evaluate the performance of various such systems in order to decide the best controller for a particular problem. (**PO: 1, 2, 5, 9, 10**)	C3-C5, P3	2	1	2	ASG, Mid Term Exam, F
CO 4	**Explain** the basics of PID and PLC control algorithms, analyze requirements, apply software/analytical approach to design control systems for real world problems. (**PO: 1-5, 9, 12**)	C2-C4, P3, P4	1	2	1	T, ASG, PR, F
CO 5	**Interpret** the use of time and frequency domain plots of control systems, analyze the outputs of MATLAB based control simulations, evaluate the stability and robustness of concerned control systems. (**PO: 1, 2, 5**)	C2-C5, P3, P4	1	1, 2	1	ASG, PR, R, T, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

i. **Control Systems:** Open and closed loop control systems; Feedback and feed-forward control architectures, their basics and performance evaluation, limitations, robustness and stability; Fundamentals of modeling dynamic systems using the laws of physics and differential equations, linear approximation using Taylor series.

ii. **Block Diagrams:** Fundamentals of block diagram representations of control systems, their simplifications and applications in designing control system architecture; Signal Flow graph models; Simulation of control systems using MATLAB.

iii. **Mass-Spring-Damper Systems:** Analogies of single and multi-body systems, natural and forced responses, damping ratios, resonant peaks and band widths; Applications in real world including active vehicle suspension system control with demonstration, and simulation via MATLAB.

iv. **RLC Circuit based Control**: Concept, mathematical models and control applications of RLC circuits including Operational Amplifiers, Demonstration, MATLAB simulation.

v. **State Variable Approach:** State variables of a dynamic system, state differential equation, system response using state transition matrix, simulation of state variable models of control systems using MATLAB.

vi. **Inputs and Responses of Control Systems:** Standard inputs (unit impulse, rectangular, step, ramp, parabolic etc.); Responses of dynamic systems (natural, forced, transient, steady-state etc.); Percentage overshoot, Lead-Lag.

vii. **Stability Analysis:** Basic concept for linear systems using the Routh array test, marginal stability, control design constraints, applications in feedback systems.

viii. **Evans Root Locus techniques:** Mathematical basis and application in control design for real world systems.

ix. **Gain and Phase margins:** Basic concept, polar plots, computation from Bode diagrams and Nyquist plots, implications in terms of robust stability of control systems.

x. Actuator Control: Pneumatic, hydro-pneumatic, electro-hydro-pneumatic actutators, study of pneumatic circuits with physical demonstration, electro-hydro-pneumatic control system demonstration and mathematical modeling for 4 post car lift, simulation using MATLAB; D.C. and servo motors control methods and mathematical models, their analysis using block diagrams and transfer functions.

xi. **Design of Feedback Control Systems:** Phase Lead and Lag-Design using Bode diagrams and root locus; Lead-Lag compensators based on frequency data for open-loop linear systems; PLC based control fundamentals, physical demonstration using trainer and MATLAB simulation; PID controller basics, algorithms for control including ladder diagrams, designing PID controllers based on empirical tuning rules, physical demonstration and modeling of water level control in water reservoir and temperature control in heating set-ups.

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	30
Computer Lab based simulation tutorials	10
Physical demonstrations of mechanical, thermal, fluid and electrical dynamic systems and their control	5
Student-Centred Learning (MIT's Open Courseware study, online blogs and class open discussion (life long learning)	5
Self-Directed Learning	
Non-face-to-face learning	40
Revision	10
Assignment Preparations	20
Formal Assessment	
Continuous Assessment	2.5
Final Examination	3
Total	125.5

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Blooms Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 2	C2-C4
			CO 4	C2-C4, P3, P4
			CO 5	C2-C5, P3, P4
	Class Participation	5%	CO 2	C2-C4
			CO 4	C2-C4, P3, P4
	Mid term	15%	CO 1	C2-C6
			CO 2	C2-C4
			CO 3	C3-C5, P3
Final Exam		60%	CO 1	C2-C6
			CO 3	C3-C5, P3
			CO 4	C2-C4, P3, P4
			CO 5	C2-C5, P3, P4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcome**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** the basics of mathematical modeling of systems, apply relevant	H	H	M						M			

	physical and engineering principles and develop suitable models. **(PO: 1, 2, 3, 9)**												
CO2	**Outline** the fundamental tenets of linearization and Laplace transformation, apply transformations and complex frequency 's' variables to analyze and visualize responses of dynamic systems to standard inputs: impulse, step, ramp and parabolic. **(PO: 1, 2, 5, 9)**	H	H			H				H			
CO3	**Apply** the analytical tools and MATLAB simulation to analyze stability of control systems and use it to evaluate the performance of various such systems in order to decide the best controller for a particular problem. **(PO: 1, 2, 5, 9, 10)**	H	M			M				H	H		
CO4	**Explain** the basics of PID and PLC control algorithms, analyze requirements, apply software/analytical approach to design control systems for real world problems**. (PO: 1-5, 9, 12)**	H	H	M	M	H				H			H
CO5	**Interpret** the use of time and frequency domain plots of control systems, analyze the outputs of MATLAB based control simulations, evaluate the stability and **robustness of concerned control systems. (PO: 1, 2, 5)**	H	H			M							

(H – High, M- Medium, L-low)

Lecture Schedule:

Week	**Lecture**	**Topics**	**ASSESSMENT**
1	Lec 1 Lec 2 Lec 3	Dynamic systems introduction and their modeling using ODEs	
2	Lec 4 Lec 5	Control systems introduction and types: feedback and feed forward, open and closed	**Class Test 1, ASG**

	Lec 6	loop control; their importance, demonstration using automobile ECU.	
3	Lec 7 Lec 8 Lec 9	Mass-spring-damper systems for single and multi-body, ODEs, Laplace transforms, demonstration via vehicle active suspension, visualization using MATLAB	
4	Lec 10 Lec 11 Lec 12	Resistor, Inductor and Capacitor (RLC) circuit basics, analogy with mechanical systems, RLC control, visualization using MATLAB	**Class Test 2, ASG, PR**
5	Lec 13 Lec 14 Lec 15	State Variable Approach to control engineering, state differential equation, system response using state transition matrix, simulation in MATLAB	
6	Lec 16 Lec 17 Lec 18	Inputs of Control Systems: Standard inputs (unit impulse, rectangular, step, ramp, parabolic etc.); Responses of dynamic systems (natural, forced, transient, steady-state etc.); Lead-Lag.	
7	Lec 19 Lec 20 Lec 21	Stability Analysis of linear systems, concept of marginal stability, control design constraints, applications in feedback systems; **Review for Mid-term Exam**	
8	Lec 22 Lec 23 Lec 24	Root Locus: Mathematical basis, plots and application in control system design	**Mid Term**
9	Lec 25 Lec 26 Lec 27	Gain and Phase margins: Basic concept, polar plots, Bode diagrams and Nyquist plots, robust stability of control systems, MATLAB simulations	
10	Lec 31 Lec 32 Lec 33	Actuator Control for pneumatic, hydro-pneumatic, electro-hydro-pneumatic actutators, demonstrations using pneumatic circuits and 4 post car lift, simulations in MATLAB; D.C. and servo motors control, block diagrams and transfer functions methods	

<table>
<tr><td>11</td><td>Lec 28
Lec 29
Lec 30</td><td>Design of Feedback Control Systems for Phase Lead and Lag-Design using Bode diagrams and root locus; Lead-Lag compensators, MATLAB visualization</td><td rowspan="4">Class Test 3, ASG, R, PR, Pr, F</td></tr>
<tr><td>12</td><td>Lec 34
Lec 35
Lec 36</td><td>PLC based control systems, physical demonstration using PLC trainer, and MATLAB simulation.</td></tr>
<tr><td>13</td><td>Lec 37
Lec 38
Lec 39</td><td>PID controller basics, ladder diagrams, PID design using empirical tuning rules, physical demonstration using water level control in water reservoir and temperature control in heating set-ups, MATLAB visualization</td></tr>
<tr><td>14</td><td>Lec 40
Lec 41
Lec 42</td><td>Control system design and evaluation using MATLAB;
Review for Final Exam</td></tr>
</table>

(PR – Project ; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations in MATLAB, Physical demonstrations of systems in laboratory, Open discussion & blogs, Assignments, Class Tests, Exams, Feedback at every step.

Text and Ref Books:

a) Modern Control Systems, 12th Edition, by Dorf and Bishop (Text Book)
b) Control System Engineering, 6th Edition, by Norman Nise (Reference Book & Further Reading)
c) Introduction to Automatic Controls, 2nd Edition, by Howard L. Harrison and John G. Bollinger (Reference)

Course Code: IPE 431 **Course Name:** Computer Integrated Manufacturing
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: (1) IPE 201: Manufacturing Process I
(2) IPE 203: Manufacturing Process II

Synopsis/Rationale:

This course emphasizes the integration of manufacturing enterprise using computer-integrated manufacturing (CIM) technologies. It employs CAD/CAM interface and other CIM sub-systems, database management, facility layout, product documentation, process planning, production planning and control, Group technology, teamwork, and manufacturing operations and management to bring about a student's-designed CIM-oriented enterprise.

Objectives:

1. To develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques.
2. To develop an understanding of computer-integrated manufacturing (CIM) and its impact on productivity, product cost, and quality.
3. To obtain an overview of computer technologies including computers, database and data collection, networks, machine control, etc., as they apply to factory management and factory floor operations.
4. To describe the integration of manufacturing activities into a complete system
5. To acquire sensitivity to human-factors related issues as they affect decision making in the factory environment.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the merit and demerits of applying group technology and cellular manufacturing in any kind of industry and analyze the feasibility of cellular manufacturing in that industry.	C2, C3	1	1	2,3	T, Mid Term Exam, F
CO2	**Design and Propose** an automated material handling system that ensure the minimum movement of the material even after satisfying every demand.	C3, C6	1,3	3	3,4	ASG, Mid Term Exam, F
CO3	**Review and analyze** the production system of any industry and identify the areas where	C4 - C6	1	1	5,6 ,8	ASG, Mid Term Exam, F

	automation can reduce the production time and unit production cost.					
CO4	**Demonstrate** the application of data management and its importance for decision making in CIMS environment.	C3 – C6	3	1	5	T, ASG, R, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Introduction: Scope, islands of automation, architecture of CIM, information flow in CIM, elements of CIM, benefits, limitations, obstacles in implementation., Product Design and CAD, application of computers in design, CAM - manufacturing planning and control, scope of CAD / CAM and CIM, concurrent engineering, design for manufacturing and assembly.
Concept, design and manufacturing attributes, part families, composite part, methods of grouping, PFA, Classification and coding system- OPITZ, Relevance of GT in CIM, GT and CAD, benefits and limitations of GT.
Computer Aided Process Planning and Control: need, retrieval and generative type CAPP, role of CAPP in CIM.
Flexible Manufacturing Systems: Concept, flexible & rigid manufacturing cell and FMS structure, types, components of FMS, Distributed Numerical Control (DNC), Building Blocks of FMS, Flexible Assembly System.
Computer Aided Production Planning and Control: Computer integrated production management system, aggregate planning, master production schedule, shop floor control, materials requirement planning, capacity planning, manufacturing resource planning and enterprise resource planning.
Computer Aided Quality Control: Objectives, non-contact inspection methods, equipment; contact type inspection: Co-ordinate Measuring Machines (CMM), construction, working principle and applications, Inspection robots.
Production Support Machines and Systems in CIM: Industrial robots for load/unload, automated material handling, automatic guided vehicles, automated storage and retrieval system.
Data Acquisition and Database Management Systems: (a) Data acquisition system,type of data, automatic data identification methods, bar code technology, machine vision.(b) Data and database management system, database design requirements, types of DBMS models- hierarchical, network and relational models and their applications.
Planning and Implementation of CIMS: Planning for CIMS, need for planning, Phases of CIM implementation, incremental implementation and one time implementation, CIM benchmarking, Economic and social justification of CIM.

Mapping of Course Outcomes and Program Outcomes:

No.		Program Outcomes (PO)

	Course Outcomes (CO) of the Course	Engineering Knowledge	Problem Analysis	Design / Development of	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** the merit and demerits of applying group technology and cellular manufacturing in any kind of industry and analyze the feasibility of cellular manufacturing in that industry.	**H**	**H**	**M**	**L**								
CO2	**Design and Propose** an automated material handling system that ensure the minimum movement of the material even after satisfying every demand.	**H**		**H**	**M**						**M**		
CO3	**Review and analyze** the production system of any industry and identify the areas where automation can reduce the production time and unit production cost.		**H**		**H**	**M**							
CO4	**Demonstrate** the application of data management and its importance for decision making in CIMS environment.	**M**	**H**	**H**									

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Revision	20
Assignment Preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	Lec 1 Lec 2 Lec 3	Introduction: Scope, islands of automation, architecture of CIM, information flow in CIM, elements of CIM, benefits, limitations, obstacles in implementation.	**Class Test 1, ASG**
2	Lec 4 Lec 5 Lec 6	Product Design and CAD, application of computers in design, CAM - manufacturing planning and control, scope of CAD / CAM and CIM, concurrent engineering, design for manufacturing and assembly.	
3	Lec 7 Lec 8 Lec 9	Concept, design and manufacturing attributes, part families, composite part, methods of grouping, PFA	
4	Lec 10 Lec 11 Lec 12	Classification and coding system- OPITZ, Relevance of GT in CIM, GT and CAD, benefits and limitations of GT.	**Class Test 2, ASG, PR**
5	Lec 13 Lec 14 Lec 15	Computer Aided Process Planning and Control: need, retrieval and generative type CAPP, role of CAPP in CIM.	
6	Lec 16 Lec 17 Lec 18	Flexible Manufacturing Systems: Concept, flexible & rigid manufacturing cell and FMS structure, types, components of FMS	

7	Lec 19 Lec 20 Lec 21	Distributed Numerical Control (DNC), Building Blocks of FMS, Flexible Assembly System.	
8	Lec 22 Lec 23 Lec 24	Computer Aided Production Planning and Control: Computer integrated production management system, aggregate planning, master	**Mid Term**
9	Lec 25 Lec 26 Lec 27	Production schedule, shop floor control, materials requirement planning, capacity planning, manufacturing resource planning and enterprise resource planning.	
10	Lec 31 Lec 32 Lec 33	Computer Aided Quality Control: Objectives, non-contact inspection methods, equipment; contact type inspection: Co-ordinate Measuring Machines (CMM), construction, working principle and applications, Inspection robots.	
11	Lec 28 Lec 29 Lec 30	Production Support Machines and Systems in CIM: Industrial robots for load/unload, automated material handling, automatic guided vehicles, automated storage and retrieval system.	**Class Test 3, ASG, R, PR, F**
12	Lec 34 Lec 35 Lec 36	Data Acquisition and Database Management Systems: (a) Data acquisition system,type of data, automatic data identification methods, bar code technology, machine vision.(b) Data and database management system, database design requirements, types of DBMS models- hierarchical, network and relational models and their applications.	
13	Lec 37 Lec 38 Lec 39	Planning and Implementation of CIMS: Planning for CIMS, need for planning, Phases of CIM implementation, incremental implementation and one time implementation, CIM benchmarking, Economic and social justification of CIM.	
14	Lec 40 Lec 41 Lec 42	**Review for Final Exam**	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies	CO	Bloom's Taxonomy

Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C2, C3
			CO 3	C4 - C6
			CO 4	C3 – C6
	Class Participation	5%	CO 2	C3, C6
			CO 1	C1-C4
	Mid term	15%	CO 1	C2, C3
			CO 2	C3, C6
			CO 3	C4 - C6
Final Exam		60%	CO 1	C2, C3
			CO 2	C3, C6
			CO 3	C4 - C6
			CO 4	C3 – C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

q) Automation, Production Systems, and Computer-integrated Manufacturing - Mikell P. Groover
r) Computer-integrated manufacturing technology and systems - Rembold, Ulrich, Christian Blume, and Ruediger Dillmann.

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 429 **Course Name:** Organizational Behavior

Credit Hour: 3.00 **Contact Hour:** 3.00

Level/Term: L-4, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Rationale:

The main objective of Organizational Behavior course is to help the students to acquire and develop skill to take rational decisions in the process of Organizational Behavior by understanding the human interactions in an organization, finding what is driving it and influencing it for getting better results in attaining business goals. It details the impact of individual, group and organizational factors on human behavior. It highlights the significance of Challenges and Opportunities of OB, perception, attribution, learning, organizational change, organizational culture, motivation, leadership and conflict management.

Objectives:

1. To explain the organizational behavioral challenges in the Bangladeshi work environment.
2. To illustrate the impact of perception, personality and emotions.
3. To articulate the impact of values, attitudes and the influence of diversity.
4. To explain interpersonal conflict and conflict resolution.
5. To critique the most popular bases of power in organizations.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**List** and **define** basic organizational behavior principles, and **analyze** how these influence behavior in the workplace.	C1,C4			1	T, Mid Term Exam, F
CO 2	**Analyze** individual human behavior in the workplace as influenced by personality, values, perceptions, and motivations.	C4	1		1	T,Mid Term Exam, F
CO 3	**Outline** the elements of group behavior including group dynamics, communication, leadership, power & politics and conflict & negotiation.	C1			1	Mid Term Exam, F
CO 4	**Demonstrate** your own management style as it relates to influencing and managing behavior in the organization systems.	C2			1	T, ASG, R, F

CO 5	**Demonstrate** critical thinking and analysis skills through the use of management case studies, personal application papers and small group exercises.	C3	1,3	1	1	ASG, PR, R
CO 6	Strengthen research, writing and presentation skills.	C1,C2				ASG,PR,R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

Behavior of individuals in organizations: values and attitudes, motivation, group and group processes: group dynamics, communication, power & conflict, organizational system: structure, job design, appraisal of performance, processes of organizational change and development.

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes	Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**List** and **define** basic organizational behavior principles, and **analyze** how these influence behavior in the workplace.				**M**								
CO2	**Analyze** individual human behavior in the workplace as influenced by personality, values, perceptions, and motivations.				**M**								
CO3	**Outline** the elements of group behavior including group dynamics, communication, leadership, power & politics and conflict & negotiation.								**M**	**M**			
CO4	**Demonstrate** your own management style as it relates to influencing and managing behavior in the organization systems.				**M**							**M**	
CO5	**Demonstrate** critical thinking and analysis skills through the use of management case studies, personal application papers and small group exercises.		**H**	**H**	**H**					**H**	**H**		

CO6	Strengthen research, writing and presentation skills.									**H**	**H**		

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Revision	20
Assignment Preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

<u>Lecture schedule:</u>

Week 1	**Organizational Behaviour:** Introduction	
Class 1	Concept and definition of Organizational Behaviour.	

Class 2	Making sense of behaviour in organizations	Class Test 1
Class 3	Challenges in the Bangladeshi workplace	
Week 2	**Perception, Personality, and Emotions**	
Class 4	Perception	
Class 5	Personality	
Class 6	Emotions	
Week 3	**Values, Attitudes, and Their Effects in the Workplace**	
Class 7	Values, Assessing cultural values	
Class 8	Values in the Bangladeshi workplace	
Class 9	Attitudes	
Week 4	**Motivating Self and Others**	Class Test 2
Class 10	Needs theories of motivation	
Class 11	Process theories of motivation	
Class 12	Responses to the reward system	
Week 5	**Motivating Self and Others**	
Class 13	Creating a motivating workplace: rewards and job redesign	
Class 14	Caveat emptor	
Class 15	Apply motivation theories wisely	
Week 6	**Working in Teams**	
Class 16	Teams versus groups	
Class 17	Stages of group and team development	
Class 18	Twenty-first century teamwork: virtual teams	
Week 7	**Communication**	Mid Term Exam
Class 19	Communication process	
Class 20	Barriers to effective communication	
Class 21	Current issues in communication	
Week 8	**Conflict, and Negotiation**	

<table>
<tr><td>Class 22</td><td>How communication breakdown leads to conflict</td><td rowspan="8"></td></tr>
<tr><td>Class 23</td><td>Conflict resolution</td></tr>
<tr><td>Class 24</td><td>Negotiation</td></tr>
<tr><td>Week 9</td><td align="center">Power and Politics</td></tr>
<tr><td>Class 25</td><td>Bases of power</td></tr>
<tr><td>Class 26</td><td>Dependency: the key to power</td></tr>
<tr><td>Class 27</td><td>Influence tactics</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Week 10</td><td align="center">Power and Politics</td><td rowspan="21" align="center">Class Test 3</td></tr>
<tr><td>Class 28</td><td>Empowerment: giving power to employees</td></tr>
<tr><td>Class 29</td><td>Abuse of power: harassment in the workplace</td></tr>
<tr><td>Class 30</td><td>Politics: power in action</td></tr>
<tr><td>Week 11</td><td align="center">Leadership</td></tr>
<tr><td>Class 31</td><td>Leadership as supervision</td></tr>
<tr><td>Class 32</td><td>Inspirational leadership</td></tr>
<tr><td>Class 33</td><td>Contemporary leadership roles</td></tr>
<tr><td>Week 12</td><td align="center">Decision Making, Creativity, and Ethics</td></tr>
<tr><td>Class 34</td><td>Group decision making</td></tr>
<tr><td>Class 35</td><td>Creativity in organizational decision making</td></tr>
<tr><td>Class 36</td><td>Corporate social responsibility</td></tr>
<tr><td>Week 13</td><td align="center">Organizational Culture and Change</td></tr>
<tr><td>Class 37</td><td>Concept and definition of Organizational culture and change.</td></tr>
<tr><td>Class 38</td><td>Creating and sustaining an organization’s culture</td></tr>
<tr><td>Class 39</td><td>Liabilities of organizational culture</td></tr>
<tr><td>Week 14</td><td align="center">Organizational Culture and Change</td></tr>
<tr><td>Class 40</td><td>Approaches to managing change</td></tr>
</table>

Class 41	Resistance to change	
Class 42	Review	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1,C4
			CO 2	C4
			CO 4	C2
	Class Participation	5%	CO 6	C1,C2
	Mid term	15%	CO 3	C1
Final Exam		60%	CO 1	C1,C4
			CO 2	C4
			CO 3	C1
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Reference Books: Langton, Robbbins and Judge, Fundamentals of Organizational Behaviour, 4th Canadian Edition, Pearson.

Bounce Back, Nelson Press.

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 435 **Course Name:** Metal Cutting
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites:
(1) IPE 201: Manufacturing Process I
(2) IPE 202: Manufacturing Process I Sessional
(3) IPE 203: Manufacturing Process II
(4) IPE 203: Manufacturing Process II Sessional

Synopsis/Rationale:

This Outcome Based Education (OBE) based course is designed to conduct in depth study on metal cutting, geometry of cutting tool, chip tool interface, cutting forces, heat generation in metal cutting, cutting tool materials and machinability.

Objectives:

i. To conduct study on geometry of metal cutting tool.
ii. To expose students to theory of metal cutting.
iii. To conduct study on cutting forces.
iv. To conduct study on heat generation in metal cutting.
v. To expose students to various cutting tool materials and machinability.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Outline** geometry of metal cutting tool	C1-C4	1		1	T, Mid Term Exam, F
CO 2	**Explain** the theory of metal cutting.	C1-C4	1		1	T, Mid Term Exam, F
CO 3	**Explain** fundamentals of cutting forces.	C3, C4	2	1	2	T, Mid Term Exam, F
CO 4	**Interpret** the heat generation process in metal cutting.	C2-C4			1	T, Mid Term Exam, F

CO 5	**Outline** various cutting tool materials and machinability.	C2-C4	1			T, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Introduction, historical background, essential features of metal cutting, turning: tool point reference system; Geometry of single point cutting tool; Mechanism of chip formation; Classification of chips.
Chip-tool interface; Chip flow under the condition of seizure, built-up edge, machined surface; Forces acting on the cutting tool, stress on the shear plane, minimum energy theory, stress on the tool, work done and power consumption in metal cutting; Effect of various factors on cutting forces, formulae for calculating components of cutting force, measurement of cutting force and dynamometry.
Heat generation in metal cutting: sources of heat and its distribution, temperature field of the chip and the tool, formulae for calculation of cutting temperatures, effect of various factors on cutting temperature, heat flow, methods of tool temperature measurement, temperature distribution in tool, relationship of tool temperature and cutting speed;
Cutting tool materials: tool life, conditions of use, HSS, cemented carbide, ceramic tools. Ultra-hard tool materials: alumina based composites, sialon, diamond, cubic boron nitride. Machinability: magnesium, aluminum, copper, steel and cast iron, nickel, zirconium, titanium and their alloys; Methods of machinability improvement. Coolants and lubricants.

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge **PO1**	Problem Analysis **PO2**	Design / Development of Solutions **PO3**	Investigation **PO4**	Modern Tool Usage **PO5**	The Engineer and Society **PO6**	Environment and Sustainability **PO7**	Ethics **PO8**	Communication **PO9**	Individual and Team Work **PO10**	Life Long Learning **PO11**	Project Management and **PO12**
CO1	Outline geometry of metal cutting tool	H	L										

CO2	Explain the theory of metal cutting.	**H**	L	L									
CO3	Explain fundamentals of cutting forces.	**H**											
CO4	Interpret the heat generation process in metal cutting.	**H**	L										
CO5	Outline various cutting tool materials and machinability.	H	L					M					

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 10 -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	137

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	Lec 1	Introduction,	
	Lec 2	historical background	

	Lec 3	essential features of metal cutting	**ASG, Class Test 1, F**
2	Lec 4	turning	
	Lec 5	tool point reference system	
	Lec 6	Geometry of single point cutting tool;	
3	Lec 7	Mechanism of chip formation;	
	Lec 8	Classification of chips.	
	Lec 9	Chip-tool interface;	
4	Lec 10	Chip flow under the condition of seizure	**ASG, Class Test 2, F**
	Lec 11	built-up edge,	
	Lec 12	machined surface;	
5	Lec 13	Forces acting on the cutting tool,	
	Lec 14	stress on the shear plane,	
	Lec 15	minimum energy theory,	
6	Lec 16	stress on the tool,	
	Lec 17	work done and power consumption in metal cutting;	
	Lec 18	Effect of various factors on cutting forces,	
7	Lec 19	formulae for calculating components of cutting force,	
	Lec 20	Measurement of cutting force and dynamometry.	
	Lec 21	Revision	
8	Lec 22	Heat generation in metal cutting:	**ASG, Mid Term, F**
	Lec 23	sources of heat and its distribution,	
	Lec 24	temperature field of the chip and the tool,	
9	Lec 25	formulae for calculation of cutting temperatures,	
	Lec 26	effect of various factors on cutting temperature,	
	Lec 27	methods of tool temperature measurement,	
10	Lec 28	temperature distribution in tool,	
	Lec 29	relationship of tool temperature and cutting speed;	

	Lec 30	Cutting tool life,	**ASG, Class Test 3, F**
11	Lec 31	conditions of use,	
	Lec 32	HSS, cemented carbide, ceramic tools.	
	Lec 33	Ultra-hard tool materials:	
12	Lec 34	alumina based composites,	
	Lec 35	sialon, diamond, cubic boron nitride.	
	Lec 36	Machinability	
13	Lec 37	magnesium, aluminum, copper,	**ASG, F**
	Lec 38	steel and cast iron,	
	Lec 39	nickel, zirconium, titanium and their alloys;	
14	Lec 40	Methods of machinability improvement.	
	Lec 41	Coolants and lubricants.	
	Lec 42	Review	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1-C4
			CO 3	C2-C4
			CO 4	C2
	Class Participa tion	5%	CO 2	C3, C4
			CO 5	A3
	Mid term	15%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
Final Exam		60%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

- *s)* Metal Cutting: Theory & Practice - *A. Bhattacharyya*
- *t)* "Fundamentals of Metal Cutting and Machine Tools" by *B L Juneja and G S Sekhon*
- *u)* "Metal Cutting Principles" by *M C Shaw*
- *v)* "Metal Cutting and Tool Design" by *Dr B J Ranganth*
- *w)* "Metal Cutting Theory and Practice" by *David A Stephenson*

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 439 **Course Name:** Green Manufacturing
Credit Hour: 3.00 **Contact Hour:** 3.00

Level/Term: L-4, T-2

Curriculum Structure: Outcome-Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

This Outcome-Based Education (OBE) based course is designed to provide an overview of green technologies and green jobs in manufacturing. Students will develop the skills necessary to preserve and restore environmental quality and create a green working environment for the industry. This course introduces students to local, state, and national green/clean/lean/sustainable resources, share industry success stories (learn how business neighbors are implementing sustainable practices) and gather input from industries on what educators should be doing to prepare the current/future green workforce.

Objectives:

1. To offer a comprehensive overview of green manufacturing.

2. To provide practice-oriented information to help students find the green manufacturing methods for the intended applications.

3. To introduce and explain the design concepts, methods, tools, and some technologies, and operations of sustainable lean and green manufacturing systems and processes.

4. To design and maintenance of sustainable green manufacturing products, processes, service systems, and leads towards the entire greening process of multi-lifecycle manufacturing operations, factories, and their supply chains.

5. To understand the structures of sustainable manufacturing, environmental, and management practice.

Course Outcomes (CO) & Generic Skills:

No.	**Course Learning Outcome**	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the design concepts, methods, tools, the key technologies, and the operation of sustainable green manufacturing.	C1-C3	1		3	T, Mid Term, F
CO2	**Apply** the principles, techniques, and methods to customize the learned generic concepts to meet the needs of a particular industry/enterprise.	C4	3	2		Mid Term Exam, F, R
CO3	**Identify** the strategies to satisfy a set of given sustainable green manufacturing requirements.	C1, C4	2	5	3	Mid Term Exam,F,PR ,Pr
CO4	**Design** the rules and processes to meet the market need and the green manufacturing requirements by selecting and evaluating suitable technical, managerial / project management, and supply chain management schemes.	C4	3	5	1, 3	Mid Term Exam,F
CO5	**Demonstrate** commitment to class ethics.	A3	1			ASG, PR, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, F – Final Exam)						

Course Contents:

Introduction to lean sustainable green manufacturing. Analytical methods and computational assessment and design tools for evaluating and designing green manufacturing sustainability processes, requirements, and risks. The sustainable lean and green audit process. International green manufacturing standards and compliance. Green rapid prototyping and rapid manufacturing.

Green flexible automation. Globally green manufacturing supply chains and logistic networks. Sustainable green manufacturing system design and project management.

Life Cycle Assessment in Sustainable Green Manufacturing. Statistics in sustainability (for quantification). Optimization for sustainability. Optimization for sustainability continued. Design of Experiments for Green Manufacturing Systems. Value Engineering Green Plan. Design for Sustainability and Maintenance. Green transportation models. Sustainable Manufacturing facility development. Design of Higher Education for Sustainable development.

Mapping of Course Outcomes and Program Outcomes:

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life-Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**Explain** the design concepts, methods, tools, the key technologies, and the operation of sustainable green manufacturing.	H		H		H		H					
CO2	**Apply** the principles, techniques, and methods to		H		H						H		

	customize the learned generic concepts to meet the needs of a particular industry/enterprise.												
CO3	**Identify** the strategies to satisfy a set of given sustainable green manufacturing requirements.				H		M					M	
CO4	**Design** the rules and processes to meet the market need and the green manufacturing requirements by selecting and evaluating suitable technical, managerial / project management, and supply chain management schemes.			H				H				M	H
CO5	**Demonstrate** commitment to class ethics.								H				

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Revision	20
Assessment Preparations	19

Formal Assessment Continuous Assessment Final Examination	 2 3
Total	126

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multimedia Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	1	Introduction to Advanced Green Manufacturing Systems.	CT 1 to be held on these topics
	2	General Concepts in Sustainable Green Manufacturing.	
2	1	Life Cycle Assessment in Sustainable Green Manufacturing.	
	2	Statistics in sustainability (for quantification)	
3	1	Statistics in sustainability (for quantification) (cont.)	
	2	Mechanical/Manufacturing Engineering Technology Curriculum Concerns	
4	1	Optimization for sustainability	
	2	Optimization for sustainability (cont.)	
5	1	Optimization for sustainability continued	
	2	Optimization for sustainability continued (cont.)	
6	1	Design of Experiments for Green Manufacturing Systems	

	2	Design of Experiments for Green Manufacturing Systems (cont.)	CT 2 to be held on these topics, ASG, PR
7	1	Value Engineering Green Plan	
	2	Value Engineering Green Plan (cont.)	
8	1	Design for Sustainability and Maintenance	CT 3 to be held on these topics
	2	Design for Sustainability and Maintenance (cont.)	
9	1	Green transportation models	
	2	Green transportation models (cont.)	
10	1	Green Manufacturing techniques	
	2	Green Manufacturing techniques (cont.)	
11	1	Life Cycle Assessment (software demonstration)	CT 4 to be held on these topics, ASG, PR
	2	Life Cycle Assessment (software demonstration) (cont.)	
12	1	Sustainable Manufacturing facility development	
	2	Sustainable Manufacturing facility development (cont.)	
13	1	Design of Higher Education for Sustainable development	
	2	Design of Higher Education for Sustainable development (cont.)	
14	1	Description of Proposed Course for Sustainable Green Manufacturing	
	2	Course Review for Final Exam	

(PR – Project; ASG – Assignment)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom’s Taxonomy
	Test 1-3	20%	CO 1	C1 - C4

			CO 2	C2 - C4
			CO 4	C2
Continuous Assessment (40%)	Class Participation	5%	CO 1	C3, C4
			CO 5	A3
	Mid-term	15%	CO 3	C1 - C4
			CO 4	C3, C4
Final Exam		60%	CO 1	C1- C4
			CO 2	C3, C4
			CO 3	C2 - C4
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Dornfeld and David, Green Manufacturing Fundamentals and Applications.
2. **Davim J** and Paulo, Green Manufacturing Processes and Systems.
3. **David A. Dornfeld**, Green Manufacturing: Fundamentals and Applications.

Reference Site:

https://classroom.google.com/ (**To be announced**)

Course Code: IPE 441 **Course Name:** Modern Manufacturing Process

Credit Hour: 3.00 **Contact Hour:** 3.00

Level/Term: L-4, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: 1. IPE 105: Engineering Materials

2. IPE 207: Engineering Economy

3. IPE 201: Manufacturing Processes I

4. IPE 203: Manufacturing Processes II

Synopsis/Rationale:

This Outcome Based Education (OBE) based course is designed to introduce students to the systematic modern manufacturing approach. It emphasizes feasible manufacturing processes which are used in modern industries. A better understanding of the modern manufacturing process provides better visualization to the unique difficulties of manufacturing and their feasible solution.

Objectives:

1. To offer a comprehensive overview of advanced materials manufacturing processes

2. To provide practice-oriented information to help students find the right manufacturing methods for the intended applications

3. To critically review extant literature and case studies in order to explicate product and suggest remedies

4. To assess solutions for material science problems in industry

5. To differ the traditional manufacturing processes from nontraditional, emerging, modern and innovative manufacturing technologies, some of which have been used only recently in mass production

Course Outcomes (CO) & Generic Skills:

No.	**Course Learning Outcome**	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Model the material removal in various modern manufacturing processes.	C1-C3	1		3	T, Mid Term ,F
CO2	Analyze the processes and evaluate the role of each process parameter during machining of various advanced materials.	C4	3	2		Mid Term Exam,F,R

CO3	Solve the various problems for the given profiles to be imparted on the work specimens.	C1, C4	2	5	3	Mid Term Exam,F,PR ,Pr
CO4	Select the best process out of the available various advanced manufacturing processes for the given job assignment.	C4	3	5	1, 3	Mid Term Exam,F
CO5	Explain requirements to achieve maximum material removal rate and best quality of machined surface while machining various industrial engineering materials.	C1, C4	3	2	2	Mid Term Exam,F, T,ASG
CO6	Demonstrate commitment towards class ethics.	A3	1			ASG, PR, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, F – Final Exam)						

Course Contents:

Ultrasonic Machining (USM): Introduction, equipment, tool materials & tool size, abrasive slurry, cutting tool system design: - Effect of parameters on Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM.

Abrasive Jet Machining (AJM): Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive work material, standoff distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM. Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of Water Jet machining.

Electrochemical Machining (ECM): Introduction, study of ECM machine, elements of ECM process: ECM Process characteristics – Material removal rate, Accuracy, surface finish, Applications, Electrochemical turning, Grinding, Honing, deburring, Advantages, Limitations.

Chemical Machining (CHM): Introduction, elements of process, chemical blanking process, process characteristics of CHM: material removal rate, accuracy, surface finish, Hydrogen embrittlement, advantages & application of CHM.

Electrical Discharge Machining (EDM): Introduction, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, EDM process characteristics: metal removal rate, accuracy, surface finish, Heat Affected Zone. Machine tool selection, Application, electrical discharge grinding, wire EDM.

Plasma Arc Machining (PAM): Introduction, equipment, non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Applications, Advantages and limitations.

Laser Beam Machining (LBM): Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.

Electron Beam Machining (EBM): Principles, equipment, operations, applications, advantages and limitation of EBM.

Introduction to Surface engineering: High speed machining and grinding: Application of advanced coatings in high performance modern cutting tools and high performance super abrasive grinding wheels, Micro and nano machining of glasses and ceramics. Theory and application of chemical processing: Chemical Machining, aching of semi-conductors, Coating and Electroless forming, PVD and CVD.

Rapid prototyping: Basic Principle of Rapid Prototyping Processes, Rapid Prototyping Processes, Selective Laser Sintering, Fused Deposition Modeling, Applications of RP Technologies.

Mapping of Course Outcomes and Program Outcomes:

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Course Learning Outcomes	Engineering Knowledge	Problem Analysis	Design / Development of	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**

CO1	Model the material removal in various modern manufacturing processes.	H	H		H								
CO2	Analyze the processes and evaluate the role of each process parameter during machining of various advanced materials.			H		H					H		
CO3	Solve the various problems for the given profiles to be imparted on the work specimens.		H		H		M					M	
CO4	Select the best process out of the available various advanced manufacturing processes for the given job assignment.	H	H	H								M	H
CO5	Explain requirements to achieve maximum material removal rate and best quality of machined surface while machining various industrial engineering materials.	H	H			H							
CO6	Demonstrate commitment towards class ethics.								H				

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-

Self-Directed Learning	
Non-face-to-face learning	40
Revision	22
Assessment Preparations	18
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multimedia Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	1	**Ultrasonic Machining (USM):** Introduction, equipment, tool materials & tool size, abrasive slurry.	
	2	**Ultrasonic Machining (USM):** Cutting tool system design: - Effect of parameters on Material removal rate, tool wear.	
2	1	**Ultrasonic Machining (USM):** Accuracy, surface finish, applications, advantages & Disadvantages of USM.	
	2	**Abrasive Jet Machining (AJM):** Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive work material, standoff distance (SOD).	
3	1	**Abrasive Jet Machining (AJM):** Nozzle design, shape of cut. Process characteristics-Material removal rate.	
	2	**Abrasive Jet Machining (AJM):** Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM. Water Jet Machining: Principle,	

		Equipment, Operation, Application, Advantages and limitations of Water Jet machining.	CT 1 to be held on these topics
4	1	**Electrochemical Machining (ECM):** Introduction, study of ECM machine, elements of ECM process: ECM Process characteristics – Material removal rate.	
	2	**Electrochemical Machining (ECM):** Accuracy, surface finish, Applications, Electrochemical turning.	
5	1	**Electrochemical Machining (ECM):** Electrochemical Grinding, Honing, deburring, Advantages, Limitations.	CT 2 to be held on these topics, ASG, PR
	2	**Chemical Machining (CHM):** Introduction, elements of process, chemical blanking process.	
6	1	**Chemical Machining (CHM):** Process characteristics of CHM: material removal rate, accuracy.	
	2	**Chemical Machining (CHM):** Surface finish, Hydrogen embrittlement, advantages & application of CHM.	
7	1	**Electrical Discharge Machining (EDM):** Introduction, mechanism of metal removal, dielectric fluid.	
	2	**Electrical Discharge Machining (EDM):** Spark generator, EDM tools (electrodes) Electrode feed control, EDM process characteristics.	
8	1	**Electrical Discharge Machining (EDM):** Metal removal rate, accuracy, surface finish, Heat Affected Zone. Machine tool selection, Application, electrical discharge grinding, wire EDM.	
	2	**Plasma Arc Machining (PAM):** Introduction, equipment, non-thermal generation of plasma.	
9	1	**Plasma Arc Machining (PAM):** Selection of gas, Mechanism of metal removal.	
	2	**Plasma Arc Machining (PAM):** PAM parameters, process characteristics. Applications, Advantages and limitations.	

10	1	**Laser Beam Machining (LBM):** Introduction, equipment of LBM mechanism of metal removal.	CT 3 to be held on these topics
	2	**Laser Beam Machining (LBM):** LBM parameters, Process characteristics, Applications, Advantages & limitations.	
11	1	**Electron Beam Machining (EBM):** Principles, equipment, operations.	CT 4 to be held on these topics, ASG, PR
	2	**Electron Beam Machining (EBM):** Process, applications, advantages and limitation of EBM.	
12	1	**Introduction to Surface engineering**: High speed machining and grinding.	
	2	Application of advanced coatings in high performance modern cutting tools and high performance super abrasive grinding wheels.	
13	1	Micro and nano machining of glasses and ceramics. Theory and application of chemical processing: Chemical Machining, aching of semi-conductors, Coating and Electroless forming, PVD and CVD.	
	2	**Rapid prototyping:** Basic Principle of Rapid Prototyping Processes, Rapid Prototyping Processes.	
14	1	**Stereolithography:** Selective Laser Sintering, Fused Deposition Modeling, Applications of RP Technologies.	
	2	Course Review for Final Exam	

(PR – Project; ASG – Assignment)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom's Taxonomy
	Test 1-3	20%	CO 1	C1 - C4

Continuous Assessment (40%)			CO 2	C2 - C4
			CO 4	C2
	Class Participation	5%	CO 1	C3, C4
			CO 6	A3
	Mid term	15%	CO 3	C1 - C4
			CO 4	C3, C4
Final Exam		60%	CO 1	C1- C4
			CO 2	C3, C4
			CO 3	C2 - C4
			CO 4	C2
			CO 5	C3, C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Pandey, P.C. and Shan H.S., Modern Machining Processes, Tata McGraw Hill (2004).

2. Mishra, P.K., Non-Conventional Machining, Narosa Publications (2006).

3. Hofy, H.E., Advanced Manufacturing Process, B and H Publication (1998).

4. Jain, V.K., Advanced Machining processes, Allied Publishers Private Limited (2004).

5. Ghosh, A. and Mullik, A., Manufacturing Science, East –West private Limited (2010).

Reference Site:

https://classroom.google.com/ (**To be announced**)

Course Code: IPE 443 **Course Name:** Total Quality Management
Credit Hour: 3.00 **Contact Hour:** 3.00

Level/Term: L- 4, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Rationale:

The objectives of this course is to generate knowledge and skills of students to use models and quality management methodology for the implementation of total quality management in any sphere of business and public sector.

Objective:

1. Implement the principles and concepts inherent in a Total Quality Management (TQM) approach to managing a manufacturing or service organization.
2. Understand the philosophies--including similarities and differences--of the gurus of TQM in order to better evaluate TQM implementation proposals offered by quality management organizations and consultants.
3. Successfully implement process improvement teams trained to use the various quality tools for identifying appropriate process improvements.
4. Assess exactly where an organization stands on quality management with respect to the ISO 9000 quality management standard and the Baldrige Award criteria.

Course Outcomes (CO):

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Outline** business excellence models and be able assess organization's performance making reference to their criteria	C1-C4	1	2	1	T, Mid Term Exam, F
CO2	**Implement** the principles of total quality management and understand peculiarities of their implementation	C1-C4	1	1	1	T, Mid Term Exam, F

CO3	**Analyze** quality management methods and solve problems of organization	C3, C4	2	1	2	T, Mid Term Exam, F
CO4	**Explain** prerequisites of evolution of total quality management and significance of quality gurus' works to the management of modern organizations.	C2,C3	1	2	2	T, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Content:

TQM definition, origins and growth of TQM, benefits of TQM, philosophies of TQM: quality circle approach, Deming's approach, Juran's approach, Philip Crosby's approach.

Planned implementation of TQM: planning and commitment, participation, continuous improvement.

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes	Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**Outline** business excellence models and be able assess organization’s performance making reference to their criteria	H		**M**		**L**							
CO2	**Implement** the principles of total quality management and understand peculiarities of their implementation		**H**		L								
CO3	**Analyze** quality management methods and solve problems of organization		**L**	**H**							**M**		
CO4	**Explain** prerequisites of evolution of total quality management and significance of quality gurus’ works to the management of modern organizations.	**L**				**H**							

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	10
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Revision	20
Assignment Preparations	20
Formal Assessment	
Continuous Assessment	2

Final Examination	3
Total	137

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture schedule:

Week 1		**ASSESSMENT**
Class 1	Orientation and Course Preview	**ASG, Class Test 1, F**
Class 2 & 3	Overview of Quality and Total Quality Management	
Week 2		
Class 4 & 5	The TQM Gurus: Crosby, Deming, and Juran .	
Class 6	Organization for total quality, process management	
Week 3		
Class 7	Leadership and empowerment	**ASG, Class Test 2, F**
Class 8 & 9	Quality teams and teamwork processes	
Week 4		
Class 10,11,12	Cost of Quality	
Week 5		
Class 13, 14,15	Organization for total quality, process management	
Week 6	**System models**	
Class 16,17,18	Quality teams and teamwork processes	**ASG, Mid**

		Term, F
Week 7		
Class 19,20,21	Basic problem solving tools for quality improvement	
Week 8		**ASG, Class Test 3, F**
Class 22,23,24	Quality through planning and design: QFD, policy deployment, design for six sigma.	
Week 9		
Class 25,26,27	Quality through improvement: Six sigma, lean six sigma, kaizen, 5S, SPC	
Week 10		
Class 28,29,30	Quality standards and award models	**ASG, F**
Week 11		
Class 31,32,33	TQM implementation and case studies	
Week 12	**Programmable Logic Controller**	
Class 34,35,36	Sustaining Leadership Through Quality	
Week 13		
Class 37,38,39	SPECIAL TOPIC (TO BE ASSIGNED)	
Week 14		
Class 40,41,42	Review	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
	Test 1-3	20%	CO 1	C1-C4

Continuous Assessment (40%)			CO 3	C2-C4
			CO 2	C2
	Class Participation	5%	CO 2	C3, C4
			CO 3	A3
	Mid term	15%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
Final Exam		60%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
			CO 2	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Reference Books:

1. Oakland G. F. Total Quality Management, Oxford, 2003. (Text)
2. Evans, J.R., Quality and Performance Excellence: Management, Organization and Strategy, Thomson South-Western, 2007.
3. Goetsch, D.L. and Davis, S.B. Quality Management, Prentice Hall, 2006

Course Code: IPE 449 **Course Name:** Industrial Fire Safety

Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

This course is aimed to imparting knowledge to and development of skills for students, by giving a strong base for industrial and building fire safety.

Objectives:

1. To introduce the concepts of fire protection/suppression principles & systems currently followed in industrial sector
2. To brief the legislation requirements-national/international codes/ standards from fire & safety perspective
3. To provide students with knowledge about how to reduce fire risks, deal with fires if appropriate and escape safely in the event of fire.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the causations and extinguishment of different kinds of fire	C1, C2	1		1	T, Mid Term Exam, F
CO2	**Describe** different stages of fire, harmful products-health effects & behavior and **demonstrate** the usage of various fire extinguishers	C2, C3	1	1	1,6	ASG, Mid Term Exam, F
CO3	**Identify** & **explain** different types of fire protection systems/ installations in industry	C2	1, EP 2	1	1,6	T, ASG, F
CO4	**Elucidate** various hazards & safety measures associated with flammable/combustible workspace materials	C1-C3	1	1,4	1,7	T, Mid Term Exam, ASG, R, F
CO5	**Explicate** types, cusses & consequences of explosions and associated safety measures	C1, C2	1		1	ASG, PR, R, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Course overview, Importance of this course for industrial engineers, Fire, History of fires, Classifications of fires, Recognition of possible fire sources and their causes, National Fire Protection Association and Occupational Safety and Health Administration standards, Human behaviour in fire, The measures needed to overcome behavioural problems and to ensure the safe evacuation of people in the event of fire, Fire risk assessment, Fire Alarms & fire detection, Fire resisting construction & compartmentation, Active fire safety for building Protection, Fire suppression & protection, Fire Protection system, Prevention of failure, fire prevention Measures.

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcomes (PO)**											
		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** the causations and extinguishment of different kinds of fire	**M**	**L**			**M**							
CO2	**Describe** different stages of fire, harmful products-health effects & behavior and **demonstrate** the usage of various fire extinguishers	**M**			**M**	**M**							
CO3	**Identify** & **explain** different types of fire protection systems/ installations in industry	**H**		**M**		**M**						**L**	
CO4	**Elucidate** various hazards & safety measures associated with flammable/combustible workspace materials	**H**	**M**	**M**	**M**	**M**		**M**					
CO5	**Explicate** types, cusses & consequences of explosions and	**H**										**M**	

	associated safety measures												

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	**Lecture**	**Topics**	**ASSESSMENT**
1	Lec 1 Lec 2 Lec 3	Course overview, Importance of this course for industrial engineers. Fire, History of fires, Classifications of fires Recognition of possible fire sources and their causes	**Class Test 1, ASG, F**
2	Lec 4	National Fire Protection Association and	

	Lec 5 Lec 6	Occupational Safety and Health Administration standards (BNBC, NIOSH, OSHA)	
3	Lec 7 Lec 8 Lec 9	Understanding fire: Human behaviour in fire The measures needed to overcome behavioural problems and to ensure the safe evacuation of people in the event of fire Devising procedures in the event of fire, Assisting disabled people to escape	
4	Lec 10 Lec 11 Lec 12	Fire risk assessment structure and layout, Means of escape principles and requirements Fire signage: National requirements	
5	Lec 13 Lec 14 Lec 15	Fire Alarms & fire detection: Basic components, and testing Emergency lighting: When it is required, Basic components, and testing, Alternatives to emergency lighting	**Class Test 2, ASG, PR, F**
6	Lec 16 Lec 17 Lec 18	Emergency Plans & Staff Training Highly Flammables & LPG Fire-fighting equipment requirements	
7	Lec 19 Lec 20 Lec 21	Fire resisting construction & compartmentation Active fire safety for building Protection Automatic roof vents	
8	Lec 22 Lec 23 Lec 24	Fire suppression & protection, Classification of fire protection systems-Active & Passive: Active FPS- Definitions, classifications- Water Based (Vs) Non water based & Fixed (Vs) Portable/Mobile	
9	Lec 25 Lec 26 Lec 27	Fire Extinguishers, Fire hydrants, Sprinklers standpipe systems, water spray systems Water as an extinguishing agent	**Mid Term, F**
10	Lec 31 Lec 32 Lec 33	Basic Components of a Fire Protection system Fire water supply systems-Types, Design philosophy acc.to OISD, Foam, DCP & other gaseous extinguishing agents	
11	Lec 28 Lec 29 Lec 30	Passive FPS- Fire Resistance: Basic Concepts(philosophy) Materials used & their Fire Resistance ratings, Fire Resistance tests Fire Proofing: Introduction, materials used in coatings & paintings	**Class Test 3, ASG, R, PR, F**
12	Lec 34 Lec 35	Concrete as a fire proofing material; Exit & Egress Arrangements: Basic definitions	

	Lec 36	Exit, Means of Egress system, Exit door, Refuge area, Safe area & other related as per standard Installation & maintenance as per relevant national and international standards	
13	Lec 37 Lec 38 Lec 39	The process of fire risk assessment Fire risk assessment recording and review procedures The potential for pollution arising from fires, Measures to prevent and reduce fire pollution	
14	Lec 40 Lec 41 Lec 42	Prevention of failure, fire prevention Measures **Review Class 1** **Review Class 2**	

(PR – Project; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1, 2	20%	CO 1	C1, C2
			CO 3	C2
			CO 4	C1-C3
	Class Participation	5%	CO 1	C1, C2
			CO 2	C2
	Mid term	15%	CO 1	C1, C2
			CO 2	C2
			CO 4	C1-C3
Final Exam		60%	CO 1	C1, C2
			CO 2	C2, C3
			CO 3	C2
			CO 4	C1-C3
			CO 5	C1, C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Principles of Fire Safety Engineering and Management-(Understanding Fire & Fire Protection)- by A.K. Das, First edition, 2014.

2. Handbook of Fire Technology- by R.S. Gupta

3. Industrial Fire Protection- R. Craig Schroll

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 451 **Course Name:** Micromanufacturing

Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

This course covers applications and various microfabrication methods to design and fabricate MEMS devices. Methods include, patterning based on photolithography, deposition, etching (wet & dry), nanofabrication technologies, next-generation fabrication technologies, and the physics behind them.

Objectives:

4. To acquire the baseline knowledge about the theory and methods of various microfabrication techniques based on photolithography, and the ability to apply for developing the MEMS devices.
5. To design the basic level of MEMS devices.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Learn** and **understand** the operation of micro devices, micro systems and their applications	C1			1	T, Mid Term Exam, F
CO2	**Study** and **design** the micro devices, micro systems using the MEMS fabrication process	C1-C6	1,7	1,3	1, 4-6	ASG, Mid Term Exam, F
CO3	**Learn, understand** and **apply** of basic approaches for various sensor and actuator design	C1-C3	1	1,3	1,4 ,5	T, ASG, F
CO4	**Develop** experience on micro-systems for photonics	C1,C2			1	T, Mid Term Exam, ASG, R, F
CO5	**Obtain** technical knowledge required for computer-aided design, fabrication, analysis and characterization of micro-structured materials, micro-scale devices	C1,C2	1		1	ASG, PR, R, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:
Fundamental of micro and nano technology, Micro elements: design and fabrication; Basics of micro-fabrication technology: thin film growth and deposition, photolithography, X-ray lithography, wet and dry chemical etching, Nano machining and Finishing, Concepts of micro forming and welding, micromachining, electrochemical machining, ultrasonic machining, plasma machining and laser machining.

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcomes (PO)**											
		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance
		1	2	3	4	5	6	7	8	9	10	11	12

CO1	**Understand** the operation of micro devices, micro systems and their applications	**H**											
CO2	**Study** and **design** the micro devices, micro systems using the MEMS fabrication process	**H**		**H**		**H**					**H**		
CO3	**Learn, understand** and **apply** of basic approaches for various sensor and actuator design	**H**	**M**	**H**		**H**					**M**		
CO4	**Develop** experience on micro-systems for photonics	**H**											
CO5	**Obtain** technical knowledge required for computer-aided design, fabrication, analysis and characterization of micro-structured materials, micro-scale devices	**H**											

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 40 20 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Visualization using Computer Simulations, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	Lec 1 Lec 2 Lec 3	Fundamental of micro and nano technology, Micro-fabrication, concepts of micro and Microsystems Products, Microsystems and Microelectronics , Application of Microsystems, Standardization and Commercialization Issues of Micro-Nano Systems	**Class Test 1, ASG, F**
2	Lec 4 Lec 5 Lec 6	Introduction to MEMS Basic design and fabrication techniques of MEMs Micro sensors, micro/nano biosensors: Classification of physical sensors	
3	Lec 7 Lec 8 Lec 9	Integrated, Intelligent or Smart sensors, Bio sensing Principles and sensing methods Biosensors arrays and Implantable devices Innovative Applications on Present Devices: Nano chips, Nanotubes and Nanowires, Integration of chips and microprocessors	
4	Lec 10 Lec 11 Lec 12	Introduction to Micro actuation MEMS with Micro actuators Micro actuators with mechanical Inertia – Micro fluidics	**Class Test 2, ASG, PR, F**
5	Lec 13 Lec 14 Lec 15	Basics of micro-fabrication technology Thin film growth and deposition Sputtering	
6	Lec 16 Lec 17 Lec 18	Fundamentals on Deposition techniques Atomic Layer Deposition I Atomic Layer Deposition II	
7	Lec 19 Lec 20 Lec 21	Chemical Vapour Deposition I Chemical Vapour Deposition II Thermal evaporation	

<table>
<tr><td>8</td><td>Lec 22
Lec 23
Lec 24</td><td>Ultra Sonic Micro Machining, Abrasive Water Jet Micro Machining – Tool based Micro-machining, Chemical and Electro Chemical Micro Machining – Electric Discharge Micro machining. Electron and Laser Beam Micro Machining, Hybrid Micro machining, Electro Chemical Discharge micro machining, Machining of Micro gear, micro nozzle, micro pins and its applications. Tool based micromachining (TBMM)</td><td rowspan="3">Mid Term, F</td></tr>
<tr><td>9</td><td>Lec 25
Lec 26
Lec 27</td><td>Nano machining and Finishing
Plasma Beam Machining
electrochemical machining</td></tr>
<tr><td>10</td><td>Lec 31
Lec 32
Lec 33</td><td>Abrasive Flow finishing
Magnetic Float polishing
Elastic Emission Machining</td></tr>
<tr><td>11</td><td>Lec 28
Lec 29
Lec 30</td><td>Chemo-Mechanical Polishing
Magnetic Abrasive Finishing
Focused Ion Beam Machining</td><td rowspan="4">Class Test 3, ASG, R, PR, F</td></tr>
<tr><td>12</td><td>Lec 34
Lec 35
Lec 36</td><td>Concepts of micro forming and welding
Micro extrusion
Roller Imprinting</td></tr>
<tr><td>13</td><td>Lec 37
Lec 38
Lec 39</td><td>Micro bending and micro welding with LASER
Electron beam for micro welding
Metrology for micro machined components.</td></tr>
<tr><td>14</td><td>Lec 40

Lec 41
Lec 42</td><td>Micro and Nano structured surface development by Nano plastic forming
Review Class 1
Review Class 2</td></tr>
</table>

(PR – Project; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

<table>
<tr><th colspan="3">Assessment Strategies</th><th rowspan="2">CO</th><th rowspan="2">Bloom’s Taxonomy</th></tr>
<tr><th colspan="2">Components</th><th>Grading</th></tr>
<tr><td rowspan="9">Continuous Assessment (40%)</td><td rowspan="3">Test 1, 2</td><td rowspan="3">20%</td><td>CO 1</td><td>C1</td></tr>
<tr><td>CO 3</td><td>C1-C3</td></tr>
<tr><td>CO 4</td><td>C1,C2</td></tr>
<tr><td rowspan="3">Class Participation</td><td rowspan="3">5%</td><td>CO 2</td><td>C1-C6</td></tr>
<tr><td>CO 3</td><td>C1-C3</td></tr>
<tr><td>CO 4</td><td>C1,C2</td></tr>
<tr><td rowspan="3">Mid term</td><td rowspan="3">15%</td><td>CO 1</td><td>C1</td></tr>
<tr><td>CO 2</td><td>C1-C6</td></tr>
<tr><td>CO 4</td><td>C1,C2</td></tr>
</table>

Final Exam	60%	CO 1	C1
		CO 2	C1-C6
		CO 3	C1-C3
		CO 4	C1,C2
		CO 5	C1,C2
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Advanced Machining Process - Hassan El-hofy
2. Non traditional machining process – Golam Kibria

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 433 **Course Name:** Production Planning and Control
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites:

1. IPE 207: Engineering Economy
2. IPE 205: Probability and Statistics
3. IPE 305: Operations Research
4. IPE 311: Operations Management

Synopsis/Rationale:

The course covers production planning and scheduling systems. The emphasis of the course is on implementing effective production planning and scheduling systems to industrial applications. Heavy emphasis is placed on developing mathematical models such as linear programming for solving manufacturing related scheduling problems.

Objectives:

1. To provide students with the basic concepts related to the operations management systems and their impact on production and inventory control system design.
2. To provide students with methodology and models for the generation of company forecasts, materials management cost elements, business operations analysis, productivity,

operations strategies for competitive advantage, location strategies, and supply-chain management.

3. To provide students with information on the design and management of operations and production planning/control systems including capacity planning, materials requirements planning, inventory models, scheduling and sequencing, and line balancing for various aspects of the manufacturing and service industry.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Analyze** operations performance measurements and analysis for continuous improvement.	C1-C4	2	2	1	T, Exam, F
CO2	**Apply** and **analyze** forecasting models to develop business enterprise forecasts for product demand, profits, sales, material requirements, capacity requirements, etc	C1-C5	2	2	1	ASG, Mid Term Exam, F
CO3	**Develop** and **analyze** production and inventory planning/control systems, and scheduling techniques by using engineering techniques for a complete production facility	C2-C4,C6	2	2	2	ASG, Mid Term, F
CO 4	**Design**, **develop**, and **analyze** a Master Production Schedule and a resultant Materials Requirement Plan (MRP) for a complete production facility.	C2-C6				F, ASG
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Introduction: Overview, and Reasons for Production Planning and Scheduling

Forecasting: Regression, Moving Average, and Exponential Smoothing Techniques, Aggregate Production , Graphical Models, Linear Models, Disaggregation

Master Production Scheduling and Capacity Planning: Inventory Modeling, Cost Components and Terminology, ABC Analysis, Economic Order Quantity and Economic Production Quantity, Dynamic Lot Sizing Techniques, Safety Stock Analysis

Material Requirements Planning: Factory Floor Scheduling , Definitions and Performance Measures, Gantt Charts, Single Machine Scheduling, Flowshop Scheduling

Jobshop Scheduling: Dispatching Rules: SPT, EDD, SLACK, SLACK/OPN, FCFS, RANDOM, Release Rules: Workload Regulating, Starvation Avoidance

Integrated Production Planning and Control: Just-in-time, KANBAN, Push Systems, Pull Systems, and Theory of Constraints

Mapping of Course Outcomes and Program Outcomes:

No.	**Course Outcomes (CO) of the Course**	**Program Outcomes (PO)**											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Analyze** operations performance measurements and analysis for continuous improvement.	**M**	**M**	**H**	**L**	**M**						**L**	**H**
CO2	**Apply** and **analyze** forecasting models to develop business enterprise forecasts for product demand, profits, sales, material requirements, capacity requirements, etc	**M**	**M**			**H**					**L**	**M**	**H**
CO3	**Develop** and **analyze** production and inventory planning/control systems, and scheduling techniques by using engineering techniques for a complete production facility	**H**	**H**	**H**	**L**	**H**				**L**	**M**	**M**	**H**
CO4	**Design**, **develop**, and **analyze** a Master Production Schedule and a resultant Materials Requirement Plan (MRP) for a complete production facility.	**L**	**H**	**M**	**L**	**H**				**L**	**M**	**M**	**H**

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42

Practical / Tutorial / Studio Student-Centred Learning	- -
Self-Directed Learning Non-face-to-face learning Revision Assignment Preparations	 18 21 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	106

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	**Introduction and Overview**	
	Lec 2	Reasons for Production Planning and Scheduling	
	Lec 3	**Forecasting**	
2	Lec 4	Regression	
	Lec 5	Moving Average, and	
	Lec 6	Exponential Smoothing Techniques	
3	Lec 7	Exponential Smoothing Techniques (contd.)	**ASG, Class Test 1**
	Lec 8	**Aggregate Production Planning**	
	Lec 9	Graphical Model	
4	Lec 10	Linear Models	
	Lec 11	Chemical Processing Paper	
	Lec 12	Disaggregation	
5	Lec 13	**Master Production Scheduling and Capacity Planning**	
	Lec 14	**Inventory Modeling**	**ASG, Class Test 2**
	Lec 15	Cost Components and Terminology	
6	Lec 16	Cost Components and Terminology	
	Lec 17	ABC Analysis	
	Lec 18	ABC Analysis	
7	Lec 19	Economic Order Quantity and	

	Lec 20	Economic Production Quantity	
	Lec 21	Dynamic Lot Sizing Techniques	
8	Lec 22	Safety Stock Analysis	**Mid Term**
	Lec 23	**Material Requirements Planning**	
	Lec 24	**Factory Floor Scheduling**	
9	Lec 25	Definitions and Performance Measures	
	Lec 26	Gantt Charts	
	Lec 27	Single Machine Scheduling	
10	Lec 28	Flowshop Scheduling	**ASG, Class Test 3**
	Lec 29	Jobshop Scheduling	
	Lec 30	Dispatching Rules: SPT, EDD, SLACK, SLACK/OPN, FCFS, RANDOM	
11	Lec 31	Release Rules: Workload Regulating,	
	Lec 32	Starvation Avoidance	
	Lec 33	Integrated Production Planning and Control	
12	Lec 34	Just-in-time	
	Lec 35	Channel management and retailing	
	Lec 36	KANBAN	
13	Lec 37	Push Systems	**ASG,F**
	Lec 38	Pull Systems	
	Lec 39	Theory of Constraints	
14	Lec 40	**Review**	
	Lec 41		
	Lec 42		

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (40%)	Class test 1-3	20%	CO 1	C1-C3
			CO 2	C4, P4
			CO 3	P4, C1,C4

	Class Participation	5%	CO 1	C1-C3, A2
			CO 2	C4, P4
	Mid term	15%	CO 1	C1-C3
			CO 2	C4, P4
Final Exam		60%	CO 1	C1-C3
			CO 2	C4, P4
			CO 3	P4, C1, C4
			CO 4	C3-C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Manufacturing Planning and Control Systems for Supply Chain Management, Vollman, Berry, Whybark, and Jacobs, McGraw-Hill, 6th Edition, 2011

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: IPE 447 **Course Name:** Advanced Material and Process
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-2
Curriculum Structure: Outcome Based Education (OBE)
Pre-requisites: (1) IPE 105: Engineering Materials

Synopsis/Rationale:

This Outcome Based Education (OBE) based course is designed to conduct in depth study on super alloys, composites, biodegradable plastics, ceramic materials, various properties of advanced engineering materials and methods of heat and surface treatments with the objective of laying a strong foundation for core manufacturing courses of program.

Objectives:

i. To conduct study on super alloys.
ii. To expose students to various composite materials.
iii. To conduct study on powder metallurgy and particulate materials.
iv. To conduct study on biodegradable plastics.
v. To expose students to electronic materials.
vi. To conduct study on smart materials.
vii. To apply advanced concepts of engineering materials to the analysis, design and development of materials, components, or processes to meet desired needs of material processing and working condition.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	**Explain** properties and processing of super alloys.	C1-C4	1		1	T, Mid Term Exam, F
CO 2	**Outline** the properties of various composites and their processing methods.	C1-C4	1		1	T, Mid Term Exam, F
CO 3	**Explain** fundamentals of ceramic processing.	C3, C4	2	1	2	T, Mid Term Exam, F
CO 4	**Explain** the structure and application of smart materials.	C2-C4			1	T, Mid Term Exam, F
CO 5	**Describe** the application of biodegradable plastics.	C2-C4	1			T, Mid Term Exam, F
CO 6	**Outline** the properties of electronic materials and their application.	C2			1	T, Mid Term Exam, F
CO 7	**Describe** the fundamentals of powder metallurgy and particulate materials.	A3	1		1	T, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Super alloys; Metal matrix composites, Ceramic matrix composites, other composites;

Polymers; Biodegradable plastics: Ceramics: Electronic materials. Powder metallurgy and particulate materials. Smart Materials.

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Explain properties and processing of super alloys.	H	L										
CO2	Outline the properties of various composites and their processing methods.	**H**	L	L									
CO3	Explain fundamentals of ceramic processing.	**H**											
CO4	Explain the structure and application of smart materials.	**H**	L										
CO5	Describe the application of biodegradable plastics.	H	L					M					

CO6	Outline the properties of electronic materials and their application.	H	L										
CO7	Describe the fundamentals of powder metallurgy and particulate materials.	H											

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Revision	20
Assignment Preparations	20
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	127

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week/class	**Topics**	**Assessment**
Week 1	**Introduction to superalloys**	
Class 1	Introduction to materials for high-temperature applications	
Class 2	Physical metallurgy of superalloys	CT, ASG
Class 3	High temperature mechanical properties of superalloys	
Week 2	**Application and processing of super alloys**	
Class 4	Processing and manufacturing of superalloys	

Class 5	Failure analysis of superalloys	
Class 6	Future trends in structural alloy design and development	
Week 3	**Introduction to composite materials**	
Class 7	Classification and properties of composite materials	
Class 8	Reinforcement and manufacturing of composite materials	
Class 9	Processing of metal matrix composites	
Week 4	**composite materials**	CT, ASG
Class 10	properties and application of metal matrix composites	
Class 11	processing of ceramic matrix composites.	
Class 12	Properties and application of ceramic matrix composites.	
Week 5	**biodegradable plastics**	
Class 13	Introduction to biodegradable plastics	
Class 14	Rationale for biodegradable plastics - the biological carbon cycle	
Class 15	Composting biodegradable plastics	
Week 6	**biodegradable plastics**	
Class 16	Design & engineering of biodegradable plastics	
Class 17	Polyester based and natural polymer based biodegradable plastics	
Class 18	Markets and business opportunities	
Week 7	**Ceramics**	Mid, ASG
Class 19	Ceramic Raw Materials and their processing	
Class 20	Ceramic forming: dry forming and wet forming processes	
Class 21	Firing of ceramics	
Week 8	**Ceramics (contd.)**	
Class 22	Statics and Kinetics of Firing, Kiln Design and Operation. Specialised Sintering Processes.	
Class 23	Glass Making Technology: Glass Compositions & Structure; Glazes & Enamels.	
Class 24	Cement and Concrete Processing	
Week 9	**Electronic materials**	
Class 25	Overview of electronic materials	
Class 26	Integrated circuit, PWB	

Class 27	Solid state structure	
Week 10	**Electronic materials (contd.)**	CT, ASG, F
Class 28	Electrical and thermal properties	
Class 29	Optical and magnetic properties	
Class 30	Applications	
Week 11	**Powder metallurgy and particulate materials**	
Class 31	Steps in Making Powder-Metallurgy Parts, Powder particles, Atomization	
Class 32	Mechanical alloying, Bowl Geometries in Blending Metal Powders, Density Variation in Compacting Metal Powders	
Class 33	Press for Compacting Metal Powder, Powder Rolling	
Week 12	**Powder metallurgy and particulate materials**	
Class 34	Spray Deposition, Mechanisms for Sintering Metal Powders, Design Considerations for P/M	
Class 35	Characteristics of Ceramics Processing, Dry or semi-dry pressing, hydroplastic forming, Slip casting, doctor blade process	
Class 36	Extruding and Jiggering, Float method, Glass tubing and manufacturing	
Week 13	**Smart materials**	
Class 37	Introduction to smart materials	
Class 38	State-of-the-Art in Smart Materials & Structures (SM&S) Development	
Class 39	Shape Memory Alloy Materials and Actuators: control design, Designing with MR Fluids	
Week 14	**Smart materials (contd.)**	
Class 40	Smart Rubber, Fiber Optic Sensors, MEMS	
Class 41	Piezoceramics and Finite Element Modeling of Piezoceramic Smart Structure, Health Monitoring using Smart Materials	
Class 42	Review	

(PR – Project ; ASG – Assignment; PR – Presentation; R - Report; F – Final Exam)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
	Test 1-3	20%	CO 1	C1-C4
			CO 3	C2-C4

Continuous Assessment (40%)			CO 4	C2
	Class Participation	5%	CO 2	C3, C4
			CO 5	A3
	Mid term	15%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
Final Exam		60%	CO 1	C1-C4
			CO 2	C3, C4
			CO 3	C2-C4
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

x) William D. Callister, ***Materials Science and Engineering an Introduction***, John Wily, 5th Edition.

y) Sidney H Avner, ***Introduction to Physical Metallurgy***, Tata Mc Graw – Hill Edition, 2nd edition..

z) Ashby, M. F.; Jones, D. R. H., ***Engineering materials 1: an introduction to properties, applications and design***. Elsevier: 2012; Vol. 1.

aa) Kakani, S., ***Material science. New Age International***: 2006.

bb) Smallman, R. E.; Ngan, A., ***Physical metallurgy and advanced materials.*** Elsevier: 2011.

Reference Site:

https://classroom.google.com/ (To be announced)

COURSE INFORMATION			
Course Code Course Title	: CSE 403 : Artificial Intelligence	Lecture Contact urs Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			

Course Code: Nil Course Title: Nil
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
RATIONALE
Artificial intelligence is the beginning of revolution for rational behaviour of intelligent agents along with knowledge perception, representation, planning, reasoning, learning and understanding ideas to solve real life complex situations.
OBJECTIVE
1. To discuss and distinguish the notions of rational behaviour and intelligent agents. 2. To develop a general appreciation of the goals, subareas, achievements and difficulties of AI. 3. To have knowledge of methods of blind as well as informed search in case of knowledge representation, planning, learning, robotics and other AI areas and ability to practically apply the corresponding techniques.
LEARNING OUTCOMES& GENERIC SKILLS

No.	Course Learning Outcome (Upon completion of the course, the students will be able to)	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	Remembering and understanding the notions of rational behaviour, goals, subareas, achievements and difficulties of AI agents.	C1, C2	1		1	T
CO 2	Able to apply problem solving methods (informed, uninformed, local search, adversarial search and CSP) of single or multi agents to solve real life problems.	C2, C6	3		5, 6	T, MT, F
CO 3	Able to apply major concepts and approaches of knowledge representation, planning and learning for improving machine intelligence.	C6, P3	2, 7		5, 8	T, MT, F
CO 4	Able to develop the communication skill by presenting topics on Artificial Intelligent.	A2		1		Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)
COURSE CONTENT
Introduction: Overview of AI and intelligent agents; **Problem Solving:** Review of Uninformed Search Strategies and game playing; Informed search Strategies: A*, Heuristic functions, Memory Bounded Search (IDA*, SMA*), Iterative improvement Search, adversarial search, local search Constraint satisfaction problems; **Knowledge representation:** Review of Propositional logic, first order Logic, **Planning:** Introduction to Planning, Partial Order Planning; **Reasoning:** Bayesian Rule and its use in probabilistic reasoning; **Learning:** Belief Networks and Decision Networks; Learning Decision Trees; Learning General Logical descriptions-Hypothesis. Introduction to Natural Language Processing.
SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Remembering and understanding the notions of rational behaviour, goals, subareas, achievements and difficulties of AI agents.	H											
CO2	Able to apply problem solving methods (informed, uninformed, local search, adversarial search and CSP) of single or multi agents to solve real life problems.			H									
CO3	Able to apply major concepts and approaches of knowledge representation, planning and learning for improving machine intelligence.			H									
CO4	Able to develop the communication skill by presenting topics on Artificial Intelligent.										L		

(H – High, M- Medium, L-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Level	Justifications
CO1-PO1	High	As graduates will have to acquire knowledge on different types of agent architecture and working procedure.
CO2-PO3	High	As the graduates will have to design solutions for real life engineering problems which can be solved by agent using different search techniques that meet specified needs with appropriate consideration.
CO3-PO3	High	As the graduates will have to design solutions for real life engineering problems which can be solved by agent which is capable of representing

		knowledge, reasoning information, able to plan and learn in different scenario along with appropriate consideration.
CO4-PO10	Low	By presenting on different recent innovation of artificial intelligent embedded machine, graduates will have improved communication skill.

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision	21
Assessment Preparations	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week	Lecture	Topics	Assessment Methods
1.	Lec 1 Lec 2 Lec 3	Introduction to AI Agent Architecture Solving Problems by Searching	Class Test - 1
2.	Lec 1 Lec 2, 3	Uninformed Search I Uninformed Search II	
3.	Lec 1 Lec 2, 3	Informed Search I Informed Search II	
4.	Lec 1 Lec 2, 3	Memory Bounded Search I Memory Bounded Search II	
5.	Lec 1 Lec 2, 3	Beyond Classical Search I Beyond Classical Search II	Class Test - 2
6.	Lec 1 Lec 2, 3	Adversarial Search I Adversarial Search II	
7.	Lec 1 Lec 2, 3	Constraint Satisfaction Problems I Constraint Satisfaction Problems II	
8.	Lec 1 Lec 2 Lec 3	Planning with State Space Search Planning with Partial Order Search Graph Search	
9.	Lec 1	Uncertainty and Probabilities	

	Lec 2 Lec 3	Propositional Logic First Oder Logic	
10.	Lec 1-3	Second Oder Logic	Mid Term Exam
11.	Lec 1 Lec 2 Lec 3	Bayesian Rule Probabilistic reasoning Bayes Net	
12.	Lec 1 Lec 2	Naive Bayes Belief Networks Decision Networks	Class Test-3
13.	Lec 1 Lec 2	Perceptions Kernels and Clustering	
14.	Lec 1-3	Learning General Logical descriptions-Hypothesis. Introduction to Natural Language Processing.	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous	Test 1-3	20%	CO1	C1, C2
			CO2	C2, C6

Assessment (40%)			CO3	C6, P3
	Class Participation	5%	CO4	A2
	Mid term	15%	CO2	C2, C6
			CO3	C6, P3
Final Exam		60%	CO2	C2, C6
			CO3	C6, P3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

1. Artificial Intelligence: A Modern Approach (4th Edition) – Stuart Jonathan Russell, Peter Norvig; Prentice Hall (2020)
2. Artificial Intelligence: A New synthesis – Nils J. Nilsson; Routledge

REFERENCE SITE

Google Classroom

CHAPTER 6

DESCRIPTION OF THE BASIC SCIENCE, MATHEMATICS, LANGUAGE, AND GENERAL EDUCATION COURSES

6.1 Detailed Curriculum of Basic Science Courses

Course Code: PHY 101 **Course Name: Waves & Oscillations, Optics and Modern Physics**

Credit Hour: 3.0 **Contact Hour: 3.0**

Level/Term: 1/I

Pre-requisite: None

Rationale: To learn the basic concepts of Waves and Oscillations, Optics and Modern physics

Objectives:

a. To define the different parameter and concepts of Waves and Oscillations, Optics and Modern physics.

b. To explain the basic concepts of Waves and Oscillations, Optics and Modern physics.

c. To solve analytical problems regarding Waves and Oscillations, Optics and Modern physics.

Course Outcomes (CO):

Course Outcomes	At the end of the course, students are able to: 1. Be able to **Define** the different parameters such as periodic motion, simple harmonic motion, undamped oscillations, interference, diffraction, polarization and prism, photoelectric effect, Compton effect, matter wave, atomic model, radioactive decay, fusion, fission etc. 2. Be capable to **Explain** the wave motion for different systems along with energy, the techniques to derive different formula for interference, diffraction, polarization and prism, different theory regarding modern physics such as special theory of relativity, Compton theory, materials according to magnetic properties, nuclear transformation, and nuclear reaction etc.

	3. Be skilled to **Solve** quantitative problems in the field of Waves and Oscillations, Optics and Modern physics such as energy of wave motion, wavelength, diffraction pattern, relativistic energy, photon energy, Compton shift, nuclear binding energy etc.

Course Contents:

a. Main Contents: Waves and Oscillations, Optics, Modern physics

b. Detail Contents:

<u>Waves and Oscillations</u>

Simple Harmonic Motion (SHM) and its properties, Differential equation of a SHM and its solution, total energy of a body executing SHM, average kinetic and potential energy of a body executing SHM, LC oscillatory circuit,

Pendulum: simple, compound and torsional pendulum, spring-mass system, two body oscillation and reduced mass, damped harmonic motion and its different condition, forced oscillation and its different condition, resonance, equation of a progressive wave,

differential equation of a progressive wave, energy density of wave motion, average kinetic and potential energy of a body executing SHM, Stationary wave

<u>Optics</u>

Lens, equivalent lens and power, defects of images and different aberrations, Interference of light, Young's double slit experiment, Interference in thin film and Newton's ring method, diffraction of light, diffraction by single slit, diffraction by double slits, Fraunhofer and Fresnel bi-prism, diffraction gratings, polarization of light, Brewster's law, Malus law, polarization by double refraction Nicole prism, optical activity and polarimeters, optical instruments, resolving power of optical instrument, Laser: spontaneous and stimulated emission

Modern Physics

Galilean relativity & Reference frame, Special theory of relativity postulates, Galilean transformation, Lorentz Transformation, Length contraction, Time dilation, Velocity addition, relativity of mass, mass energy relation, Momentum energy relation, Photoelectric effect, Compton effect, de Broglie matter wave, Bohr atom model and explanation, atomic orbital and energy equation, classification of nucleus, nuclear binding energy, radioactivity, radioactive decay law, half-life, mean life, nuclear reaction, introduction to nuclear reactor

Teaching-learning and Assessment Strategy:

Teaching Strategies	Lecture, tutorial, Problem Based Learning (PBL), Assignments, Homework
Learning Strategies	Face to face, Guided learning, Independent learning, Assignments and Homework solving
Assessment Strategies	Class Test/Mid-Term Exam/ Assignments/Homework/Final examination

Linkage of Course Outcomes with Assessment Methods and their Weights:

COs	Assessment Method	(100%)	Remarks
	Class Assessment		
1 & 3	Class test (CT)	**20%**	
1 & 3	Class performance	**5%**	
	Exam		
2 & 3	Mid Term	**15%**	
1,2 & 3	Final	**60%**	

Mapping of Course Outcomes and Program Outcomes:

Course Outcomes (CO) of the Course	Program Outcome												Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	
1. Be able to **Define** the different parameters such as periodic motion, simple harmonic motion, undamped oscillations, interference, diffraction, polarization and prism, photoelectric effect, Compton effect, matter wave, atomic model, radioactive decay, fusion, fission etc.	√												
2. Be capable to **Explain** the wave motion for different systems along with energy, the techniques to derive different formula for interference, diffraction, polarization and prism, different theory regarding modern physics such as special theory of relativity, Compton theory, materials according to magnetic properties, nuclear transformation, and nuclear reaction etc.	√												
3. Be skilled to **Solve** quantitative problems in the field of Waves and Oscillations, Optics and Modern physics such as energy of wave motion, wavelength, diffraction pattern, relativistic energy, photon energy, Compton shift, nuclear binding energy etc.	√												

Lecture Schedule:

Week-1	Topic	CT	Remarks
Class-1	Introductory class: Brief discussion on total syllabus, basic requirements of the course, assessment of the course	CT-1	

Class-2	Simple harmonic motion (SHM) and its differential equations, graphical representation of SHM		
Class-3	Average K.E and total energy		
Week-2			
Class-4	Spring-mass system , electric oscillatory circuit		
Class-5	Simple, compound and torsional pendulum		
Class-6	Combination of two SHM		
Week-3		Mid exam	
Class-7	Combination of two SHM		
Class-8	Two body oscillations, reduced mass		
Class-9	Damped oscillations and its differential equation		
Week-4			
Class-10	Displacement equation of damped oscillation, electric damped oscillatory circuit		
Class-11	Forced oscillation and its differential equation		
Class-12	Displacement equation of forced oscillation, resonance		
Week-5			
Class-13	Plane progressive wave, energy density of wave		
Class-14	Stationary wave		
Class-15	Lens and combination of lenses, power of lens		
Week-6			
Class-16	defects of images and different aberrations		
Class-17	defects of images and different aberrations		
Class-18	Interference of light, young's double slit expeiment		
Week-7		CT-2	
Class-19	Interference in Thin films, Newton's ring		
Class-20	Diffraction : Fresnel & Fraunhofer diffraction		

Class-21	Diffraction by single slit		
Week-8			
Class-22	Diffraction by double slit, Diffraction gratings		
Class-23	Polarization and Production and analysis of polarized light		
Class-24	Optics of crystals, Nicole prism		
Week-9			
Class-25	Brewster's and Malus law		
Class-26	Optical activity and polarimeter		
Class-27	Laser & its applications		
Week-10			
Class-28	Theory of relativity: Frame of Reference, Postulates of special relativity, Galilean Transformation		
Class-29	Theory of relativity: Lorentz Transformations, Length Contraction and Time dilation		
Class-30	Velocity addition, Relativistic mass: Concept of relativistic mass and its expression		
Week-11			
Class-31	Theory of relativity: Mass and Energy equivalence equation and concept of Massless particle and its expression. Related numerical problems		
Class-32	Photoelectric Effect, photocurrent and work function, kinetic energy, stopping potential	CT-3	
Class-33	photoelectric equation, characteristics of photoelectric effect		
Week-12			

Class-34	Compton effect: Definition, Compton wavelength shift, limitation		
Class-35	De Broglie Concept, Condition for wave and particle behavior, Bohr atomic model		
Class-36	Expression for Bohr radii and orbital energy for hydrogen atom		
Week-13			
Class-37	Classification of Nucleus, nuclear binding energy		
Class-38	Radioactivity and its transformation, Radioactive Decay Law,		
Class-39	half- life, Mean life, nuclear reaction		
Week-14			
Class-40	Concept of Fusion, Fission and nuclear chain reaction		
Class-41	General idea on nuclear reactor and nuclear power plant		
Class-42	Follow up of the course		

Text and Ref Books:

Books	1. **Fundamentals of Physics** : Halliday, Resnick and Walker 2. **Physics for Scientists and Engineers**: Serway and Jewett 3. **Concept of Modern Physics**: Arthur Beiser 4. **University Physics with Modern Physics**: Hugh D. Young and Roger A. Freedman 5. **Modern Physics for Science and Engineering**: Marshall L. Burns 6. **Waves and Oscillations**: Walter Fox Smith 7. **The Physics of Vibrations and Waves**: H. J. Pain 8. **Waves and Oscillations** : BrijLal and Subramannyam 9. **Fundamental of Optics**: Francis A. Jenkins and Harvey E.White 10. **Introduction to Modern Optics**: Grant R. Fowles 11. **Fundamental Optical Design**: Michael J. Kidger

Course Code: PHY 102 **Course Name: Physics Sessional**

Credit Hour: 1.5 **Contact Hour: 3.0**

Level/Term: 1/I

Pre-requisite: N/A

Rationale: To learn the basic concepts of Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics related parameter in practical

Objectives: To develop basic engineering knowledge practically

Course Outcomes (CO):

Course Outcomes	At the end of the course, students will: 1. Be able to **Define** the different parameters regarding Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics etc. 2. Be capable to **Describe** the different phenomena regarding Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics etc. 3. Be skilled to **Construct** Experiments by an individual or by a group to determine different phenomena regarding Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics etc. 4. Be able to **Prepare** a report for an experimental work.

Course Contents:

a. Main Contents: Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics

b. Detail Contents:
Determination of specific resistance of materials of a wire by using Meter Bridge, Determination of a high resistance by the method of deflection, Determination of ECE of copper by using copper voltameter, Determination of the wavelength of light by using diffraction grating, Determination of the focal length of a plano-convex lens by Newton's ring method, Determination of the specific rotation of sugar by poralimeter Determination of the conductivity of a bad conductor by Lee's method, Determination of the acceleration due to gravity by means of compound pendulum, Determination of the spring constant and the rigidity modulus of a spiral spring, Verification of the law of conservation of linear momentum, Determination of the Young's modulus of bar by bending method, Determination of the Planck's constant using photoelectric effect,

Determination of focal length of a concave lens by auxiliary lens method, Determination of specific heat of a liquid by the method of cooling

Teaching-learning and Assessment Strategy:

Teaching Strategies	Lecture, Tutorial, Experiment, Homework, Report writing
Learning Strategies	Face to face, Guided learning, Independent learning, Experiment, Homework and Report writing
Assessment Strategies	Class performance, Report Writing, Experimental exam, Viva, Quiz

Linkage of Course Outcomes with Assessment Methods and their Weights:

COs	Assessment Method	(100%)	Remarks
	Class Assessment		
1, 2 & 3	Class performance	**10%**	
4	Report Writing	**30%**	
	Exam		
1, 2 & 3	Experimental exam	**30%**	
1 & 2	Viva	**10%**	
1	Quiz	**20%**	

Mapping of Course Outcomes and Program Outcomes:

Course Outcomes (CO) of the Course	Program Outcome												Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	
1. Be able to **Define** the different parameters regarding Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics etc.	√												
2. Be capable to **Describe** the different phenomena regarding Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics etc.	√												

3. Be skilled to **Construct** Experiments by an individual or by a group to determine different phenomena regarding Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics etc.									√				
4. Be able to **Prepare** a report for an experimental work.										√			

Lecture Schedule:

Week-1	**Topic**	**CT**	**Remarks**
Class-1	Introductory class: Brief discussion on total syllabus, basic requirements of the course, evaluation system of the course, grouping, visit different section of the laboratory, introduction to different basic equipment's		
Week-2			
Class-2	Determination of specific resistance of materials of a wire by using Meter Bridge / Determination of focal length of a concave lens by auxiliary lens method.		
Week-3			
Class-3	Determination of a high resistance by the method of deflection/ Determination of specific heat of a liquid by the method of cooling		
Week-4			
Class-4	Determination of ECE of copper by using copper voltameter / Determination of the Young's modulus of bar by bending method,		
Week-5			
Class-5	Determination of the wavelength of light by using diffraction grating		
Week-6			
Class-6	Determination of the focal length of a plano-convex lens by Newton's ring method		
Week-7			

Class-7	Determination of the specific rotation of sugar by poralimeter		
Week-8			
Class-8	Determination of the conductivity of a bad conductor by Lee's method / Verification of the law of conservation of linear momentum		
Week-9			
Class-9	Determination of the acceleration due to gravity by means of compound pendulum		
Week-10			
Class-10	Determination of the spring constant and the rigidity modulus of a spiral spring		
Week-11			
Class-11	Determination of the Planck's constant using photoelectric effect		
Week-12			
Class-12	Viva & experimental exam		
Week-13			
Class-13	Viva & experimental exam		
Week-14			
Class-14	Quiz		

Text and Ref Books:

Books	1. **Practical Physics**: G. L. Squires 2. **Practical Physics**: Dr Giasuddin and Md. Sahabuddin. 3. **B.Sc. Practical Physics**: C. L Arora 4. **Practical Physics**: S.L. Gupta and V. Kumar

COURSE INFORMATION			
Course Code Course Title	: CHEM 101 : Fundamentals of Chemistry	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE
None

CURRICULUM STRUCTURE
Outcome Based Education (OBE)

SYNOPSIS/RATIONALE
To learn the basic concepts of inorganic, organic and physical chemistry

OBJECTIVE
1. To define the different parameter and concepts of inorganic chemistry. 2. To apply different chemical theory to evaluate structure of molecules. 3. To explain the basic concepts of physical chemistry. 4. To describe basic reaction mechanism of selective organic reactions.

COURSE OUTCOMES AND GENERIC SKILLS

No.	Course Outcomes	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Be able to **define** the different parameter and concepts regarding atomic structure, periodic table, chemical bonding, acids and bases.	1	C1			1	T, F
CO2	Be able to **apply** different theory on chemical bonding and hybridization to **evaluate** structure of molecules.	1	C3, C5			1,2	T, F, ASG
CO3	Be able to classify hydrocarbons and **explain** the mechanism of selective organic reactions.	1	C2			1,2	T, F, ASG
CO4	**Explain** chemical equilibrium, thermo-chemistry, chemical and ionic equilibria, electro-chemical cells.	1	C2			1,2	ASG ,Mid Term Exam, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)
COURSE CONTENT
Atomic Structure: Concepts of atomic structure, Different atom models, Quantum theory and electronic configurations, Heisenberg's uncertainty principle **Periodic Table:** Periodic classification of elements, Periodic properties of elements, Properties and uses of noble gases **Chemical Bonding:** Types and properties, Lewis theory, VBT, MOT, Hybridization and shapes of molecules **Basic Concepts of Organic Chemistry**: History, Physical and chemical properties, Classification **Hydrocarbon:** Chemistry of hydrocarbon, Nomenclature, Properties **Selective Organic Reactions:** Oxidation-reduction, Substitution, Addition, Polymerization, Alkylation reactions **Acids-Bases/Buffer Solution:** Different concepts of acids-bases, Buffer solution, Mechanism of buffer solution, Henderson-Hasselbalch equation, Water chemistry and pH of water **Solutions:** Solutions and their classification, Unit expressing concentration, Colligative properties and dilute solutions, Raoult's law, Van't Hoff's law of osmotic pressure **Thermochemistry:** Laws of thermochemistry, Enthalpy, Heat of reaction, Heat of formation, Heat of neutralization, Kirchoff's equations, Hess's law **Electrochemistry:** Conductors and nonconductors, Difference between electrolytic and metallic conduction, Electrolytic conductance, Factors influencing the conductivity of electrolytes, Kohlrausch Law and conductometric titrations **Chemical Equilibria:** Equilibrium law/constant, K_p and K_c, Homogeneous and heterogeneous equilibrium, Van't Hoff's reaction isotherm, Le Chatelier's principle **Phase Rule:** Basic terms and phase rule derivation, Phase diagram of water and carbon dioxide **Chemical Kinetics:** Order and rate of reaction, Pseudo and zero order reaction, Half-life, Determination and factors affecting the rate of a reaction, First order reaction, Second order reaction, Collision theory, Transition state theory

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **define** the different parameter and concepts regarding atomic structure, periodic table, chemical bonding, acids and bases.	1											
CO2	Be able to **apply** different theory on chemical bonding and hybridization to evaluate structure of molecules.	2											
CO3	Be able to **classify** hydrocarbon and **explain** the mechanism of selective organic reactions.	2											
CO4	**Explain** chemical equilibrium, thermo-chemistry, chemical and ionic equilibria, electro-chemical cells.	2											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Class Performance	-
	-
Self-Directed Learning	
Assignments	42
Revision of the previous lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1	**Atomic Structure**	**CT**
Class 1	Concepts of atomic structure, Different atom models	**CT-1**
Class 2	Concepts of atomic structure, Different atom models	
Class 3	Quantum numbers, Electronic configuration	
Week 2	**Atomic Structure/Periodic Table**	
Class 4	Hydrogen spectral lines, Heisenberg's uncertainty principle	
Class 5	Classification of elements according to electronic configurations	
Class 6	Periodic classification of elements	
Week 3	**Periodic Table/Chemical Bonding**	
Class 7	Periodic properties of elements, Properties and uses of noble gases	
Class 8	Alkali metals: Chemical properties and uses	
Class 9	Chemical bonding (types, properties, Lewis theory, VBT)	
Week 4	**Chemical Bonding**	**CT-2**
Class 10	Molecular orbital theory (MOT)	
Class 11	Molecular orbital theory (MOT)	
Class 12	Hybridization and shapes of molecules	
Week 5	**Chemical Bonding/Organic Chemistry**	
Class 13	Hybridization and shapes of molecules	
Class 14	Hybridization and shapes of molecules	
Class 15	Basic concepts of organic chemistry: History, Physical and chemical properties, Classification	
Week 6	**Organic Chemistry**	
Class 16	Chemistry of hydrocarbon, Nomenclature, Properties	

Class 17	Selective organic reactions: Oxidation-reduction, Substitution	
Class 18	Selective organic reactions: Addition, Polymerization, Alkylation	
Week 7	**Acids-Bases**	
Class 19	Different concepts of acids-bases	
Class 20	Buffer solution, Mechanism of buffer solution	
Class 21	Henderson-Hasselbalch equation	
Week 8	**Acids-Bases/Solutions**	
Class 22	Water chemistry and pH of water	
Class 23	Solutions and their classification, Unit expressing concentration	
Class 24	Effect of temperature and pressure on solubility, Validity and limitations of Henry's law	**CT-3/Mid Term**
Week 9	**Solutions/Thermochemistry**	
Class 25	Colligative properties and dilute solutions, Raoult's law, deviation from Raoult's law, Elevation of boiling point	
Class 26	Freezing point depression, Van't Hoff's law of osmotic pressure	
Class 27	Laws of thermochemistry, Enthalpy	
Week 10	**Thermochemistry/Electrochemistry**	
Class 28	Heat of reaction, Heat of formation, Heat of neutralization	
Class 29	Hess's law, Kirchoff's equations	
Class 30	Electrolytic conduction and its mechanism	
Week 11	**Electrochemistry**	
Class 31	Faraday's law, Kohlrausch Law, Debye-Huckel-Onsagar theory	
Class 32	Conductrometric titrations	**CT-4**
Class 33	Different types of cells	
Week 12	**Chemical Equilibrium**	

Class 34	Reversible reactions, Characteristics of chemical equilibrium, Law of mass action, Equilibrium constant, Units of equilibrium constant	
Class 35	Relation between K_p and K_c,Van't Hoff's reaction isotherm	
Class 36	Free energy and its significance Heterogeneous equilibrium, Le Chatelier's principle	
Week 13	**Phase Rule/Chemical Kinetics**	
Class 37	Phase Rule: Basic terms and phase rule derivation	
Class 38	Phase Diagram of water and carbon dioxide	
Class 39	Pseudo and zero order reaction, Half-life	
Week 14	**Chemical Kinetics**	
Class 40	Determination and factors affecting the rate of a reaction	
Class 41	First order reaction, Second order reaction	
Class 42	Collision theory, Transition state theory	

ASSESSMENT STRATEGY

<table>
<tr><th colspan="2">Components</th><th>Grading</th><th>CO</th><th>Bloom's Taxonomy</th></tr>
<tr><td rowspan="7">Continuous Assessment (40%)</td><td rowspan="4">Class Test/ Assignment</td><td rowspan="4">20%</td><td>CO1</td><td>C1</td></tr>
<tr><td>CO2</td><td>C3, C5</td></tr>
<tr><td>CO3</td><td>C2</td></tr>
<tr><td>CO4</td><td>C2</td></tr>
<tr><td rowspan="2">Class Performance</td><td rowspan="2">5%</td><td>CO3</td><td>C2</td></tr>
<tr><td>CO4</td><td>C2</td></tr>
<tr><td>Mid term</td><td>15%</td><td>CO4</td><td>C2</td></tr>
<tr><td colspan="2" rowspan="4">Final Exam</td><td rowspan="4">60%</td><td>CO1</td><td>C1</td></tr>
<tr><td>CO2</td><td>C3, C5</td></tr>
<tr><td>CO3</td><td>C2</td></tr>
<tr><td>CO4</td><td>C2</td></tr>
<tr><td colspan="2">Total Marks</td><td>100%</td><td colspan="2"></td></tr>
</table>

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT AND REFERENCE BOOKS

1. Modern Inorganic Chemistry – S. Z. Haider
2. Concise Inorganic Chemistry – J. D. Lee
3. A Textbook of Organic Chemistry – Arun Bahl And B. S. Bahl
4. Organic Chemistry – Morrison and Boyd
5. Principles of Physical Chemistry – Haque and Nawab
6. Essentials of Physical Chemistry – Bahl and Tuli
7. Physical Chemistry – Atkins

COURSE INFORMATION

Course Code Course Title	: CHEM 102 : Chemistry Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: N/A
Course Title:

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

To implement the basic concepts of inorganic and physical chemistry in a laboratory environment.

OBJECTIVE
1) To familiarize the students with experimentation of acid and base neutralization, titration and quantitative analysis of metals etc. 2) To make students proficient in iodimetric and iodometric analysis and complexometric titration etc. 3) To develop students' ability in estimating zinc, ferrous content in water sample by using various titrimetric methods.

LEARNING OUTCOMES AND GENERIC SKILLS

No.	Course Outcomes	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Be able to **describe** the different parameters regarding acid and base neutralization, titration and quantitative analysis of metals etc. and others key words like primary standard substances, secondary standard substances, molarity, normality, indicator, equivalent weights and so on.	1	P1			1,2	R,Q,T
CO2	Be able to **explain** the different phenomena and **perform** experimentation regarding iodimetric and iodometric method, complexometric titration etc.	1,5,10	P2,P3, P4,P5			1,2	R,Q,T
CO3	Be able to **measure** zinc, ferrous content in water sample by using various titrimetric methods.	1,5,10	P3,P4,P5			1,2	R,Q,T, Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

Quantitative chemical analysis in the field of inorganic and physical chemistry such as:
Acid-base titration, Redox titration, Iodometric and Iodimetric titration, Complexometric titration.

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO 1	Be able to **describe** the different parameters regarding acid and base neutralization, titration and quantitative analysis of metals etc. and others key words like primary standard substances, secondary standard substances, molarity, normality, indicator, equivalent weights and so on.	2											
CO 2	Be able to **explain** the different phenomena and **perform** experimentation regarding iodimetric and iodometric method, complexometric titration etc.	2				2				3			
CO 3	Be able to **measure** zinc, ferrous content in water sample by using various titrimetric methods.	2				2				3			

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Experiment	 12 30
Self-Directed Learning Preparation of Lab Reports Preparation of Lab-test Preparation of Quiz	 24 10 10
Preparation of Presentation	6
Formal Assessment Continuous Assessment Final Quiz	 10 1
Total	103

TEACHING METHODOLOGY
Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE	
Class/ Week	**Intended topics to be covered**
Class 1	Introduction
Class 2	Standardization of Sodium Hydroxide (NaOH) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2 O$) Solution.
Class 3	Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Hydroxide (NaOH) Solution.
Class 4	Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Carbonate (Na_2CO_3) Solution.
Class 5	Determination of Calcium (Ca) Content in a Calcium Chloride dihydrate ($CaCl_2.2H_2O$) Solution with Standard Di-Sodium Ethylene Diammine Tetra Acetic Acid (Na_2-EDTA) Solution.
Class 6	Standardization of Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3.5H_2O$) Solution with Standard Potassium Dichromate ($K_2Cr_2O_7$) Solution.
Class 7	Estimation of Copper (Cu) Content in a Copper Sulphate Pentahydrate ($CuSO_4.5H_2O$) (Blue Vitriol) Solutions by Iodometric Method with Standard Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3.5H_2O$) Solution.
Class 8	Standardization of Potassium Permanganate ($KMnO_4$) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.
Class 9	Determination of Ferrous (Fe) Content in a Ammonium Ferrous Sulphate (Mohr`s Salt) [$FeSO_4.(NH_4)_2SO_4.6H_2O$] Solution with Standard Potassium Permanganate ($KMnO_4$) Solution.
Class 10	Determination of Zinc (Zn) Content in a Zinc Sulphat Heptahydrate ($ZnSO_4.7H_2O$) Solution with Standard Di-Sodium Ethylene Diamine Tetra Acetic acid (Na_2-EDTA) (Na_2-EDTA) Solution by using Eriochrome black T indicator.
Class 11	Practice Lab
Class 12	Lab Test
Class 13	Quiz Test
Class 14	Viva

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Lab participation and Report	15%	CO 1	P1
			CO 2	P2,P3,P4,P5
			CO 3	P3,P4,P5
	Labtest-1, Labtest-1, Labtest-2 Labtest-2	25%	CO 1	P1
			CO 2	P2,P3,P4,P5
			CO 3	P3,P4,P5
	Presentation	20%	CO3	P3,P4,P5
Lab Quiz		30%	CO 1	P1
			CO 2	P2,P3,P4,P5
			CO 3	P3,P4,P5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT AND REFERENCE BOOKS

1. G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Scientific and Technical, 1989
2. G. D. Christian., Analytical Chemistry, 6th Edition, Wiley India Pvt. Limited, 2007
3. A. Jabbar Mian and M. Mahbubul Haque-Practical Chemistry

6.2 Detailed Curriculum of Mathematics Courses

COURSE INFORMATION			
Course Code Course Title Level/Term	: Math 101 : Differential and Integral Calculus : 1/I	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
Purpose of this course is to introduce basic knowledge of Differential Calculus and use it in engineering study.			
OBJECTIVE			
1. Be able to impart basic knowledge on differential and Integral Calculus to solve engineering problems and other applied problems. **2.** Developing understanding some of the important aspects of rate of change, area, tangent, normal and volume. **3.** Be expert in imparting in depth knowledge of functional analysis such as increasing, decreasing, maximum and minimum values of a function			
COURSE OUTCOMES & GENERIC SKILLS			

No.	Course Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** the limit, continuity and differentiability of functions, **identify** the rate of change of a function with respect to independent variables and **describe** the different techniques of evaluating indefinite and definite integrals.	C1-C2	1		3	T, F, ASG
CO2	**Apply** the concepts or techniques of differentiation and integration to solve the problems related to engineering study.	C3	1		3	T, Mid Term Exam, F
CO3	**Calculate** the length, area, volume, center of gravity and average value related to engineering study	C3	1		3	Mid Term Exam, F, ASG

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; F – Final Exam)

COURSE CONTENT

Differential Calculus: Introduction, Differential Calculus for Engineering, Function and Limit, Continuity and Differentiability, Successive Differentiation, Leibnittz's Theorem, Rolle's Theorem, Mean Value Theorem, Taylor's theorem, Expansion of Finite and Infinite forms, Lagrange's form of remainder, Cauchy's form of remainder, Expansion of functions differentiation and integration, Indeterminate form, Cartesian differentiation, Euler's theorem, Tangent, sub tangent and Normal, sub normal, Maxima and Minima, Curvature, Asymptotes, Partial differentiation.

Integral Calculus: Definition of Integration, Importance of Integration in Eng., Integration by substitution, Integration by parts, Standard integrals, Integration by successive reduction, Definite integrals and its use, Integration as a limit of sum, summing series, Walli's formula, Improper Integrals, beta and gamma function, multiple integral and its application, Area, volume of solid revolution, Area under a plain curve, Area of the region enclosed by two curves, Arc lengths of curves.

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** the limit, continuity and differentiability of functions, **identify** the rate of change of a function with respect to independent variables and **describe** the different techniques of evaluating indefinite and definite integrals	3											
CO2	**Apply** the concepts or techniques of differentiation and integration to solve the problems related to engineering study.	3											
CO3	**Calculate** the length, area, volume, center of gravity and average value related to engineering study	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for CO-PO mapping:

Mapping	Corresponding Level of matching	Justifications
CO1-PO1(a)	**3**	The knowledge of mathematics, science and engineering sciences has to be applied to describe the complete concept of differential and integral calculus.
CO2-PO1(a)	**3**	To apply proper and improper integral in the field of engineering study, the knowledge of mathematics, science and engineering sciences is required.
CO3-PO1(a)	**3**	In order to calculate volume, average, center of gravity and area of any solid revolution object, the knowledge of mathematics, and engineering sciences is needed.

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision of the previous lecture at home Preparation for final examination	 42 21 21
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1		CT 1
Class 1	Introduction to Differential Calculus for Engineering study, Limit of a function and its properties.	
Class 2	Basic limit theorems with proofs, Limit of infinity and infinite limit, Sandwich (Squeezing) theorem with problems.	
Class 3	Concept of Differentiation, definition, classification of discontinuity and solving problems	
Week 2		
Class 4	Basic concept of Differentiability, definition, derivative of a function, differentiable function.	
Class 5	Differentiability – one sided derivatives (R.H.D and L.H.D), solving problems	

Class 6	Successive differentiation – Concept and problem solving	
Week 3		
Class 7	Leibnitz’s theorem and its applications	
Class 8	Determination of $(\square_{\square})_0$	
Class 9	Mean Value theorem, Taylor theorem	
Week 4		
Class 10	Expansion of finite and infinite forms, Lagrange’s and Cauchy’s form of remainder.	CT 2
Class 11	Indeterminate forms – concept and problem solving,	
Class 12	L’Hospital’s rules with application	
Week 5		
Class 13	Partial differentiation - partial derivatives of a function of two variables and problems	
Class 14	Partial differentiation - partial derivatives of a homogeneous function of two variables, Euler’s theorem for two variables and problems	
Class 15	Partial differentiation - partial derivatives of a homogeneous function of several variables, Euler’s theorem for several (three and m) variables and problem solving	
Week 6		
Class 16	Tangents and Normals – Tangents and Normals in Cartesian, equation of tangent at the origin, equation of normal of functions of explicit and implicit forms, Angle between two intersection of two curves; problem solving	
Class 17	Tangents and Normals – Tangents and Normals in polar, Angle between two intersection of two curves; problem solving	
Class 18	Tangents and Normals – Subtangent and subnormals in Cartesian and polar coordinate; problem solving	
Week 7		

Class 19	maxima and minima of functions of single variables – concept,Increasing and decreasing function, Concave up and down with problems	Mid Term
Class 20	Curvature	
Class 21	Asymptotes	
Week 8		
Class 22	Introduction to integral calculus	
Class 23	Standard integrals – concept of definite and indefinite integrals, applications.	
Class 24	Indefinite integrals – Method of substitution, Techniques of integration	
Week 9		
Class 25	Indefinite integrals – Integration by parts, Special types of integration, integration by partial fraction,	
Class 26	Integration by the method of successive reduction	
Class 27	Definite integrals – definite integrals with properties and problems	
Week 10		CT 4
Class 28	Definite integrals – Reduction formula, Walli's formula	
Class 29	Definite integrals – definite integral as the limit of the sum	
Class 30	Beta function – concept and problem solving	
Week 11		
Class 31	Gamma function - concept and problem solving	
Class 32	Relation between beta and gamma function, Legendre duplication formula, problems and applications	
Class 33	Multiple integrals – double integrals	
Week 12		
Class 34	Multiple integrals – triple integrals	

Class 35	Multiple integrals – successive integration for two and three variables	
Class 36	Area in Cartesian	
Week 13		
Class 37	Area in polar	
Class 38	Volume of solid revolution	
Class 39	Area under a plain curve in Cartesian and polar coordinates	
Week 14		
Class 40	Area of a region enclosed by two curves in Cartesian and polar coordinates	
Class 41	Arc lengths of curves in Cartesian coordinates	
Class 42	Arc lengths of curves in polar coordinates	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
			CO 2	C3
	Class Participation	5%	CO 3	C3
	Mid term	15%	CO 2, CO3	C3
Final Exam		60%	CO 1	CO 1
			CO 2	CO 2
			CO 3	CO 3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS
1. Calculus (9th Edition) by Howard Anton (Author), Irl C. Bivens (Author), Stephen Davis. 2. Calculus: An Intuitive and Physical Approach By Morris Kline.

COURSE INFORMATION			
Course Code Course Title Levl/Term	: Math 103 : Differential Equations and Matrix : 1/II	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
Math 101			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
Purpose of this course is to introduce basic knowledge to identify and solve differential equations and concept of matrix.			
OBJECTIVE			
1. Be able to impart basic knowledge on ordinary and partial differential equations. **2.** Developing understanding some of the important aspects of ordinary and partial differential equations. **3.** Be able to provide knowledge on using concept of Differential equations and matrix in engineering problems and solve other applied problems. 3. Be expert in imparting in depth knowledge on inverse matrix			

COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** various types of differential equations and **identify** the classifications of partial differential equations.	C1, C2	1		3	T, F, ASG
CO2	**Apply** the knowledge and **solve** ordinary and partial differential equations.	C3	1		3	T, Mid Term Exam, F
CO3	**Apply** the technique to obtain the inverse matrix that **solve** the system of linear equations.	C3	1		3	Mid Term Exam, F, ASG
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; F – Final Exam)						

COURSE CONTENT

Differential Equations: Introduction & Formulation of DE in Eng, Degree and order of ODE, solution of first order but higher degree DE by various methods, solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs, Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial, linear first order PDE, Non linear first order PDE, Standard form DEs of higher order and wave equation, particular solutions with boundary and initial condition, Non-linear PDE of order one, Charpit's method, Linear PDE with constant coefficients, Applications of DE.

Matrix: Definition of Matrix, different types of matrices, Algebra of Matrices, Transpose and adjoint of a matrix and inverse matrix, rank and elementary transformation, solution of linear equation or System of Linear Equation, Matrix polynomials determination characteristic roots and vectors, characteristic subspace of matrix and Eigen values and Eigen Vectors, Cayley Hamilton theorem.

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** various types of differential equations and **identify** the classifications of ordinary and partial differential equations.	3											
CO2	**Apply** the knowledge to identify and **solve** ordinary and partial differential equations.	3											
CO3	**Apply** the technique to obtain the inverse matrix that **solve** the system of linear equations.	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for CO-PO mapping:		
Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1(a)	**3**	The knowledge of mathematics, science and engineering sciences has to be applied to describe for the physical explanation of differential equations.
CO2-PO1(a)	**3**	The application of differential equations need the knowledge of mathematics, science and engineering for describing exponential growth and decay, the population growth of species or change in investment return over time.

CO3-PO1(a)	**3**	In order to establish for finding the technique to obtain the inverse matrix of mathematics and natural science is required.

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision of the previous lecture at home Preparation for final examination	 42 21 21
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1		CT 1
Class 1	Introduction & Formulation of DE in Eng, Degree and order of ODE	
Class 2	Introduction & Formulation of DE in Eng, Degree and order of ODE	
Class 3	Introduction & Formulation of DE in Eng, Degree and order of ODE	
Week 2		
Class 4	Solution of first order but higher degree DE by various methods	
Class 5	Solution of first order but higher degree DE by various methods	
Class 6	Solution of first order but higher degree DE by various methods	
Week 3		
Class 7	Solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs	
Class 8	Solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs	
Class 9	Solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs	
Week 4		CT 2
Class 10	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	
Class 11	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	
Class 12	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	
Week 5		
Class 13	Linear first order PDE, Non linear first order PDE	
Class 14	Standard form DEs of higher order and wave equation	

Class 15	Standard form DEs of higher order and wave equation	
Week 6		
Class 16	Particular solutions with boundary and initial condition, Non-linear PDE of order one: Charpit's method	
Class 17	Particular solutions with boundary and initial condition, Non-linear PDE of order one: Charpit's method	
Class 18	Particular solutions with boundary and initial condition, Non-linear PDE of order one: Charpit's method	
Week 7		Mid Term
Class 19	Linear PDE with constant coefficients, Applications of DE	
Class 20	Linear PDE with constant coefficients, Applications of DE	
Class 21	Linear PDE with constant coefficients, Applications of DE	
Week 8		
Class 22	Wave equations	
Class 23	Particular solutions with boundary and initial conditions	
Class 24	Particular solutions with boundary and initial conditions	
Week 9		
Class 25	Second order PDE and classifications to canonical (standard)- parabolic, elliptic, hyperbolic solution by separation of variables,	
Class 26	Second order PDE and classifications to canonical (standard)- parabolic, elliptic, hyperbolic solution by separation of variables,	
Class 27	Second order PDE and classifications to canonical (standard)- parabolic, elliptic, hyperbolic solution by separation of variables,	
Week 10		CT 4
Class 28	Application of OD and PDE in Eng study	
Class 29	Definition of Matrix, different types of matrices, Algebra of Matrices,	

Class 30	Transpose and adjoint of a matrix and inverse matrix	
Week 11		
Class 31	Solution of linear equation or System of Linear Equation	
Class 32	Solution of linear equation or System of Linear Equation	
Class 33	Solution of linear equation or System of Linear Equation	
Week 12		
Class 34	Solution of linear equation using Inverse Matrix	
Class 35	Rank, Nullity and elementary transformation	
Class 36	Rank, Nullity and elementary transformation	
Week 13		
Class 37	Dependent and independent of vectors	
Class 38	Dependent and independent of vectors with examples	
Class 39	Matrix polynomials determination characteristic roots and vectors	
Week 14		
Class 40	Characteristic subspace of matrix and Eigen values and Eigen Vectors,	
Class 41	Characteristic subspace of matrix and Eigen values and Eigen Vectors,	
Class 42	Cayley Hamilton theorem and its application. Finding inverse matrix using this theorem.	

ASSESSMENT STRATEGY

			CO	Blooms Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
			CO 2	C3
	Class Participation	5%	CO 3	C3
	Mid term	15%	CO 2, CO3	C3
Final Exam		60%	CO 1	CO 1
			CO 2	CO 2
			CO 3	CO 3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

1. Elementary Linear Algebra 10th Edition by Howard Anton (Author).
2. Ordinary and Partial Differential Equations By Dr. M.D. Raisinghania , S. Chand Publishing

COURSE INFORMATION			
Course Code Course Title Level/Term	: Math 103 : Differential Equations and Matrix : 1/II	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Math 101

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

Purpose of this course is to introduce basic knowledge to identify and solve differential equations and concept of matrix.

OBJECTIVE

1. Be able to impart basic knowledge on ordinary and partial differential equations.

2. Developing understanding some of the important aspects of ordinary and partial differential equations.

3. Be able to provide knowledge on using concept of Differential equations and matrix in engineering problems and solve other applied problems.

4. Be expert in imparting in depth knowledge on inverse matrix.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** various types of differential equations and **identify** the classifications of partial differential equations.	C1, C2	1		3	T, F, ASG
CO2	**Apply** the knowledge and **solve** ordinary and partial differential equations.	C3	1		3	T, Mid Term Exam, F
CO3	**Apply** the technique to obtain the inverse matrix that **solve** the system of linear equations.	C3	1		3	Mid Term Exam, F, ASG

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; F – Final Exam)

COURSE CONTENT

Differential Equations: Introduction & Formulation of DE in Eng, Degree and order of ODE, solution of first order but higher degree DE by various methods, solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs, Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial, linear first order PDE, Non linear first order PDE, Standard form DEs of higher order and wave equation, particular solutions with boundary and initial condition, Non-linear PDE of order one, Charpit's method, Linear PDE with constant coefficients, Applications of DE.

Matrix: Definition of Matrix, different types of matrices, Algebra of Matrices, Transpose and adjoint of a matrix and inverse matrix, rank and elementary transformation, solution of linear equation or System of Linear Equation, Matrix polynomials determination characteristic roots and vectors, characteristic subspace of matrix and Eigen values and Eigen Vectors, Cayley Hamilton theorem.

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** various types of differential equations and **identify** the classifications of ordinary and partial differential equations.	3											
CO2	**Apply** the knowledge to identify and **solve** ordinary and partial differential equations.	3											
CO3	**Apply** the technique to obtain the inverse matrix that **solve** the system of linear equations.	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for CO-PO mapping:

Mapping	Corresponding Level of matching	Justifications
CO1-PO1(a)	**3**	The knowledge of mathematics, science and engineering sciences has to be applied to describe for the physical explanation of differential equations.
CO2-PO1(a)	**3**	The application of differential equations need the knowledge of mathematics, science and engineering for describing exponential growth and decay, the population growth of species or change in investment return over time.
CO3-PO1(a)	**3**	In order to establish for finding the technique to obtain the inverse matrix of mathematics and natural science is required.

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1		CT 1
Class 1	Introduction & Formulation of DE in Eng, Degree and order of ODE	
Class 2	Introduction & Formulation of DE in Eng, Degree and order of ODE	
Class 3	Introduction & Formulation of DE in Eng, Degree and order of ODE	
Week 2		
Class 4	Solution of first order but higher degree DE by various methods	
Class 5	Solution of first order but higher degree DE by various methods	
Class 6	Solution of first order but higher degree DE by various methods	
Week 3		
Class 7	Solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs	
Class 8	Solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs	
Class 9	Solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs	
Week 4		CT 2
Class 10	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	
Class 11	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	
Class 12	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	
Week 5		
Class 13	Linear first order PDE, Non linear first order PDE	
Class 14	Standard form DEs of higher order and wave equation	
Class 15	Standard form DEs of higher order and wave equation	
Week 6		

Class 16	Particular solutions with boundary and initial condition, Non-linear PDE of order one: Charpit's method	
Class 17	Particular solutions with boundary and initial condition, Non-linear PDE of order one: Charpit's method	
Class 18	Particular solutions with boundary and initial condition, Non-linear PDE of order one: Charpit's method	
Week 7		Mid Term
Class 19	Linear PDE with constant coefficients, Applications of DE	
Class 20	Linear PDE with constant coefficients, Applications of DE	
Class 21	Linear PDE with constant coefficients, Applications of DE	
Week 8		
Class 22	Wave equations	
Class 23	Particular solutions with boundary and initial conditions	
Class 24	Particular solutions with boundary and initial conditions	
Week 9		
Class 25	Second order PDE and classifications to canonical (standard)- parabolic, elliptic, hyperbolic solution by separation of variables,	
Class 26	Second order PDE and classifications to canonical (standard)- parabolic, elliptic, hyperbolic solution by separation of variables,	
Class 27	Second order PDE and classifications to canonical (standard)- parabolic, elliptic, hyperbolic solution by separation of variables,	
Week 10		CT 4
Class 28	Application of OD and PDE in Eng study	
Class 29	Definition of Matrix, different types of matrices, Algebra of Matrices,	
Class 30	Transpose and adjoint of a matrix and inverse matrix	
Week 11		

Class 31	Solution of linear equation or System of Linear Equation	
Class 32	Solution of linear equation or System of Linear Equation	
Class 33	Solution of linear equation or System of Linear Equation	
Week 12		
Class 34	Solution of linear equation using Inverse Matrix	
Class 35	Rank, Nullity and elementary transformation	
Class 36	Rank, Nullity and elementary transformation	
Week 13		
Class 37	Dependent and independent of vectors	
Class 38	Dependent and independent of vectors with examples	
Class 39	Matrix polynomials determination characteristic roots and vectors	
Week 14		
Class 40	Characteristic subspace of matrix and Eigen values and Eigen Vectors,	
Class 41	Characteristic subspace of matrix and Eigen values and Eigen Vectors,	
Class 42	Cayley Hamilton theorem and its application. Finding inverse matrix using this theorem.	

ASSESSMENT STRATEGY

			CO	Blooms Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
			CO 2	C3
	Class Participation	5%	CO 3	C3
	Mid term	15%	CO 2, CO3	C3
Final Exam		60%	CO 1	CO 1
			CO 2	CO 2
			CO 3	CO 3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

1. Elementary Linear Algebra 10th Edition by Howard Anton (Author).
2. Ordinary and Partial Differential Equations By Dr. M.D. Raisinghania , S. Chand Publishing

COURSE INFORMATION

Course Code Course Title Level/Term	: Math 201 : Vector Analysis, Laplace Transform & Co-ordinate Geometry : 2/I	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Math 101 and Math 103

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

Purpose of this course is to introduce basic knowledge to identify and solve vector mathematical problems, to demonstrate practical applications of Laplace Transform and analyze co-ordinate geometry.

OBJECTIVE
1. Be able to impart basic knowledge on the vector analysis, laplace transform and geometry. **2.** Achieving ability to familiarize the students with straight lines, pair of straight lines, circles, conics in 2D and 3D co-ordinate systems. **3.** Be able to find the length, volume and area of objects related to engineering study by using vector, application of Laplace transform to ordinary differential equations and also solve the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Know** the physical explanation of different vector notation and **Define** Laplace transform, inverse Laplace transform, different types of matrices, and their properties.	C1-C2	1		3	T, F, ASG
CO2	**Explain** the characteristics of conics and familiarize with straight lines, pair of straight lines, circles, radical axis and center in 2D and 3D co-ordinate systems.	C2	1		3	T, Mid Term Exam, F
CO3	**Calculate** length, volume and area of objects related to engineering study by using vector, **Apply** Laplace transform to ODE and PDEs and	C3	1		3	Mid Term Exam, F, ASG

	the knowledge of geometry in engineering study. **Solve** the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc.					

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; F – Final Exam)

COURSE CONTENT

Vector Analysis: Definition of Vector and scalers & vector algebra, Scaler and vector products of two vectors and their geometrical interpretation, Triple products and multiple products, Linear dependence and independence of vectors, Differentiation of vectors, Gradient of scaler functions, Divergence and curl of point functions, physical significance of gradient, divergence and curl, Definition of line, surface and volume integral, Integration of Vectors, Green's theorem and its application, Stoke's theorem and its application, Gauss theorem and its application in Engineering.

Laplace Transform: Definition of LT and Application of LT for Engineering , LT of some elementary functions and properties of LT, Sufficient condition for existence of LT, Inverse LT, LT of derivatives, Unit step function, Periodic function, Some special theorems on LT, Partial fraction, Solution of DEs by LT, Heaviside expansion formula, Convolution theorem, Evaluation of improper integral, Application of LT.

Co-ordinate Geometry: Introduction to geometry for Engineering and Rectangular co-ordinates, Transformation of co-ordinates, changes of axes, pair of straight lines, general equation of second degree and reduction to its standard forms and properties, circles (tangents, normal, chord of contact, pole and polar), Equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves, equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points), Three dimensional co-ordinate system, direction cosines, projections, the plane (angle between two planes, parallel & perpendicular plane, distance of a point from a plane) and the straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid straight lines, standard equation of coincides, sphere and ellipsoid.

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Learn** the physical explanation of different vector notation and **Define** Laplace transform, inverse Laplace transform, different types of matrices, and their properties.	3											
CO2	**Explain** the characteristics of conics and familiarize with straight lines, pair of straight lines, circles, radical axis and center in 2D and 3D co-ordinate systems.	3											
CO3	**Calculate** length, volume and area of objects related to engineering study by using vector, **Apply** Laplace transform to ODE and PDEs and the knowledge of geometry in engineering study. **Solve** the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc.	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for CO-PO mapping:		
Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1(a)	**3**	The knowledge of mathematics, science and engineering sciences has to be applied to describe the operation of being able to identify the physical explanation of different vector notation, explain the complete concept about Laplace transform, 2D and 3D geometry.
CO2-PO1(a)	**3**	To explain the differentiation and integration of a vector valued functions in Cartesian, cylindrical and spherical geometry and to solve the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc. the concept of mathematics and engineering sciences is required.
CO3-PO1(a)	**3**	In order to construct and calculate the area and volume of objects related to engineering study by using vector, solve the

		differential equations by Laplace transform is needed the concept of mathematics, physics and engineering sciences.

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision of the previous lecture at home Preparation for final examination	 42 21 21
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1		CT 1
Class 1	Definition of Vector and scalers & vector algebra, Scaler and vector products of two vectors and their geometrical interpretation	
Class 2	Definition of Vector and scalers & vector algebra, Scaler and vector products of two vectors and their geometrical interpretation	
Class 3	Definition of Vector and scalers & vector algebra, Scaler and vector products of two vectors and their geometrical interpretation	
Week 2		
Class 4	Triple products and multiple products, Linear dependence and independence of vectors, Differentiation of vectors	
Class 5	Gradient of scaler functions, Divergence and curl of point functions	
Class 6	Physical significance of gradient, divergence and curl	
Week 3		
Class 7	Definition of line, surface and volume integral, Integration of Vectors, Green's theorem and application	
Class 8	Definition of line, surface and volume integral, Integration of Vectors, Green's theorem and application	
Class 9	Green’s theorem and it’s application	
Week 4		CT 2
Class 10	Gauss theorem and application in Engineering	
Class 11	. Stoke's theorem and it’s application.	
Class 12	Introduction to geometry for Engineering and Rectangular co-ordinates, Transformation of co-ordinates	
Week 5		
Class 13	Introduction to geometry for Engineering and Rectangular co-ordinates, Transformation of co-ordinates, changes of axes, pair of straight lines, general equation of second degree and reduction to its standard forms and properties	
Class 14	Changes of axes, pair of straight lines, general equation of second degree and reduction to its standard forms and properties	

Class 15	Changes of axes, pair of straight lines, general equation of second degree and reduction to its standard forms and properties	
Week 6		
Class 16	Circles (tangents, normal, chord of contact, pole and polar), Equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves	
Class 17	Circles (tangents, normal, chord of contact, pole and polar), Equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves	
Class 18	Circles (tangents, normal, chord of contact, pole and polar), Equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves	
Week 7		Mid Term
Class 19	Circles (tangents, normal, chord of contact, pole and polar), Equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves	
Class 20	Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points	
Class 21	Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points	
Week 8		
Class 22	Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points	
Class 23	Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points	
Class 24	Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points	
Week 9		
Class 25	Three dimensional co-ordinate system, direction cosines, projections, the plane (angle between two planes, parallel & perpendicular plane, distance of	

	a point from a plane) and the straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid	
Class 26	Three dimensional co-ordinate system, direction cosines, projections, the plane (angle between two planes, parallel & perpendicular plane, distance of a point from a plane) and the straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid	
Class 27	Three dimensional co-ordinate system, direction cosines, projections, the plane (angle between two planes, parallel & perpendicular plane, distance of a point from a plane) and the straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid	
Week 10		CT 4
Class 28	Three dimensional co-ordinate system, direction cosines, projections, the plane (angle between two planes, parallel & perpendicular plane, distance of a point from a plane) and the straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid	
Class 29	Definition of LT and Application of LT for Engineering, LT of some elementary functions and properties of LT	
Class 30	Definition of LT and Application of LT for Engineering, LT of some elementary functions and properties of LT	
Week 11		
Class 31	Sufficient condition for existence of LT	
Class 32	LT of derivatives and it’s application	
Class 33	LT of Integration with application, LT of sine and cosine integral	
Week 12		
Class 34	Unit step function and it’s application	
Class 35	Periodic function with examples, LT of some special function.	
Class 36	Definition of inverse Laplace Transform and it’s properties	
Week 13		
Class 37	Partial fraction and it’s application in inverse Laplace Transform	

Class 38	Heaviside formula and it's application	
Class 39	Convoulution theorem, Evaluation of improper integral, Application of LT	
Week 14		
Class 40	Solve ODE s by Laplace transform	
Class 41	Solve PDE s by Laplace transform	
Class 42	Application of LT in Eng study	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
			CO 2	C3
	Class Participation	5%	CO 3	C3
	Mid term	15%	CO 2, CO3	C1, C2
Final Exam		60%	CO 1	C1, C2
			CO 2	C1, C2
			CO 3	C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

1. Vector Analysis, 2nd Edition 2nd Edition by Murray Spiegel, Seymour Lipschutz, Dennis Spellman
2. Schaum's Outline of Laplace Transforms by Murray R. Spiegel.
3. Engineering Mathematics, Volume Two 2 II: Containing Coordinate Geometry of Two Dimensions, Co-ordinate Geometry of Three Dimensions, Matrices.
4. Theory of Equations and Vector Calculus by K. Kandasamy, P.; Thilagavathy, K.; Gunavathy
5. A Text Book on Co-ordinate Geometry with Vector Analysis - Rahman & Bhattacharjee.

Course Code: MATH 215 **Course Name:** Numerical Analysis
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-2, T-2

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Rationale:

The objective of this course is to provide students with numerical techniques that makes complex and time-consuming analytical calculations simple.

Objectives:

1. To provide students with numerical techniques to solve complex non-linear equations, differentiation, integration, systems of equations, constrained optimization, curve fitting.
2. To make students adept at coding these techniques using a programming language to make complex calculations quick and easy.

Course Outcomes (CO) & Generic Skills:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Familiarize** students with the nature of engineering problems and **apply** appropriate numerical techniques to solve the problem	C1-C4	1	1	1	ASG, T, Mid Term Exam, F
CO2	**Compare** the different numerical techniques for advantages and disadvantages and choose the most suitable one for solving problems.	C3, C4	1	1	1	ASG, Mid Term Exam, F
CO3	**Transfer** knowledge of different techniques and algorithms in practical situation to **solve** complex real-life problems	C2-C4	2	2	2	ASG, Mid Term Exam, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Modelling, Computer and Error Analysis: A Simple Mathematical Model, Conservation Laws and Engineering, Problems related to Mathematical Modeling, Programming and Software , Significant Figures, Accuracy and Precision, Error Definitions, Round-Off Errors

Roots of Equations : Graphical Methods, The Bisection Method, The False-Position Method, Incremental Searches and Determining Initial Guesses, Simple Fixed-Point Iteration, The Newton-Raphson, The Secant Method, Brent's Method, Multiple Roots, Systems of Nonlinear Equations

Linear Algebraic Equations: Polynomials in Engineering and Science, Computing with Polynomials, Conventional Method, Müller's Method, Bairstow's Method, Solving Small Numbers of Equations, Naive Gauss Elimination, Pitfalls of Elimination, Techniques for Improving Solutions, Complex Systems, Nonlinear Systems of Equations, Gauss-Jordan, Problems, LU Decomposition, The Matrix Inverse

Curve fitting: Linear Regression, Nonlinear Regression, Newton's Divided-Difference Interpolating Polynomials, Lagrange Interpolating Polynomials, Coefficients of an Interpolating Polynomial, Inverse Interpolation, Spline Interpolation, Multidimensional Interpolation

Numerical Differentiation and Integration: Newton Cotes Integration Formulas, The Trapezoidal Rule, Simpson's Rules, Integration with Unequal Segments, Open Integration Formulas, Multiple Integrals

Ordinary and Partial Differential Equations: Taylor's series method, Euler's method, Milne's method, Runge-Kutta methods, numerical optimization techniques.

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of	Investigation	Modern Tool Usage	The Engineer and	Environment and Sustainability	Ethics	Communication	Individual and Team	Life Long Learning	Project Management and Finance
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	Familiarize students with the nature of	**H**	**H**		**M**	**M**						**H**	

	engineering problems and apply appropriate numerical techniques to solve the problem.												
CO2	Compare the different numerical techniques for advantages and disadvantages and choose the most suitable one for solving problems.		**H**		**H**	**H**						**L**	
CO3	Transfer knowledge of different techniques and algorithms in practical situation to solve complex real-life problems.		**H**	**H**	**M**	**H**						**H**	

(H – High, M- Medium, L- Low)

Teaching-learning and Assessment Strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning Lecture Practical/ Tutorial/ Studio	 42 -

Student-centered learning	-
Self-directed learning Non face-to-face learning Revision Assessment preparations	 18 21 20
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	106

Teaching methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Visualization using Computer Softwares, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	Introduction: A Simple Mathematical Model	**ASG, Class Test 1, F**
	Lec 2	Conservation Laws and Engineering	
	Lec 3	Problems related to Mathematical Modeling	
2	Lec 4	Programming and Software	
	Lec 5	Significant Figures, Accuracy and Precision	
	Lec 6	Error Definitions , Round-Off Errors, Problems	
3	Lec 7	Graphical Methods, The Bisection Method	
	Lec 8	The False-Position Method	

	Lec 9	Incremental Searches and Determining Initial Guesses, Problems	
4	Lec 10 Lec 11 Lec 12	Simple Fixed-Point Iteration, The Newton-Raphson Method	**ASG, Class Test 2, F**
		The Secant Method, Brent's Method	
		Multiple Roots, Systems of Nonlinear Equations, Problems	
5	Lec 13 Lec 14 Lec 15	Polynomials in Engineering and Science, Computing with Polynomials, Conventional Methods	
		Müller's Method, Bairstow's Method	
		Case Studies: Roots of Equations	
6	Lec 16 Lec 17 Lec 18	Solving Small Numbers of Equations, Naive Gauss Elimination, Pitfalls of Elimination Methods	
		Techniques for Improving Solutions, Complex Systems	
		Nonlinear Systems of Equations, Gauss-Jordan, Problems	
7	Lec 19 Lec 20 Lec 21	LU Decomposition	
		The Matrix Inverse	
		Error Analysis and System Condition, Problems	
8	Lec 22 Lec 23 Lec 24	Linear Regression	**ASG, Mid Term, F**
		Polynomial Regression.	
		Multiple Linear Regression	
9	Lec 25 Lec 26 Lec 27	General Linear Least Squares	
		Nonlinear Regression	
		Problems related to Least Square Regression	

10	Lec 28 Lec 29 Lec 30	Newton's Divided-Difference Interpolating Polynomials	**ASG, F, CT-3**
		Lagrange Interpolating Polynomials	
		Coefficients of an Interpolating Polynomial	
11	Lec 31 Lec 32 Lec 33	Inverse Interpolation	
		Spline Interpolation	
		Multidimensional Interpolation	
12	Lec 34 Lec 35 Lec 36	The Trapezoidal Rule, Simpson's Rules	
		Integration with Unequal Segments	
		Open Integration Formulas, Multiple Integrals. Problems	
13	Lec 37 Lec 38 Lec 39	Euler's Method, Improvements of Euler's Method	**ASG, F**
		Runge-Kutta Methods	
		Systems of Equations	
14	Lec 40 Lec 41 Lec 42	Mathematical Problems Related to Numerical Analysis	
		Programming Techniques Related to Numerical Analysis	
		Review	

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (40%)	Class test 1-3	20%	CO 1	C1-C3, P1-P2
			CO 2	C4-C5, P3-P4
		5%	CO 1	C2, P2

	Class Participation		CO 2	C4, P5
	Mid term	15%	CO 1	C1-C3, P1-P2
			CO 2	C4-C5, P3-P4
			CO 3	C5-C6, P5
Final Exam		60%	CO 1	C1-C3,P1-P2
			CO 2	C4-C5, P3-P4
			CO 3	C5-C6, P5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Numerical Methods for Engineers- Steven C. Chapra, Raymond P. Canale
2. Introduction to Numerical Analysis- Francis B. Hildebrand.

6.3 Detailed Curriculum of Language Courses

Course Code: LANG 102 **Course Name:** Communicative English -1

Credit Hour: 1.5 **Contact Hour:** 3.0

Level/Term: 1/II

Pre-requisite: Nil

Rationale: This course has mainly been designed to improve speaking and oral communication skills of the students. The course includes instructions and experience in speech preparation and speech delivery within various real life situations, formal and informal. Emphasis will be given on various speeches, such as informative, persuasive and interactive. This course will help students progress in real life both personally and professionally. Students will be able to understand class lectures and can comfortably continue the Engineering course, and also to compete in the global job market and increase career skills.

Objectives:

a. To develop the four basics skills of English language, i.e. listening, speaking, reading and writing.

b. To develop students' interpersonal skills engaging them in various group interactions and activities.

c. To improve students' pronunciation in order to improve their level of comprehensibility in both speaking and listening.

d. To give the students exposure to different types of texts in English in order to make them informed using different techniques of reading.

e. To gain an understanding of the underlying writing well-organized paragraphs and also to teach how to edit and revise their own as well as peer's writing.

Course Outcomes (CO): At the end of the course, students are able to :

a. Listen, understand, and learn the techniques of note taking and answering questions

b. Understand and speak English quickly and smartly using the techniques learnt in the class.

c. Communicate effectively within the shortest possible time to present their ideas and opinions.

d. Develop competency in oral, written communication/presentation

e. Understand the techniques of academic reading and summarizing any book article/literature for review

Course Contents:

Main Contents	Detail Contents
	Introduction to Language: Introducing basic skills of language.

	English for Science and Technology
	Self-introduction and introducing others: How a speaker should introduce himself to any stranger / unknown person / a crowd. Name, family background, education, experience, any special quality/interest, likings/disliking, etc.
	Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and giving directions
Speaking	Discussing everyday routines and habits, Making requests /offers /invitations /excuses /apologies/complaints
	Describing personality, discussing and making plans(for a holiday or an outing to the cinema), Describing pictures / any incident / event
	Practicing storytelling, Narrating personal experiences/Anecdotes
	Telephone conversations (role play in group or pair) Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)
	Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions
Listening	Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand
	Listening to short conversations between two persons/more than two
Reading	Reading techniques: scanning, skimming, predicting, inference;
	Reading Techniques: analysis, summarizing and interpretation of texts
	Introductory discussion on writing, prewriting, drafting;
Writing	Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event
	Paragraph writing, Compare-contrast and cause- effect paragraph

Teaching-learning and Assessment Strategy: This course is mostly activity based. Students will often be engaged in interactive discussion. The tasks and activities include pair work, group work, brainstorming, guesswork, describing picture/graph/diagrams, word puzzle, making jokes, storytelling, role play, responding to reading, writing and listening texts.

Linkage of Course Outcomes with Assessment Methods and their Weights:

COs	Assessment Method	(100%)	Remarks
	Class Assessment		
1	Listening Test	15%	
2	Descriptive writing	25%	
3	Public Speaking	30%	
4	Presentation	30%	
	Exam		

Mapping of Course Outcomes and Program Outcomes:

Course Outcomes (CO) of the Course	Program Outcome												Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	
Listen, understand and speak English quickly and smartly using the technics learnt in the class.	√												
understand the techniques of academic reading and academic writing	√												
Communicate effectively within the shortest possible time to present ideas and opinions										√			
Develop competency in oral, written communication/presentation										√			

Lecture Schedule:

Week	Class	Topic	CT
Week 1	Class 1	Introduction to Language: Introducing basic skills of language. English for Science and Technology	

	Class 2	Self-introduction and introducing others: How a speaker should introduce himself to any stranger / unknown person / a crowd. Name, family background, education, experience, any special quality/interest, likings/disliking, etc.	
	Class 3	Self-introduction and introducing others: How a speaker should introduce himself to any stranger / unknown person / a crowd. Name, family background, education, experience, any special quality/interest, likings/disliking, etc.	
Week 2	Class 4	Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and giving directions	
	Class 5	Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and giving directions	
	Class 6	Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and giving directions	
Week 3	Class 7	Discussing everyday routines and habits, Making requests/offers/invitations/excuses/apologies/complaints	
	Class 8	Discussing everyday routines and habits, Making requests/offers/invitations/excuses/apologies/complaints	
	Class 9	Discussing everyday routines and habits, Making requests/offers/invitations/excuses/apologies/complaints	
Week 4	Class 10	Describing personality, discussing and making plans(for a holiday or an outing to the cinema), Describing pictures / any incident / event	
	Class 11	Describing personality, discussing and making plans(for a holiday or an outing to the cinema), Describing pictures / any incident / event	
	Class 12	Describing personality, discussing and making plans(for a holiday or an outing to the cinema), Describing pictures / any incident / event	
Week 5	Class 13	Practicing storytelling, Narrating personal experiences/Anecdotes	

	Class 14	Practicing storytelling, Narrating personal experiences/Anecdotes	
	Class 15	Practicing storytelling, Narrating personal experiences/Anecdotes	
Week 6	Class 16	Telephone conversations (role play in group or pair) Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)	
	Class 17	Telephone conversations (role play in group or pair) Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)	
	Class 18	Telephone conversations (role play in group or pair) Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)	
Week 7	Class 19	Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions	
	Class 20	Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions	
	Class 21	Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions	
Week 8	Class 22	Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand	

	Class 23	Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand	
	Class 24	Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand	
Week 9	Class 25	Listening to short conversations between two persons/more than two	
	Class 26	Listening to short conversations between two persons/more than two	
	Class 27	Listening to short conversations between two persons/more than two	
Week 10	Class 28	Reading techniques: scanning, skimming, predicting, inference;	
	Class 29	Reading techniques: scanning, skimming, predicting, inference;	
	Class 30	Reading techniques: scanning, skimming, predicting, inference	
Week 11	Class 31	Reading Techniques: analysis, summarizing and interpretation of texts	
	Class 32	Reading Techniques: analysis, summarizing and interpretation of texts	
	Class 33	Reading Techniques: analysis, summarizing and interpretation of texts	
Week 12	Class 34	Introductory discussion on writing, prewriting, drafting;	
	Class 35	Introductory discussion on writing, prewriting, drafting;	
	Class 36	Introductory discussion on writing, prewriting, drafting	
Week 13	Class 37	Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event	
	Class 38	Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event	
	Class 39	Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event	
Week 14	Class 40	Paragraph writing, Compare-contrast and cause- effect paragraph	
	Class 41	Paragraph writing, Compare-contrast and cause- effect paragraph	

	Class 42	Paragraph writing, Compare-contrast and cause- effect paragraph	

Text and Ref Books:

a. Langan, J. (2005). College Writing Skills with Readings (6th Ed). McGraw-Hill Publication
b. Interactions 1 (Reading), John Langan, Latest edition, McGraw-Hill Publication
c. Jones, L. (1981). Functions of English. (Student's Book, 2nd Ed.) Melbourne, Australia: Cambridge University Press.
d. Dixon, R.J. (1987). Complete course in English. (Book 4). New Delhi, India: Prentice Hall of India. (For book presentation)
e. From Paragraph to Essay - Maurice Imhoof and Herman Hudson
f. Headway Series – Advanced Level (2 parts with CDs): Oxford University Press Ltd.
g. Speak like Churchill stand like Lincoln - James C. Humes
h. Cambridge IELTS Practice Book
j. Selected Sample Reports and Selected Research Articles

Course Code: LANG 202 **Course Name:** Communicative English - II

Credit Hour: 1.5 **Contact Hour:** 3.0

Level/Term: 2/I

Pre-requisite: Communicative English – 1

Rationale: The English language course is designed for the students to develop their competence in communication skills for academic purposes especially in reading and writing. The approach will be communicative and interactive and will involve individual, pair and group work. Students will be exposed to different types of texts to develop efficient reading skill. Reading will also involve activities and discussions leading to effective writing. The course incorporates a wide range of reading texts to develop students' critical thinking which is one of the most essential elements required to write a good piece of academic writing. Emphasis is particularly put on the various forms of essay writing such as descriptive, narrative, cause-effect, compare-contrast, and argumentative. Upon completion of this course, students are expected to be able to communicate at various situations, participate in group activities and prepare formal speech for academic, professional and social purposes. This course also incorporates classroom instructions to provide guidelines on presentations and communication skills. In addition, the course emphasizes on providing constructive feedback on students' oral performances.

Objectives:

a. To develop English language skills to communicate effectively and professionally.

b. To strengthen students' presentation skills.
c. To develop competency in academic reading and writing.

Course Outcomes (CO): At the end of the course, students will be able to:

a. **Understand** the technics of academic reading and become familiar with technical terms.
b. **Develop** competency in academic reading, preparing report written communication/presentation.
c. **Analyse** any problem critically, analyse and interpret data and synthesize information to provide valid conclusions.
d. **Communicate effectively** within the shortest possible time to present their reports and academic writings
e. **Apply** the technics to find out the main points of any long article within a very limited time as well as know the technics of any effective writing. In short with consistent practice they will be able to overcome language barrier.

Course Contents:

Main Content	Detail Contents
Reading	Reading Comprehension: Practice using different techniques
	Academic reading: comprehension from departmental or subject related passages
	Vocabulary for Engineers (some common Engineering terms for both general and dept specific)
	Reading subject specific text to develop vocabulary
Writing	Writing semi-formal, Formal/official letters, Official E-mail
	Applying for a job: Writing Cover Letter and Curriculum Vitae
	Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading;
	Narrative and descriptive writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing;
	Analyzing and describing graphs or charts
	Practicing analytical and argumentative writing

Speaking	Public Speaking: Basic elements and qualities of a good public speaker
	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore.
	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.
Listening	Listening to long lecture on some topics
	Listening and understanding speeches/lectures of different accent

Teaching-learning and Assessment Strategy: This course is mostly activity based. Students will often be engaged in interactive discussion. The tasks and activities include pair work, group work, brainstorming, guesswork, describing picture/graph/diagrams, word puzzle, making jokes, storytelling, role play, responding to reading, writing and listening texts.

Linkage of Course Outcomes with Assessment Methods and their Weights:

COs	**Assessment Method**	**(100%)**	**Remarks**
	Class Assessment		
1	Testing vocabulary level	**20%**	
2	Argumentative/analytical writing	**25%**	
3	Individual Presentation	**25%**	
4	Group Presentation	30%	
	Exam		

Mapping of Course Outcomes and Program Outcomes:

Course Outcomes (CO) of the Course	**Program Outcome**												**Remarks**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Understand the techniques of academic reading and become	√												

acquainted with technical vocabularies													
Understand the techniques of effective academic writing such as research article/report writing	√												
Communicate effectively within the shortest possible time to present any report and research work										√			
Analyze any problem critically, analyze and interpret data and synthesize information to provide valid conclusions										√			

Lecture Schedule:

Week	Class	Topic	CT
Week 1	**Class 1**	Reading Comprehension: Practice using different techniques	
	Class 2	Reading Comprehension: Practice using different techniques	
	Class 3	Reading Comprehension: Practice using different techniques	
Week 2	**Class 4**	Academic reading: comprehension from departmental or subject related passages	
	Class 5	Academic reading: comprehension from departmental or subject related passages	
	Class 6	Academic reading: comprehension from departmental or subject related passages	
Week -3	**Class 7**	Vocabulary for Engineers (some common Engineering terms for both general and dept specific) Reading subject specific text to develop vocabulary	

	Class 8	Vocabulary for Engineers (some common Engineering terms for both general and dept specific) Reading subject specific text to develop vocabulary	
	Class 9	Vocabulary for Engineers (some common Engineering terms for both general and dept specific) Reading subject specific text to develop vocabulary	
Week -4	**Class 10**	Writing semi-formal, Formal/official letters, Official E-mail	
	Class 11	Writing semi-formal, Formal/official letters, Official E-mail	
	Class 12	Writing semi-formal, Formal/official letters, Official E-mail	
Week -5	**Class 13**	Applying for a job: Writing Cover Letter and Curriculum Vitae	
	Class 14	Applying for a job: Writing Cover Letter and Curriculum Vitae	
	Class 15	Applying for a job: Writing Cover Letter and Curriculum Vitae	
Week -6	**Class 16**	Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading;	
	Class 17	Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading;	
	Class 18	Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading;	
Week -7	**Class 19**	Narrative and descriptive writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing;	
	Class 20	Narrative and descriptive writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing;	
	Class 21	Narrative and descriptive writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing;	
Week -8	**Class 22**	Analyzing and describing graphs or charts	
	Class 23	Analyzing and describing graphs or charts	
	Class 24	Analyzing and describing graphs or charts	
Week -9	**Class 25**	Practicing analytical and argumentative writing	
	Class 26	Practicing analytical and argumentative writing	
	Class 27	Practicing analytical and argumentative writing	

Week -10	**Class 28**	Public Speaking: Basic elements and qualities of a good public speaker	
	Class 29	Public Speaking: Basic elements and qualities of a good public speaker	
	Class 30	Public Speaking: Basic elements and qualities of a good public speaker	
Week 11	**Class 31**	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore.	
	Class 32	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore.	
	Class 33	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore.	
Week -12	**Class 34**	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.	
	Class 35	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.	
	Class 36	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.	
Week -13	**Class 37**	Listening to long lecture on some topics	
	Class 38	Listening to long lecture on some topics	
	Class 39	Listening to long lecture on some topics	
Week -14	**Class 40**	Listening and understanding speeches/lectures of different accents	
	Class 41	Listening and understanding speeches/lectures of different accents	
	Class42	Listening and understanding speeches/lectures of different accents	

Text and Ref Books:

a. Jones, L. (1981). Functions of English. (Student's Book, 2nd Ed.) Melbourne, Australia: Cambridge University Press.

b. Dixon, R.J. (1987). Complete course in English. (Book 4). New Delhi, India: Prentice Hall of India. (For book presentation)

c. Langan, J. (2005). College Writing Skills with Readings (6th Ed). McGraw-Hill Publication

d. Interactions 1 (Reading), John Langan, Latest edition, McGraw-Hill Publication

e. Headway Series – Advanced Level (2 parts with CDs): Oxford University Press Ltd.

f. Speak like Churchill stand like Lincoln - James C. Humes

g. Cambridge IELTS Practice Book

h. Selected Sample Reports and Selected Research Articles

6.4 Detailed Curriculum of General Education Courses

Course Code: GES 101 **Course Name:** Fundamentals of Sociology

Credit Hour: 2.0 **Contact Hour:** 2.0

Level/Term: 1/I

Pre-requisite: Nil

Rationale:

Objectives: Understanding social phenomena

Course Outcomes (CO):

a. **Understand** the basic nature, scope and perspective of sociology

b. **Understand** the stages of social research process and methodologies

c. **Analyse** different culture and civilization

d. **Apply** contextual knowledge to assess societal and cultural issues in national and global context

e. **Analyse** different social problems and stratifications and design solutions for those

f. **Analyse** socialism, capitalism and economic life and manage projects

g. **Apply** the knowledge of sociology in environmental context for sustainable development

Course Contents:

a. Main Contents: Understanding society, social phenomena and social change

b. Detail Contents: Nature and scope Sociological imagination, Perspectives of sociology, Stages of social research and research method, Culture and civilization, Socialization and self -development, Globalization and social changes, Media and individual, Social organizations and social problems, social stratification; industrial revolution, Capitalism and socialism, Work and economic life, Environment and human activities, Climate change and global risk, Population and human society, Urbanization and city development, Social changes and technology

Teaching-learning and Assessment Strategy: Lectures, class performances, assignments, class tests, final exam.

Linkage of Course Outcomes with Assessment Methods and their Weights:

COs	**Assessment Method**	**(100%)**	**Remarks**
	Class Assessment		
1-3	Class Performance	05	
1-3	Class Tests/Assignments	20	
1-3	Mid-Term Assessment (Exam/Project)	15	
	Exam		
1-3	Final exam	60	

Mapping of Course Outcomes and Program Outcomes:

Course Outcomes (CO) of the Course	**Program Outcome**												**Remarks**
	1	2	3	4	5	6	7	8	9	10	11	12	
Understand the basic nature, scope and perspectives of sociology.	√	√											
Apply sociological imagination to the context of social problems of BD society			√										
Understand the stages of social research processes and methodologies							√						
Analyze different cultures, civilizations and different social problems and design solutions for those											√		
Understand and analyze social stratification, different social systems, socialism, capitalism and relate them to BD society							√						

Apply contextual knowledge to assess societal and cultural issues in environmental context for sustainable development							√						

Lecture Schedule:

Weeks	Lectures	Lecture/Tutorial/Assignment Topic	CT	remarks
1	1.	Definition, nature and scope of sociology	Class test-1	
	2.	Sociological imagination		
2	3.	Perspectives of sociology		
	4.	Orientation of sociological theories		
3	5.	Social research and its process		
	6.	Research designs and techniques.		
4	7.	Introducing culture and its variations		
	8.	civilization		
5	9.	Defining family and its changes		
	10.	Socialization process and development of self		
6	11.	Introducing globalization and its impact on human life	Class test-2	
	12.	Factors responsible to globalization		
7	13.	Media and its impact in modern society		
	14.	Addressing social problems of Bangladesh		
8	15.	Introducing social groups and organizations		
	16.	Introducing bureaucracy and good governance		
9	17.	Introducing social stratifications and social inequality		
	18.	Poverty and its types and dimensions		
10	19.	Industrial revolution and aftermath		
	20.	Urbanization and city development		
11	21.	Capitalism: features and influence	Class test-3	
	22.	Socialism: features and influence		
12	23.	Environment and human activities		
	24.	Climate change and global risk		
13	25.	Population of Bangladesh: problem or prospect		
	26.	Crime and deviance: a brief analysis		
14	27.	Review 1		
	28.	Review 2		

Text and Ref Books:

a. Sociology in Modules: by – Richard Schaefer, 2nd edition, 2013

b. Sociology - Primary Principles: by CN Shankar Rao

c. Anthony Giddens- 5th edition

d. Relevant journal

Course Code: GEBS 101 **Course Name: Bangladesh Studies**
Credit Hour: 2.0 **Contact Hour: 2.0**

Level/Term: 1/II

Pre-requisite: None

Rationale: This course has been designed for undergraduate engineering students to help them learn the rich history of Bangladesh, to understand present Bangladesh in the light of history and to provide them with basic knowledge of historical events which eventually led to the formation of Bangladesh and constitution of Bangladesh, current trends in economic development and thereby to enhance their understanding of present phenomena in the light of history which will make them responsible citizen.

Objectives:

a. To equip students with factual knowledge that will enable them to learn and critically appreciate the history, culture, and economy of Bangladesh.
b. To trace the historical roots of Bangladesh as an independent state focusing on the social, cultural and economic developments that have taken place since its independence.
c. To promote an understanding of the development of Bangladesh and its culture from ancient time.
d. To create an awareness among the students about the History, Geography, Economics, Politics and Culture of Bangladesh.

Course Outcomes (CO):

Course Outcomes	At the end of the course, students are able to: 1. **Identify** specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and critically analyze plurality of cultural identities of Bangladesh. 2. **Explain** the economy and patterns of economic changes through qualitative and quantitative analysis.

Course Contents:

a. Main Contents: Geography, History, Environment, Economy and Culture of Bangladesh

b. Detail Contents:

Bangladesh Geography: Location, Area, Boundary, Physiography, River system, Forest and Climate, Demography of Bangladesh, Maritime zones.

History: Overview of the ancient Bengal; anthropological identity of the Bengali race; main trends in the history of medieval Bengal; Bengal under the East India Company; religious and social reform movements; nationalist movements, division of the Indian sub-continent; language movement 1948-1952; education movement of 1962; six-point movement of 1966; mass uprising of 1969; war of independence and emergence of Bangladesh in 1971, Constitution of Bangladesh, Political Development and Democratic Transition (1971-1990), Political Development (1991- Present), Bangladesh's contribution to world peace and its security.

Environment, Economy and Culture

Land, Characteristics of tropical monsoon climate, Forests and biomass, Fish, Minerals, Health, Education, Agriculture, Industries, NGOs, Population, Sociological and Cultural aspects of Bangladesh, Economy and National development, Development and Progress of the Millennium Development Goals (MDGs), Public Administration in Bangladesh, State of Good Governance in Bangladesh, Art and Literature, Main traditional cultural events, Vision-2021, Digitalization, Tourism and Natural Resources, Bangladesh and International Relations.

Teaching-learning and Assessment Strategy:

Teaching Strategies	Lecture, Tutorial, Assignments
Learning Strategies	Face to face, Guided learning, Independent learning, Assignments

Assessment Strategies	Class Test, Mid-Term Exam, Assignments, Final examination

Linkage of Course Outcomes with Assessment Methods and their Weights:

COs	Assessment Method	(100%)	Remarks
	Class Assessment		
1	Class test (CT)	**20%**	
1	Class performance	**5%**	Assignment, quiz etc
	Exam		
1 & 2	Mid Term	**15%**	
1 & 2	Final	**60%**	

Mapping of Course Outcomes and Program Outcomes:

Course Outcomes (CO) of the Course	Program Outcome												Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	
1. **Identify** specific stages of angladesh's political history, through e ancient, medieval, colonial and post-lonial periods and critically analyze e plurality of culture of Bangladesh.						x							
2. **Explain** the economy and patterns of economic changes through qualitative and quantitative analysis.						x							

Lecture Schedule:

Week-1	Topic	CT	Remarks
Class-1	Introductory class: Brief discussion on the total syllabus, basic requirements of the course, methods of assessment of the course	CT-1	

Class-2	Bangladesh Geography: Location, Area, Boundary, Physiography, River System, Forest and Climate, Demography of Bangladesh.		
Week-2			
Class-3	Overview of the ancient Bengal; anthropological identity of the Bengali race; main trends in the history of medieval Bengal		
Class-4	Bengal under the East India Company, ;		
Week-3			
Class-5	Religious and Social reform movements		
Class-6	Nationalist movements, division of the Indian sub-continent		
Week-4			
Class-7	Language movement 1948-1952, Education movement of 1962	Mid exam	
Class-8	Language movement 1948-1952, Education movement of 1962		
Week-5			
Class-9	Six-point movement of 1966; Mass uprising of 1969;		
Class-10	War of Independence and Emergence of Bangladesh in 1971		
Week-6			
Class-11	Constitution of Bangladesh, Political Development and Democratic Transition (1971-1990)		
Class-12	Constitution of Bangladesh, Political Development and Democratic Transition (1971-1990)		
Week-7			
Class-13	Political Development (1991- Present), Bangladesh's contribution to world peace and security.		

Class-14	Political Development (1991- Present), Bangladesh's contribution to world peace and security.		
Week-8			
Class-15	Land, Characteristics of tropical Monsoon climate,		
Class-16	Forests and biomass, Fish		
Week-9			
Class-17	Minerals, Health and Education,		
Class-18	Agriculture, Industries		
Week-10		CT-2	
Class-19	NGOs, Population, Sociological and Cultural aspects of Bangladesh		
Class-20	Economy and national development,		
Week-11			
Class-21	Development and Progress of the Millennium Development Goals (MDGs)		
Class-22	Public Administration in Bangladesh, State of Good Governance in Bangladesh		
Week-12			
Class-23	Art and Literature		
Class-24	Traditional cultural events		
Week-13		CT-3	
Class-25	Vision-2021, Digitalization		
Class-26	Tourism and Natural Resources		
Week-14			
Class-27	Bangladesh and International Relations		
Class-28	Revision of the course		

Text and Ref Books:

Books	12. **Bangladesh Studies**: Md. Shamsul Kabir Khan and Daulatunnahar Khanam 13. **The Constitution of the People's Republic of Bangladesh** 14. **Discovery of Bangladesh**: Akbar Ali Khan 15. **History of Bangladesh, Vols, 1-3**: Sirajul Islam 16. **History of Modern Bengal, Vol, 1**: R C Majumdar 17. **Dynastic History of Bengal**: Dr. Abdul Mumin Chowdhury 18. **A History of Bangladesh**: William Van Schendel 19. **A History of Sufism in Bengal**: Dr. Enamul Huq 20. **Geography of Bangladesh**: Harun Er Rashid 21. **Banglapedia: National Encyclopedia of Bangladesh, Vols, 1-10**: Sirajul Islam 22. **History of Bengal: (Mughal Period 1526-1765)**: R. A. Chandra 23. **Land of Two Rivers:** Nitesh Sengupta

Course Code: GEA 101 **Course Name:** Principles of Accounting
Credit Hour: 2.0 **Contact Hour:** 2.0

Level/Term: 1/II

Pre-requisite: Nil

Objectives: At the end of the course, students will be able to:

a. Understand the meaning, history and definition of accounting, the users and uses of accounting, importance of ethics in financial reporting.

b. Understand the International Financial Reporting (IFRS), Generally Accepted Accounting Principles (GAAP), cost principle, monetary unit assumption and the economic entity assumption.

c. Understand the worksheet, preparation of financial statements, cost benefit analysis of different projects with honesty and integrity.

d. To provide the students with an in-depth knowledge of Management Accounting to enable them to apply its methods and techniques for preparing and presenting information for management decision-making and control purposes.

e. Applying selected management accounting techniques and analyze the implications of the techniques with regards to cost-volume profit analysis, budgeting, standard costing and variance analysis.

Course Outcomes (CO):

a. Understand the cost principle, monetary unit assumption and the economic entity assumption and ethics in financial reporting for each and every project.

b. Understand worksheet, preparation of financial statements, cost benefit analysis of different projects.

c. Acquire knowledge of Management Accounting and apply it for preparing and presenting information for management decision-making and control purposes.

d. Apply and analyze the cost-volume profit, budgeting, standard costing and variance analysis for any project.

Course Contents:

a. Main Contents:

(1) Accounting in Action
(2) Recording Process
(3) Adjusting the Accounts and prepare financial statement
(4) Financial Statement Analysis
(5) Computerized Accounting System and
(6) Cost Concepts
(7) Absorption costing and Variable costing
(8) Job Order Costing and Process Costing
(9) Short & Long-Term Decision-Making in Accounting

b. Detail Contents:

(1) Accounting in Action

(a) History & Definition of Accounting,
(b) Objectives and Importance of Accounting
(c) Accounting & Engineering
(d) International Financial Reporting Standard (IFRS), Generally Accepted Accounting Principles (GAAP), Ethics in Accounting
(e) Accounting Equation (Math)

(2) **Recording Process :** Journal, Ledger, T-account and Trial balance

(3) **Adjusting the Accounts :** Adjusting Entries , Adjusted Trial Balance, Income Statement, Retained Earnings Statement and Statement of Financial Position (Balance Sheet) , Worksheet

(4) **Financial Statement Analysis :** Horizontal Analysis, Vertical Analysis and Ratio Analysis

(5) **Computerized Accounting System:** Manual vs. Computerized Accounting system, Some Accounting Software: NetSuite ERP. Tipalti. Sage Business Cloud Accounting. Sage 50cloud. Plooto. Tradogram. Tally accounting software.

(6) Cost Concepts:

(a) Explain The Distinguishing Features of Managerial Accounting
(b) Identify The Three Broad Functions of Management
(c) Classification of Costs on Various Bases

(d) Indicate How Cost of Goods Manufactured is Determined, Break Even Point (BEP) for Different Projects.

(7) Absorption costing and Variable costing :

(a) Prepare Profit Statements Based on a Variable Costing and Absorption Costing System

(b) Cost Volume Profit (CVP) Analysis for different engineering projects

(c) Account for the difference in profits between variable and absorption costing profit calculations

(d) Explain the arguments for and against variable and absorption costing

(8) Job Order Costing and Process Costing :

(a) Job Order Costing

(b) Process Costing

(9) Short & Long-Term Decision-Making in Accounting :

(a) Relevant & Irrelevant Costs for Decision-Making

(b) How to Determine Costs & Make Decisions

(c) Contrast annual rate of return and cash Payback in Capital Budgeting, Budgeting for Various Engineering Projects.

(d) Distinguish between the Net Present Value And Internal Rate Of Return Methods

Teaching-learning and Assessment Strategy:

COMPONENTS	**TEACHING AND LEARNING ACTIVITIES**	**STUDENT LEARNING TIME (SLT)**
Face to Face	Lecture (2 hours/week x 14 weeks)	28
Guided Learning	Tutorial/ Assignments (2 hours/week x 5 weeks)	10
Independent Learning	Individual learning (1-hour lecture ≈ 1 hour learning) Preparation for tests and examination	24 13
Assessment	Pop Quiz/Class Test/Mid-Term Exam Final examination	2 3
	TOTAL SLT	**80**
	CREDIT = SLT/40	**2**

Note: 40 notional hours= 1 Credit

Assessment Methods*	Continuous assessment : 40% Final examination:60%
Methodologies for Feedback on Performance	1. Discussions in class 2. Returning graded assignments and tests 3. Final grades are announced

Linkage of Course Outcomes with Assessment Methods and their Weights:

COs	Assessment Method	(100%)	Remarks
	Class Assessment		
1	Class Assessment	60	
2	Class Assessment	40	
3	Class Assessment	60	
4	Class Assessment	40	
	Exam		
1	Exam	40	
2	Exam	60	
3	Exam	40	
4	Exam	60	

Mapping of Course Outcomes and Program Outcomes:

COURSE OUTCOMES (COs)	PROGRAMME OUTCOMES (POs)												Bloom's taxonomy domain/ level	Assessment tools
	1	2	3	4	5	6	7	8	9	10	11	12		
Understand the cost principle, monetary unit assumption and the economic entity assumption and ethics in	√												C2	Pop Quiz, Final Exam

COURSE OUTCOMES (COs)	PROGRAMME OUTCOMES (POs)												Bloom's taxonomy domain/ level	Assessment tools
	1	2	3	4	5	6	7	8	9	10	11	12		
financial reporting														
Understand worksheet, preparation of financial statements, cost benefit analysis of different projects.	√												C2	Mid-Term, Final Exam
Acquire knowledge of Management Accounting and **apply** it for preparing and presenting information for management decision-making and control purposes.		√											C3	Class Test, Final Exam
Apply and **analyze** cost-volume profit, budgeting, standard costing and variance analysis.		√											C4	Class Test, Final Exam

Lecture Schedule:

Lectures	Lecture/Tutorial/Assignment Topic	CT	Remarks
Week-1			
1	Meaning, history and definition of accounting		
2	The users and uses of accounting.		
Week-2			
3	Ethics in financial reporting		
4	The cost principle, monetary unit assumption and the economic entity assumption		
Week-3			
5	Accounting equation and its components	**1**	
6	The effects of business transactions on the accounting equation.		
Week-4			
7	Four financial statements and how they are prepared.		
8	Journal		
Week-5			
9	Journal		
10	T-account, Ledger, Trial balance		
Week-6			
11	Adjusting Accounts		
12	Worksheet.		
Week-7			
13	Completion of the Accounting cycle.		
14	Financial Statement Analysis		
Week-8		**2**	
15	Managerial Accounting Basics		
16	Cost Concepts		
Week-9			
17	Job Order Cost Accounting		

18	Job Order Cost Accounting		
Week-10			
19	Process Cost Accounting		
20	Process Cost Accounting		
Week-11			
21	Cost-Volume-Profit Relationships		
22	Cost-Volume-Profit Relationships		
Week-12			
23	Performance Evaluation through Standard Costs		
24	Performance Evaluation through Standard Costs		
Week-13			
25	Incremental Analysis		
26	Incremental Analysis		
Week-14			
27	Capital Budgeting	**3**	
28	Capital Budgeting		

Text and Ref Books:

a. Financial Accounting IFRS edition by Weygand, Kimmel & Kieso (3th)
b. Accounting Principles by Weygandt, Kieso& Kimmel (IFRS Latest edition)

Course Code: GELM 275 **Course Name:** Leadership and Management
Credit Hour: 2.00 **Contact Hour:** 2.00
Course Curriculum: Outcome Based Education (OBE)
Pre-requisite: None

Level/Term: 2/I

Rationale:

The course is designed to make students understand the overlapping connection between engineering and management in an organization through the study of varied management practices and leadership traits as an engineer.

Objectives:

1. To introduce different management functions and approaches.
2. To expose students to different views and styles of leadership
3. To understand how an organization functions collaboratively with managers and engineers.
4. To understand various personality traits and its impact on leadership and management.
5. To solve real-world management problems as an engineer.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Familiarize** with the fundamental concepts of leadership and management skills	C1-C2			1	T, R, F
CO2	**Explain** the role and contribution of a leader in achieving organizational goals	C1-C2			1	T, ASG, R, F
CO3	**Outline** the contribution of leadership traits and management skills in decision making and solving real life problems	C1-C2			1	T, ASG, R, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

a. Main Contents:

Introduction to Leadership and Management; Management Fundamentals; Leadership & Motivation; Organizational Management; Planning and goal setting; Control; Change and Innovation; Attitude; Personality; Perception and Individual Decision Making; Understanding Work Team; HR Management; Operations Management; Information Technology and Management; Case studies.

b. Detailed Contents:

Introduction to Leadership and Management: Definition of leadership and management; basic difference between a leader and a manager; relation of leaders and managers with respect to efficiency and effectiveness; qualities of leader and managers with examples from history.

Management Fundamentals: Definition of management & manager; levels of management; management functions and skills; Mintzberg's managerial roles; Henri Fayol's management principles; strategic management.

Leadership & Motivation: Motivation, Maslow's hierarchy needs; theory of X & Y; motivators and hygiene factors; goal setting theory; reinforcement theory; equity theory; expectancy theory; Leadership styles; leadership trait theory; managerial grid; contemporary leadership; conflicts negotiation; leadership issues in 21st century; cross cultural leadership; engineer as a leader and some simple case discussions on leadership (positive and toxic leadership) in the class (Interactive Learning).

Organizational Management: Organization; departmentalization; chain of command; unity of command; cross functional area; authority; centralization and decentralization; traditional & contemporary organization; matrix project structure; learning structure; organizing collaboration.

Planning and goal setting: Foundation of planning; goals of plan; types of goal; types of goal & plan; goal setting; MBO; well written goal.

Control: Controlling process; controlling for organizational performance; types of control: (feed-forward, feedback & concurrent); balanced scorecard; contemporary issues in control; workplace concern & workplace violence.

Change and Innovation: Change and innovation; internal and external for change; changing process; creativity vs innovation.

Attitude: Components of Attitude; behavior model and characteristics model; behavior vs. attitude; job attitude; job involvement; job satisfaction and customer satisfaction.

Personality: Personality determinants: heredity and environment; Myers-Briggs Type Indicator; Big five personality model; personality traits (core self-evaluation, Machiavellianism, narcissism, self-monitoring, risk taking, proactive personality).

Perception and Individual Decision Making: Factors influencing perception; attribution theory; errors/biases in attribution; Factors of individual decision making; rational decision making; bounded rationality; satisfice; common errors in decision making; creativity in decision making.

Understanding Work Team: Work group; work team; problem solving team; self-managed work team; cross functional team; virtual team; team effectiveness; team challenges.

HR Management: Process of Human Resource Planning; forecasting demand for labor; staffing; internal supply of labor; performance appraisal.

Operations Management: Project managing basics; goals and boundary of project; WBS; scheduling a project; Demand and supply forecasting; inventory control.

Information Technology and Management: Management Information System (MIS); Enterprise Resource Planning (ERP) - For introductory knowledge

Teaching-learning and Assessment Strategy:

Teaching learning strategy:

Teaching and learning activities	Engagement (hours)
Face-to-face learning	
Lecture	28
Practical/ Tutorial/ Studio	-
Student-centred learning	-
Self-directed learning	
Non face-to-face learning	10
Revision	14

Assessment preparations	14
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	71

Teaching methodology:
Lecture and Discussion, Co-operative and Collaborative Method, Case Study Based Method

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class test 1-2	20%	CO 1	C1-C2, P1
			CO 2	C1-C2
	Class Participation	5%	CO 1	C1-C2, P1, A1
			CO 2	C1-2, P1-P2, A1
	Mid term	15%	CO 1	C1-C2, P1, A1
			CO 2	C1-C2, P1-P2, A1-A2
			CO 3	C1-C2, P1-P2, A1-A2
Final Exam		60%	CO 1	C1-C2, P1, A1
			CO 2	C1-C2, P1-P2, A1-A2
			CO 3	C1-C2, P1-P2, A1-A2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Mapping of Course Outcomes and Program Outcomes:

Course Learning Outcomes	Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life Long Learning	Project Management and Finance

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**Familiarize** with the fundamental concepts of leadership and management skills									H	H		
CO2	**Explain** the role and contribution of a leader in achieving organizational goals									H	H	M	
CO3	**Outline** the contribution of leadership traits and management skills in decision making and solving real life problems		M						M	H	H	M	M

(H – High, M- Medium, L- Low)

Lecture Schedule:

Week	Lecture	Topics	TEST
1	Lec 1	**Introduction to Leadership and Management:** Definition of leadership and management; basic difference between a leader and a manager; relation of leaders and managers with respect to efficiency and effectiveness; qualities of leader and managers with examples from history.	**Class Test 1**
	Lec 2	**Management Fundamentals:** Definition of management & manager; levels of management; management functions and skills; Mintzberg's managerial roles; Henri Fayol's management principles; strategic management.	
2	Lec 3 Lec 4	**Leadership & Motivation**: Motivation, Maslow's hierarchy needs; theory of X & Y; motivators and hygiene factors; goal setting theory; reinforcement theory; equity theory; expectancy theory	
3	Lec 5 Lec 6	**Leadership:** Leadership styles; leadership trait theory; managerial grid; contemporary leadership; conflicts negotiation; leadership issues in 21st century; cross cultural leadership; engineer as a leader and some simple case	

		discussions on leadership (positive and toxic leadership) in the class (Interactive Learning).	
4	Lec 7	**Case Study – I : Engineer as Great Leaders**	
	Lec 8		
5	Lec 9	**Organizational Management:** Organization; departmentalization; chain of command; unity of command; cross functional area; authority; centralization and decentralization; traditional & contemporary organization; matrix project structure; learning structure; organizing collaboration.	
	Lec 10	**Planning and goal setting:** Foundation of planning; goals of plan; types of goal; types of goal & plan; goal setting; MBO; well written goal.	
6	Lec 11	**Control:** Controlling process; controlling for organizational performance; types of control: (feed-forward, feedback & concurrent); balanced scorecard; contemporary issues in control; workplace concern & workplace violence.	
	Lec 12	**Change and Innovation:** Change and innovation; internal and external for change; changing process; creativity vs innovation.	
7	Lec 13	**Case Study – II : Planning and Goal Setting; A Managerial Approach: Engineer as Great Managers (Interactive Discussions in the Class)**	
	Lec 14	**Attitude:** Components of Attitude; behavior model and characteristics model; behavior vs. attitude; job attitude; job involvement; job satisfaction and customer satisfaction.	
8	Lec 15	**Personality:** Personality determinants: heredity and environment; Myers-Briggs Type Indicator; Big five personality model; personality traits (core self-evaluation, Machiavellianism, narcissism, self-monitoring, risk taking, proactive personality).	**Mid Term / Project**
	Lec 16	**Perception and Individual Decision Making**: Factors influencing perception; attribution theory; errors/biases in attribution	
9	Lec 17	**Perception and Individual Decision Making**: Factors of individual decision making; rational decision making; bounded rationality; satisfice; common errors in decision making; creativity in decision making.	
	Lec 18	**Case Study – III : A Case on Decision Making – Involves both leadership and managerial skills (Interactive Discussion in the Class)**	
10	Lec 19	**Understanding Work Team:** Work group; work team; problem solving team; self-managed work team; cross	**Class Test 2**

		functional team; virtual team; team effectiveness; team challenges.	
	Lec 20	**HR Management:** Process of Human Resource Planning; forecasting demand for labor; staffing.	
11	Lec 21	**HR Management:** Internal supply of labor; performance appraisal.	
	Lec 22	**Operations Management:** Project managing basics; goals and boundary of project; WBS; scheduling a project.	
12	Lec 23	**Operations Management:** Demand and supply forecasting; inventory control.	
	Lec 24	**Exercise – Use of Microsoft Project (MSP) for scheduling a project at student level**	
13	Lec 25 Lec 26	**Case Study – IV:** A case that covers all relevant theories taught throughout the course and involves both leadership and management issues, e.g., Columbia's Final Mission. (This may be given as group assignment followed by in class short presentations/discussions)	
14	Lec 27	**Information Technology and Management:** Management Information System (MIS); Enterprise Resource Planning (ERP) - For introductory knowledge.	
	Lec 28	**Revision**	

Text and Reference Books:

1. Students must be provided with SOLID reading material instead of referring text books. However, course teacher may select any text book as per his choice.
2. Engineering Management (Revised Edition) – A.K. Gupta
3. Industrial Engineering and Production Management - Martand T. Telsang
4. Leadership in Organizations – Gary Yukl
5. Developing Management Skills – David A. Whetten and Kim S. Cameron

Reference Site:
https://classroom.google.com/ (To be announced)

	COURSE INFORMATION		
Course Code Course Title	: GERM 352 : Fundamentals of Research Methodology	Contact Hours Credit Hours	: 4.00 : 2.00
	PRE-REQUISITE		
	None		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		

	SYNOPSIS/RATIONALE
	This course is essential for students to conduct research as well as for keeping abreast on the latest development in science, engineering, and technology fields.
	OBJECTIVES
	1. To understand the basic concepts of research and familiarize with various research methodologies 2. To expose students to techniques for reviewing research materials 3. To develop appropriate research problems, ideas, provide solution and recognize their limitations 4. To prepare a project and research proposals 5. To develop writing and presentation skills 6. To discuss research management and ethics
	LEARNING OUTCOMES
	1. Identify research problems, objectives and research questions. 2. Write effectively a literature review in relevant research areas. 3. Identify the key components of scientific and technical style, and the pitfalls associated with that style. 4. Present research reports both orally and in writing and evaluate research reports and finding. 5. Apply ethical code in research management and publications.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Identify** research problems, objectives and research questions.	PO1, PO2	C1- C3	-	-	3	ASG
CO2	**Write** effectively a literature review in relevant research areas.	PO5	C4	-	-	4	ASG
CO3	**Identify** the key components of scientific and technical style, and the pitfalls associated with that style.	PO7	C4	-	-	5	PR
CO4	**Present** research reports both orally and in writing and evaluate research reports and finding.	PO3	C5-C6	1		6	Pr
CO5	**Apply** ethical code in research management and publications.	PO-3	C4	1		6	R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)

	COURSE CONTENT

Definition of research, Objectives of research, Significance of research, Research characteristics, Types of research, Fundamental research, Applied research, Qualitative and Historical research, Quantitative research (Descriptive research, Experimental research, Quasi-Experimental research, Mixed-Methods research), Research process, Research design, Methodologies to do engineering research, Descriptions and characteristics of Theoretical, Experimental, and Computational research, Review of related literature and contemporary scientific information, Methods of data collections, Data analyses and Uncertainty analyses, Making effective Charts, Graphs, Tables, Gantt chart, Survey & Interview methods for research, Case study research, Case studies formation, Case study exercises, Research planning, Research proposals, Budget preparation, Research ethics, Plagiarism, Copyright, Intellectual Property (IP) rights, Thesis/Dissertation/Report/Paper writing format & style, Review paper structure, Importance of Literature review, References, Bibliography, End Note, Foot note, Reference styles, Reference management tools, Presentation skills (Oral, Poster), Editing and proofreading strategies, Research paper authorships.

SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Identify** research problems, objectives and research questions.	3											
CO2	**Write** effectively a literature review in relevant research areas	3											
CO3	**Identify** the key components of scientific and technical style, and the pitfalls associated with that style.		2										
CO4	**Present** research reports both orally and in writing and evaluate research reports and finding.				2						2		
CO5	**Apply** ethical code in research management and publications.				2				2			2	

(3 – High, 2- Medium, 1-low)

Justification for CO-PO Mapping:

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to identify research problems, objectives and research questions, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.
CO2-PO1	3	In order to write effectively a literature review in relevant research areas, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.

CO3-PO2	3	In order to identify the key components of scientific and technical style, and the pitfalls associated with that style, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.
CO4-PO4	2	In order to present research reports both orally and in writing and evaluate research reports and finding, it is required to conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
CO4-PO10	2	In order to present research reports both orally and in writing and evaluate research reports and finding, it is required to communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
CO5-PO4	2	In order to apply ethical code in research management and publications, it is required to conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
CO5-PO8	2	In order to apply ethical code in research management and publications, application of ethical principles and commit to professional ethics and responsibilities and norms of engineering practice is required.
CO5-PO11	2	In order to apply ethical code in research management and publications, it is required to demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical / Tutorial / Studio	14
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	28
Revision	-
Formal Assessment	
Continuous Assessment (Assignment)	14
Mini Projects	28
Presentation	01
Report	28
Mid-Term	01
Final Examination	

Total	102

TRASNFERABLE SKILLS

Skills and how they are developed and assessed:

Skills	Development	Assessment
Technical	Lectures	Written Assessment
Analytical	Projects	Report

ASSESSMENT METHODS AND TYPE/COURSE ASSESSMENT

Weightage of each type of assessment is stated:

CO	Method	Grading (%)
CO 1, CO 2	Assignments	20
CO 3	Projects	30
CO 4	Presentation	20
CO 5	Report	30
Total Marks		100

TEACHING METHODOLOGY

Lectures and Presentation, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	**Introduction to research**: Research and its purposes, main elements and process of research, qualitative and quantities approach.	
Week-2	Paradigms in research knowledge, processes and strategies for a specific piece of research, knowledge dissemination	
Week-3	**Literature Review Procedures**: Reasons of surveying literature; sources of literatures: journal, conference paper, thesis and dissertations, professional periodicals, indexes, catalogues, Encyclopaedias, etc.	
Week-4	**Reviewing Research Paper**: Process of acquiring literature; Assessing literature relevance, classify and categorizing, keeping records, commenting and critiquing;	
Week-5	**Reviewing Research Paper**: Structure of writing review reports;	

	Evaluating and reviewing reports. **Case Study**	
Week-6	**Research Objectives and Methodologies**: Identifying relevant research problems based on literature survey, selection of a target research topic; Explore and determine the objectives, assumptions, methods and scopes.	
Week-7	Design of experiments, simulation studies, performance evaluation. **Case study**: Choose a highly cited paper for critical review.	
Week-8	**Data acquisition and Analysis:** Experimental setup, error analysis.	
Week-9	Statistical analysis & data validation.	
Week-10	**Guidelines to preparation of research presentation**: Presentation outline, organization of material, hyperlinks, animation, video clip etc.	
Week-11	**Research Planning**: Reasons for a research plan, benefits and problems of planning, sustainability, techniques of planning: hierarchical task decomposition, Gantt chart, monitoring progress, research expenses, budgeting. Case Study	
Week-12	**Research presentation from researchers**	
Week-13	**Ethical Research Issues**: Ethical and legal issues in conducting research, plagiarism; Patenting, Intellectual Property Rights (IPR), Case Study **Effective Report Writing**: Reports writing, style and format of writing, data analysis software, standard presentation software, justifying and defending the critics by reviewers.	
Week-14	**Research Presentation**: Oral presentation of a research, selection of journal and conference for presentation/submission, Oral Presentation of research proposal.	

ASSESSMENT STRATEGY

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

[1] P.D. Leedy and J.E. Ormond, *Practical Research: Planning and Design*, Pearson Education, New Jersey (USA), 2013

[2] C.R Kothari, *Research Methodology: Methods & Techniques*, New Age International (P) Ltd Publishers, New Delhi, 2004.

[3] R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.

[4] S. Melville and W. Goddard, *Research Methodology: An Introduction for Science & Engineering Students*, Juta & Co Ltd, 1996.

[5] K. N. Krishnaswamy, A. I. Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education, New Delhi, 2009.
[6] D. Chawla, and N. Sondhi, *Research Methodology – Concepts & Cases*, Vikas Publishing House, 2018.
[7] G. M. Hall, *How to write a paper,* 4th ed., Malden, Mass.: BMJ Books, 2008.

REFERENCE SITE

Google classroom

Course Code: IPE 415 **Course Name:** Project Management
Credit Hour: 3.00 **Contact Hour:** 3.00
Level/Term: L-4, T-1

Curriculum Structure: Outcome Based Education (OBE)

Pre-requisites: None

Rationale: This course provides the students with the ability to predict as many dangers and problems as possible and to plan, organize and control activities so that one project can be completed as successfully as possible in spite of all the risks. Illustrates the principles to protect the environment by ensuring that a local planning authority when deciding whether to grant planning permission for a project which likely to have significant effects on environment.

Objective:

1. Successful development of projects procedures of initiation, planning, execution, regulation and closure as well as the guidance of the project team's operation towards achieving all the agreed upon goals within the set scope, time, quality and budget standards.
2. Develop, implement, monitor and maintain environmental strategies, policies, programs and systems that promote sustainable development.

Course Outcomes (CO) & Generic Skills:

Upon completion of this course, the student should be able to:

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods

CO 1	**List** and **describe** the selection and initiation of individual projects and of portfolios of projects in the enterprise.	C1, C2	1		1	T, F
CO 2	**Prepare** project planning activities that accurately forecast project costs, timelines and quality. **Implement** processes for successful resource, communication and risk and change management.	C3	1,2		1,3	ASG, Mid Term Exam, F
CO 3	**Demonstrate** effective project execution & control techniques and **conduct** project closure activities to obtain formal project acceptance.	C2-C4	1		1	ASG, T, F
CO 4	**Demonstrate** effective organizational leadership and change skills for financial management, managing projects, projects teams and stakeholders.	C2			1	T, ASG, R, F
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)						

Course Contents:

Identification, planning, appraisal, project implementation, project organization, budgeting, scheduling, using bar diagram, CPM, PERT, resource allocation, information system and project control, project termination, project organizations, matrix organization, project manager, contract negotiation and conflict resolution, case study, planning and evaluation of an investment project

Mapping of Course Outcomes (CO) and Program Outcomes:

Course Learning Outcomes	Engineering Knowledge	Problem Analysis	Design / Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team	Life Long Learning	Project Management and Finance

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**List** and **describe** the selection and initiation of individual projects and of portfolios of projects in the enterprise.	**H**											
CO2	**Prepare** project planning activities that accurately forecast project costs, timelines and quality. **Implement** processes for successful resource, communication and risk and change management.	**H**		**H**		**M**							**H**
CO3	**Demonstrate** effective project execution & control techniques and **conduct** project closure activities to obtain formal project acceptance.	**H**											
CO4	**Demonstrate** effective organizational leadership and change skills for financial management, managing projects, projects teams and stakeholders.	**M**	**M**		**M**	**M**					**M**		
CO5	**List** and **describe** the selection and initiation of individual projects and portfolios of	**M**				**M**							**M**

	projects in the enterprise.												

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	28
Revision	14
Assignment Preparations	7
Formal Assessment	
Continuous Assessment	3
Final Examination	3
Total	97

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multi-media Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week 1	**Projects in Contemporary Organizations**	**CT 1**
Class 1-3	Introduction to Project management	
	Project and Project management, Project Life Cycle	
Week 2	**Project initiation**	
Class 4-6	Project management maturity and project selection models	
	Project Portfolio Process, Projects Bids and RFP	
Week 3	**Project manager**	
Class 7-9	Project management and Project Manager	
	Attributes of effective Project Manager	
Week 4	**Managing conflicts and the art of negotiation**	**CT 2**
Class 10-12	Introduction to Conflict and negotiation	

	The nature of negotiation	
Week 5	**The project in the organizational structure**	
Class 13-15	Projects in different types of organization I	
	Projects in different types of organization II, Project management team	
Week 6	**Project planning**	
Class 16-18	Project plan, WBS, Project risk management	
	RACI matrix and agile projects	
Week 7	**Budgeting: estimating costs and risks**	**Mid Term Exam**
Class 19-21	Estimating project budget	
	Cost estimation, Risk estimation	
Week 8	**Scheduling**	
Class 22-24	Introduction to Scheduling	
	Network techniques	
Week 9	**Resource allocation**	
Class 25-27	Critical path method	
	Resource allocation problem, Resource loading, leveling	
Week 10	**Continued…**	**CT 3**
Class 28-30	Constrained resource scheduling, Goldratt's Critical Chain	
	Multi project Scheduling and Resource allocation	
Week 11	**Project execution**	
Class 31-33	Fundamentals of project execution	
	Monitoring and information system	
Week 12	**Project auditing**	
Class 34-36	Fundamentals of project controls II	

	Fundamentals of project controls II	
Week 13	**Project auditing and termination**	
Class 37-39	Project audit life cycle	
	Some essentials of an Audit/Evaluation, The Termination Process and Final Report	
Week 14	**Review classes**	
Class 40-42	Review class 01	
	Review class 02	

Linkage of Course Outcomes with Assessment Methods and their Weights:

Assessment Strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1,C2
			CO 3	C2-C4
			CO 4	C2
	Class Participation	5%	CO 2	C3
	Mid term	15%	CO 2	C3
Final Exam		60%	CO 1	C1, C2
			CO 2	C3
			CO 3	C2-C4
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. Jack R. Meredith, Samuel J. Mantel, Jr. " Project Management- A Managerial Approach"
2. Eugene R. Brigham and Joel F. Houston- Fundamentals of Financial Management

Reference Site:

https://classroom.google.com/ (To be announced)

Course Code: GESL 313 **Course Name:** Environment, Sustainability and Law
Credit Hour: 2.00 **Contact Hour:** 2.00

Level/Term: L-3, T-1

Curriculum Structure: Outcome-Based Education (OBE)

Pre-requisites: None

Synopsis/Rationale:

This Outcome-Based Education (OBE) based course is designed to provide an introduction to the concepts and principles which underpin environmental law from the international to the local level. The course will address Constitutional responsibilities and roles relating to the environment; sustainable development and the law; environmental planning through environmental impact assessment and land-use law; environmental protection principles, climate change water resources law; heritage issues and the protection of biological diversity.

Objectives:

1. To offer a comprehensive overview of environment sustainability.

2. To provide practice-oriented information to help students find the sustainable methods for the intended environment applications.

3. To understand and appreciate the ethical dimensions of the role of lawyers, and the functioning of law and legal systems.

4. To understand the structures of sustainable environmental, and management practice.

Course Outcomes (CO) & Generic Skills:

No.	**Course Learning Outcome**	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** an awareness of the incompleteness of law and the continuous state of development of legal principles.	C1-C3	1		3	T, Mid Term, F

CO2	**Apply** the principles, techniques, and methods to problem-solving exercises.	C4	3	2		Mid Term Exam, F, R
CO3	**Identify** an ability to critically analyse and apply legislation, rules and cases in context.	C1, C4	2	5	3	Mid Term Exam,F,PR ,Pr
CO4	**Develop** the capacity to analyse, evaluate and synthesise information from a wide variety of sources and experiences.	C4	3	5	1, 3	Mid Term Exam,F
CO5	**Demonstrate** commitment to class ethics.	A3	1			ASG, PR, R
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, F – Final Exam)						

Course Contents:

Introduction to Environmental Sustainability & Law. Domestic and international law. Traditional environmental issues and broader development. International environmental law: Principles and Sustainable development. Environmental Law: National Perspectives Common Law & Constitutional Law. Commonwealth Environmental Assessment and Approval. Regulating and Assessing Development.

Regulation of Activities of Environmental Significance. Climate Change and Greenhouse issues. Water Resources –Law and Policy issues. Public participation in defending the environment. Conservation of Biological Diversity.

Mapping of Course Outcomes and Program Outcomes:

(H – High, M- Medium, L-low)

Teaching-learning and Assessment Strategy:

Teaching and Learning Activities	Engagement (hours)

Course Learning Outcomes		Engineering Knowledge	Problem Analysis	Design / Development of	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Communication	Individual and Team Work	Life-Long Learning	Project Management and
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**Explain** an awareness of the incompleteness of law and the continuous state of development of legal principles.	H		H		H		H					
CO2	**Apply** the principles, techniques, and methods to problem-solving exercises.		H		H						H		
CO3	**Identify** an ability to critically analyse and apply legislation, rules and cases in context.				H		M					M	
CO4	**Develop** the capacity to analyse, evaluate and synthesise information from a wide variety of sources and experiences.			H				H				M	H
CO5	**Demonstrate** commitment to class ethics.								H				

Face-to-Face Learning	
Lecture	28
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	40
Revision	20
Assessment Preparations	19
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	112

Teaching Methodology:

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method, Multimedia Presentation, Class Presentation, Assignments, Class Tests, Exams, Feedback at every step.

Lecture Schedule:

Week	Lecture	Topics	ASSESSMENT
1	1	Introduction to Environmental Sustainability & Law	
	2	Introduction to Environmental Sustainability & Law (cont.)	
2	1	International environmental law: Principles and Sustainable development	
	2	International environmental law: Principles and Sustainable development (cont.)	

3	1	Environmental Law: National Perspectives Common Law & Constitutional Law	CT 1 to be held on these topics
	2	Environmental Law: National Perspectives Common Law & Constitutional Law (cont.)	
4	1	Commonwealth Environmental Assessment and Approval	
	2	Commonwealth Environmental Assessment and Approval (cont.)	
5	1	Regulating and Assessing Development: State Level – Part 1	CT 2 to be held on these topics, ASG, PR
	2	Regulating and Assessing Development: State Level – Part 1 (cont.)	
6	1	Regulating and Assessing Development: State level – Part 2	
	2	Regulating and Assessing Development: State level – Part 2 (cont.)	
7	1	Regulation of Activities of Environmental Significance	
	2	Regulation of Activities of Environmental Significance (cont.)	
8	1	Climate Change and Greenhouse issues	ASG
	2	Climate Change and Greenhouse issues (cont.)	
9	1	Water Resources –Law and Policy issues	
	2	Water Resources –Law and Policy issues (cont.)	
10	1	Public participation in defending the environment	
	2	Public participation in defending the environment (cont.)	
11	1	Conservation of Biological Diversity	
	2	Conservation of Biological Diversity (cont.)	

12	1	Heritage issues-protection of built, natural and aboriginal heritage	ASG \
	2	Heritage issues-protection of built, natural and aboriginal heritage (cont.)	
13	1	Problem-based practice in the application of the law	
	2	Problem-based practice in the application of the law (cont.)	
14	1	Problem-based practice in the application of the law (cont.)	
	2	Course Review for Final Exam	

(PR – Project; ASG – Assignment)

Linkage of Course Outcomes with Assessment Methods and their Weights:

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (40%)	Test 1-2	20%	CO 1	C1 - C4
			CO 2	C2 - C4
			CO 4	C2
	Class Participation	5%	CO 1	C3, C4
			CO 5	A3
	Mid-term	15%	CO 3	C1 - C4
			CO 4	C3, C4
Final Exam		60%	CO 1	C1- C4
			CO 2	C3, C4
			CO 3	C2 - C4
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

Text and Ref Books:

1. DE Fisher, Australian Environmental Law (2nd ed, Thomson Reuters, 2010).
2. Bates and Lipman, Corporate Liability for Pollution (LBC Information Services, 1998).
3. Godden, Lee & Peel, Jacqueline, Environmental Law: Scientific,Policy and Regulatory dimensions, Oxford University Press, 2009.

Reference Site:

https://classroom.google.com/ (**To be announced**)

COURSE INFORMATION			
Course Code Course Title	: GEEM 343 : Engineering Ethics and Moral Philosophy	Contact Hours Credit Hours	: 2.00 : 2.00
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
RATIONALE			
This course motivates engineers to perform under a standard of professional behaviour that requires adherence to the highest principles of ethical conduct and manage the resources and decisions effectively. Part of professional ethics is the understanding of the ethics of other professions: how they interact and what can be expected from them as correct ethical behaviour. It elevates the profession and raises future standards and imprints on individual moral mindsets and behaviours.			

OBJECTIVE

1. To develop a firm ethical base.
2. To gain the ability to continue professional development with an understanding of the legal issues, and to critically assess the codes of professional conduct for IPE professionals.
3. To identify and analyze practical legal problems commonly encountered in computing industry.

LEARNING OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome (Upon completion of the course, the students will be able to)	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the theoretical aspects of ethics and moral philosophy in professional fields.	C1-C2	1		1	T, F
CO2	**Identify** practical and legal problems commonly encountered by engineers in their professional industry.	C3	1		7	MT
CO3	**Develop** foundation knowledge of ethics to be and apply them to solve engineering problems.	C3-C6	3, 5		3	F
CO4	**Develop** the communication skill by presenting topics on Engineering Ethics and Moral Philosophy.	A2		1		Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test ; PR – Project ; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)

COURSE CONTENT

Engineering Ethics: **Introduction to Ethics**; Theories of Ethics; **Principles of Engineering Ethics**; Ethical expectation: Employers and employees, Inter-professional relationship, **Standards and codes**: Institutionalization of ethical conduct. Ethical Dilemmas, Choices, **Industrial Ethics**: Roles of IPE engineers to society, BNBC in industries, Ethical Challenges for IPE Engineers, The Rights and Responsibilities of Engineers Safety, Risk and Liability; **Case studies** related to ethical issues in IPE and other Engineering disciplines. Introduction to **Philosophy of Engineering**, metaphysics, epistemology, axiology, and logic

SKILL MAPPING.

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Explain the theoretical aspects of ethics and moral philosophy in professional fields.	M											
CO2	Identify practical and legal problems commonly encountered by engineers in their professional industry.		H										
CO3	Develop foundation knowledge of ethics to be and apply them to solve engineering problems.								M				
CO4	Develop the communication skill by presenting topics on Engineering Ethics and Moral Philosophy.										L		

(H – High, M- Medium, L-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Level	Justifications
CO1-PO1	Medium	Understand theoretical aspects of ethics and moral philosophy in professional fields.
CO2-PO2	High	Analyze & identify practical and legal problems commonly encountered by engineers in their professional industry.
CO3-PO8	Medium	Build foundation knowledge of ethics to be and apply them to solve engineering problems.
CO4-PO10	Low	Develop communication skills through participating in quiz, presentation etc.

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	28
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	28
Revision	14
Assessment Preparations	14
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	89
TEACHING METHODOLOGY	
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method	

COURSE SCHEDULE

Week	Lecture	Topics	Assessment Methods
1	Lec 1 Lec 2	Introduction to Ethics Principles of Engineering Ethics	**Class Test 1**
2	Lec 3 Lec 4	Ethical expectation Employers and Employees Relationship Obligation of an Engineer to Clients	
3	Lec 5 Lec 6	Professional Organization: Standards and Codes Institutionalization of Ethical Conduct	
4	Lec 7 Lec 8	BNBC in industries	**Class Test 2**
5	Lec 9 Lec 10	Ethical Problem Solving Techniques	
6	Lec 11 Lec 12	Case study methodology, different case studies	
7	Lec 13 Lec 14	Roles of IPE engineers to society	**Mid Term**
8	Lec 15 Lec 16	Ethical Dilemmas Choices (Whistle Blowing)	
9	Lec 17 Lec 18	Ethical Challenges for IPE Engineers	
10	Lec 19 Lec 20	The Rights and Responsibilities of Engineers Safety, Risk and Liability	
11	Lec 21 Lec 22		
12	Lec 23	Case study methodology, different case studies	

	Lec 24		
13	Lec 25 Lec 26	Introduction to Philosophy of Engineering Metaphysics	
14	Lec 27 Lec 28	Epistemology, Axiology and logic	

SSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Test 1-2	20%	CO 1	C1-C2
	Class Participation	5%	CO 4	A2
	Mid term	15%	CO 2	C3
Final Exam		60%	CO 1	C1-C2
			CO 3	C3-C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

1. Engineering Ethics: Concepts and Cases (4th Edition) - Charles E. Harris
2. Engineering Ethics (4th Edition) - Charles B. Fleddermann,
3. The Elements Of Moral Philosophy – James Rachels & Stuart Rachels

REFERENCE SITE

CHAPTER 7

DESCRIPTION OF OTHER ENGINEERING COURSES

7.1 Detailed Curriculum of CSE Courses

COURSE INFORMATION			
Course Code Course Title	: CSE 281 : Computer Programming	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
Course Code: Nil Course Title: Nil			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
RATIONALE			
The Computer programming Technique course is designed to introduce the fundamental principles, mechanism of programming skills and develop basic programming skills to program design and development. The course begins with introductory concepts of structured programming language and then covers other important topics related to structured programming language. It also deals with basic data structures like stack and queue.			
OBJECTIVE			
1. Describe algorithm and solve problems using computers. 2. To know about various syntax, semantics of computer programming languages. 3. Develop basic programming skills with respect to program design and development.			

LEARNING OUTCOMES& GENERIC SKILLS

No.	Course Learning Outcome (Upon completion of the course, the students will be able to)	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Describe algorithm and solve problems using computers.	C1-C3	1		1	T
CO2	Analyse the fundamental principles, typical characteristics and mechanisms of computer programming techniques.	C4	3		2	T, F, MT
CO3	Develop basic programming skills with respect to program design and development.	C6	1,3		5	F
CO4	Able to develop the communication skill by presenting topics on Computer Programming Techniques.	A2		1		PR

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)

COURSE CONTENT

Introduction to computer programming: Programming Concepts, Program Development Stages, Structured Programming Language; **Number System:** binary, octal, decimal and hexadecimal systems; **Basic programming Structures:** Data types and their memory allocation, Operators, Expressions, Basic Input/output; **Control Structure:** “if else”, “switch”, Flow Charts, Loop, Nested Loop; **Arrays:** One-dimensional array, Multi-dimensional array, Character array/ string; **Function:** Function definition, Function declaration, Function call; **Pointer:** Different types of pointers, Pass pointer as arguments, Call by value vs call by reference; **Dynamic Memory Allocation:** Malloc, Calloc, Free, Realloc; **User defined data types:** Structures, Unions, Enumerations; **Bitwise operations:** AND, OR, NOT, XOR, Left shift, Right Shift; File I/O; Header files, Preprocessor; Error Handling; **Introduction to C++:** Basic Ideas of OOP-encapsulation, inheritance and polymorphism, Classes and objects;

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Describe algorithm and solve problems using computers.	H											
CO2	Analyse the fundamental principles, typical characteristics and mechanisms of computer programming techniques.		H										
CO3	Develop basic programming skills with respect to program design and development.			H									
CO4	Able to develop the communication skill by presenting topics on Computer programming Technique.										L		

(H – High, M- Medium, L-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Level	Justifications
CO1 – PO1	High	In order to solve complex engineering problems, knowledge of algorithms and computer usage is very important.
CO2 – PO2	High	To analyse the complex engineering problems one need to analyse the fundamental principles, typical characteristics and mechanisms of a structured programming language.
CO3 – PO3	High	To design and develop solutions for complex engineering problems, one need to develop basic programming skills.
CO4-PO10	Low	In order to give presentation on the selective topics from the course taught we need strong communication skills.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision	21
Assessment Preparations	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week	Lecture	Topics	Assessment Methods
1	Lec 1 Lec 2 Lec 3	Programming Concepts, Program Development Stages, Structured Programming Language	**Class Test – 1**
2	Lec 4 Lec 5 Lec 6	Number System: binary, octal, decimal and hexadecimal systems; Data types and their memory allocation	
3	Lec 7 Lec 8 Lec 9	Operators, expressions, Basic Input/output; Control Structure: “if else”, “switch”, Flow Charts	
4	Lec 10 Lec 11 Lec 12	Control Structures: Loop	**Class Test – 2**
5	Lec 13 Lec 14 Lec 15	Control Structures: Nested Loop	
6	Lec 16 Lec 17 Lec 18	Arrays, Multidimensional Arrays	
7	Lec 19 Lec 20 Lec 21	String	
8	Lec 22 Lec 23 Lec 24	Function, parameter passing convention	**Mid Term**
9	Lec 25 Lec 26	Pointer	

	Lec 27		
10	Lec 31 Lec 32 Lec 33	Dynamic Memory Allocation	
11	Lec 28 Lec 29 Lec 30	User defined data types: structures, unions, enumerations. File I/O; Header files, Preprocessor	**Class Test – 3**
12	Lec 34 Lec 35 Lec 36	Error Handling; Bitwise Operations	
13	Lec 37 Lec 38 Lec 39	Introduction to C++: Basic Ideas of OOP-encapsulation, inheritance and polymorphism	
14	Lec 40 Lec 41 Lec 42	Introduction to C++: Classes and objects	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Test 1-3	20%	CO1	C1-C3
			CO2	C4
	Class Participation	5%	CO4	A2
	Mid term	15%	CO2	C4
Final Exam		60%	CO2	C4
			CO3	C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

1. Teach Yourself C - Herbert Schildt
2. Programming in Ansi C - E Balagurusamy
3. C: The Complete Reference - Herbert Schildt

4. C Programming Language – Dennis M. Ritche

COURSE INFORMATION			
Course Code Course Title	: CSE 282 : Computer Programming Sessional	Lecture Contact urs Credit Hours	: 3.00 : 1.50
PRE-REQUISITE			
Course Code: Nil Course Title: Nil			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
RATIONALE			
The Computer programming Technique Sessional course is designed to practically introduce the fundamental principles, mechanism of programming skills and develop basic programming skills to program design and development. The course begins with introductory concepts of structured programming language and then covers other important topics related to structured programming language. It also deals with basic data structures like stack and queue.			
OBJECTIVE			
1. To learn basic idea of programming languages. 2. To learn how to program with C, C++. 3. To learn how to think about the problems, their solutions and translating it to programming language.			
LEARNING OUTCOMES& GENERIC SKILLS			

No.	Course Learning Outcome (Upon completion of the course, the students will be able to)	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO 1	Discuss algorithm and solve problems using computers.	C1-C3	1	3	5	F, T, ASG
CO 2	Practically analyze the fundamental principles, typical characteristics and mechanisms of a computer programming technique.	C4	3		7	F, T, ASG, Q
CO 3	Apply practical knowledge to develop basic programming skills with respect to program design and development.	C3, C6	1,3	3	7	ASG

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)

COURSE CONTENT

Basic programming Structures: Mathematical problems using printf, scanf, Data types and their memory allocation, Operators, Expressions, Basic Input/output, Data type conversion; **Control Structure:** Practice problems on "if else", "switch", Flow Charts, Loop, Nested Loop; **Arrays:** Practice problems on One-dimensional array, Multi-dimensional array, Character array/ string; **Function:** Practice problems on Function, Parameter Passing Convention; **Pointer:** Practice problems on Different types of pointers, Pass pointer as arguments, Call by value vs call by reference; **Dynamic Memory Allocation:** Dynamically allocate memory using Malloc, Calloc, Free, Realloc; **User defined data types:** Practice problems on Structures, Unions, Enumerations; File I/O; Header files, Preprocessor; Error Handling; **Introduction to C++:** classes and objects

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Discuss algorithm and solve problems using computers.									H			
CO2	Practically analyze the fundamental principles, typical characteristics and mechanisms of a structured programming technique.						H						
CO3	Apply practical knowledge to develop basic programming skills with respect to program design and development.						H						

(H – High, M- Medium, L-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Level	Justifications
CO1 – PO9	High	In order to function effectively as a member or leader of a team, one need to discuss algorithm with team members in order to solve problems using computers.
CO2 – PO6	High	In order to apply reasoning and take responsibilities relevant to the professional engineering practice, one need to analyse the fundamental

		principles, typical characteristics and mechanisms of a structured programming language.
CO3 – PO6	High	In order to apply reasoning and take responsibilities relevant to the professional engineering practice, Apply practical knowledge to develop basic programming skills with respect to program design and development

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	-
Practical / Tutorial / Studio	42
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision	–
Assessment Preparations	–
Formal Assessment	
Continuous Assessment	4
Final Examination	3
Total	49

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week	Lab	Topics	Remarks
1	Lab 1	Mathematical problems using printf, scanf	
2	Lab 1	Introduction to data types, mathematical problems using data types, data type conversion	Evaluation
3	Lab 1	Control Structure: “if else”, “else if”, “switch”	Evaluation
4	Lab 1	Control Structure: Nested “if else”	Evaluation
5	Lab 1	Control Structure: Problem on Loop- For, Do While, Nested Loop	Evaluation
6	Lab 1	Problem on Nested Loop, Array,	Evaluation
7	Lab 7	Problem on Multidimensional Array	Online -1
8	Lab 1	Problem on Nested Loop, String	Evaluation
9	Lab 1	Problem on Function, Parameter Passing Convention	Evaluation

10	Lab 1	Problem on Pointer, Dynamic Memory Allocation	Evaluation
11	Lab 1	Problem on User Defined Data Types: Structure, Union	Evaluation
12	Lab 1	File I/O;	Evaluation
13	Lab 1	Error Handling	Evaluation
14	Lab 1	Problems on C++: Objects and Classes	Online -2, Viva/ Quiz

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Lab Test	20%	CO1	C1-C3
			CO2	C4
	Class Participation	5%	CO1	C1-C3
	Assignment	15%	CO3	C3, C6
Online Test – 1		20%	CO1	C1-C3
			CO2	C4
Online Test – 2		20%	CO1	C1-C3
			CO2	C4

Viva/ Quiz	20%	CO2	C4
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS
1. Teach Yourself C - Herbert Schidlt **2. Programming in Ansi C - E Balagurusamy** **3. C: The Complete Reference - Herbert Schildt** **4. C Programming Language – Dennis M. Ritche**

7.2 Detailed Curriculum of ME Courses

COURSE INFORMATION			
Course Code	: SHOP 172	Lecture Contact Hours	: 2.00
Course Title	: Machine Shop Practice	Credit Hours	: 1.00
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
To help the students to explore various welding techniques and put theory in practice. Our mission is to expose students to the constructions of different machines. This course is targeted to verify the working principle of types of welding, casting, molding and also to gain knowledge of different			

manufacturing parts from lathe, drilling, milling and drilling machine etc. and relate them with their theoretical knowledge.

OBJECTIVE

1. The student will be able to use different manufacturing (machining, welding, foundry, sheet metal working, etc.) processes required to manufacture a product from the raw materials.

2. He will be able to use different measuring, marking, cutting tools used in workshop.

3. He will be aware of the safety precautions while working in workshop.

LEARNING OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** the basics of tools and equipment used in machining, welding, casting and molding	1	C3			1	R, Q, LT
CO2	Be able to **compare** between different types of welding and machining processes and **select** proper cutting tool for specific machining processes.	2,3	C1, C3			1	R, Q, LT
CO3	**Find** out about the importance of general safety precautions on different shop floors	1	C4			1	R, Q, LT
CO4	**Develop** practical skills by performing the experiments in different shops of workshop	5	C3			6	R, Q, LT

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, LT – Lab Test, PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

Experiments:

1) **Design and making of pattern for casting**
2) **Mold making, casting and assembly of final project**
3) **Study of electric arc welding**
4) **Study of Resistance Welding/Spot Welding**
5) **Study of Welding joints and welding positions**
6) **Study of Gas Welding/cutting**
7) **Study of TIG and MIG Welding**
8) **Manufacturing of machine component by using Lathe machine**
9) **Manufacturing of machine component by using Shaper machine**
10) **Manufacturing of a machine component by using Milling Machine**
11) **Manufacturing of a machine component by using Drilling Machine**

CO-PO MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **identify** the basics of tools and equipment used in machining, welding, casting and molding	3											
CO2	Be able to **compare** between different types of welding and machining processes and **select** proper cutting tool for specific machining processes.		3	2									
CO3	**Find** out about the importance of general safety precautions on different shop floors	3											
CO4	**Develop** practical skills by performing the experiments in different shops of workshop					3							

Justification for CO-PO mapping:		
Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1	**3**	In order to identify the basics of tools and equipment, the knowledge of engineering fundamental would be required.
CO2-PO2	**3**	In order to perform the experiments, the knowledge of engineering fundamentals would be required
CO2-PO3	**2**	In order to perform the experiments, the knowledge of engineering fundamentals is also required.

CO3-PO1	**3**	For performing the experiments, safety precautions are very essential in this laboratory.
CO4-PO5	**3**	Students will acquire knowledge on how to select and apply appropriate techniques, resources, and modern engineering tools.

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical	28
	Total 42
Self-Directed Learning	
Preparation of Lab Reports	10
Preparation of Lab Test	10
Preparation of presentation	5
Preparation of Quiz	10
Engagement in Group Projects	20
Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Total	112

TEACHING METHODOLOGY

Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE	
Week-1	Expt-01: Design and making of pattern for casting
Week-2	Expt-02: Mold making, casting and assembly of final project
Week-3	Expt-03: Study of electric arc welding
Week-4	Expt-04: Study of Resistance Welding/Spot Welding
Week-5	Expt-05: Study of Welding joints and welding positions
Week-6	Expt-06: Study of Gas Welding/cutting
Week-7	Expt-07: Study of TIG and MIG Welding
Week-8	Expt-08: Manufacturing of machine component by using Lathe machine
Week-9	Expt-09: Manufacturing of machine component by using Shaper machine
Week-10	Expt-10: Manufacturing of a machine component by using Milling Machine
Week-11	Expt-11: Manufacturing of a machine component by using Drilling Machine

Week-12	Final Lab Report Submission
Week-13	Viva
Week-14	Quiz Test

Components		**Grading**
Continuous Assessment (60%)	Lab participation and Report	30%
	Labtest-1, Labtest-2	30%
Lab Quiz		40%
Total Marks		100%

REFERENCE BOOKS
1. Machine Shop Practice – James Anderson, W. A. Chapman. 2. Callister W. D., Material Science & Engineering, John Wiley & Sons.

COURSE INFORMATION			
Course Code	ME 160	Lecture Contact Hours	3.00
Course Title	Engineering Drawing	Credit Hours	1.50
PRE-REQUISITE			

None
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
The rationale for this course is to motivate students by fostering creativity and introducing conceptual design, sustainable design in engineering, industrial design, computer aided design and drafting early in the course. Early training and practice in the engineering design method, the introduction to engineering handbooks. Engineers need skills in graphical communication and spatial vision in the practice of their profession.
OBJECTIVE
1. To enable students to acquire and use engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions. 2. To enable students to acquire requisite knowledge, techniques and attitude required for advanced study of engineering drawing.
LEARNING OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	To be able to **create** simple engineering drawing and sketches based on current practice.	3	C4			5	T,ASG,Q
CO2	To **develop** the skills to read manufacturing and construction drawings used in industry.	10	C3			5	T,ASG,Q
CO3	Be able to **make use of** and **interpret** standard conventions used in engineering drawing.	1	C2,C3			5	T,ASG,Q
CO4	Learn basic Auto Cad skills and be able to **make use of** AutoCAD for 2-D representations.	5	C3			6	T,ASG,Q

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT
Manual Drawing (50%): Introduction; Instruments and their uses; First and third angle projections; Orthographic drawings; Isometric views; Missing lines and views; sectional views and conventional practices; Auxiliary views.

CAD (50%): Importance to design and drafting, Setting up a drawing: starting SolidWorks, menu, planning for a drawing, basic commands, making a simple 2-D drawing, layers, object snap, poly lines and other features, file handling and display control, editing and dimensioning.

CO-PO MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	To be able to **create** simple engineering drawing and sketches based on current practice.			3									
CO2	To **develop** the skills to read manufacturing and construction drawings used in industry.										3		
CO3	Be able to **make use of** and **interpret** standard conventions used in engineering drawing.	1											
CO4	Learn basic Auto Cad skills and be able to **make use of** AutoCAD for 2-D representations.					3							

Justification for CO-PO mapping:

Mapping	**Corresponding Level of matching**	**Justifications**
CO1PO3	**3**	In order to design system and components ability to create simple engineering drawing and sketches is required.
CO2PO10	**3**	To communicate with other industrial engineering professionals and manufacturers of industrial system, skill to read manufacturing and construction drawing is must.
CO3PO1	**1**	To interpret and understand standard engineering conventions knowledge of engineering fundamentals will be required.
CO4PO5	**3**	In order to operate AutoCad and make use of it, knowledge regarding modern engineering and IT tools will be required.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical	28

	Total 42
Self-Directed Learning	
Preparation of Assignments	10
Preparation of Mid Quiz	10
Preparation of presentation	5
Preparation of Quiz	10
Engagement in Group Projects	20
Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Total	112

TEACHING METHODOLOGY

Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE

Week-1	Introduction; Instruments and their uses; First and third angle projections;
Week-2	Orthographic drawings;
Week-3	Orthographic drawings;
Week-4	sectional views and conventional practices;
Week-5	sectional views and conventional practices;
Week-6	Auxiliary views
Week-7	Isometric views
Week-8	

Week-9	
Week-10	Importance to design and drafting, Setting up a drawing: starting SolidWorks, menu, planning for a drawing
Week-11	Basic commands, making a simple 2-D drawing.
Week-12	Layers, object snap, poly lines and other features.
Week-13	File handling and display control, editing and dimensioning.
Week-14	Viva and Quiz Test

ASSESSMENT STRATEGY

Assessment Method		Grading
Continuous Assessment (60%)	Class Performance	20%
	Attendance	10%
	Assignment	10%
Final Lab Quiz		50%
Viva		10%
Total Marks		100%

REFERENCE BOOKS

1.Metric Drafting –Paul Wallah, Publisher –GlenceoPublishing Co, Inc; 1979.

2 .Drafting Technology and Practice –William P. Spence, Publisher –Chas A. Bennett Co, Inc, 1973.

3.Technical Drawing –Frederick E Giesecke, Alva Mitchell, Henry C. Spencer

4.Mechanical Engineering Drawing-AC Mandal & M.Q. Islam

7.3 Detailed Curricula of EECE Courses

COURSE INFORMATION			
Course Code Course Title	: EECE 171 : Basic Electrical and Electronic Circuit	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
The foundational course on electrical circuits is a basis of making freshmen engineering students well familiarize about the arena of DC and AC circuits. The course is aimed towards the methods of electric circuit analysis and evaluating their responses which can be very well achieved by the understanding of circuit laws, techniques and theorems for both AC and DC excitations. Investigation of first and second order DC circuits is vital in understanding circuit elements like capacitors and inductors used in daily life. A hands-on flavour of the course is the assessment of poly phase circuits which addresses the issue of faults and usable power in the transmission lines. Finally, this course is also aimed to teach the students the concepts, principles and working of basic electronic circuits (Diodes, BJTs)			
OBJECTIVE			
1. **Create** a foundation of basic electrical engineering and circuits. 2. **Familiarize** students with basic Circuit laws (Ohm, Kirchhoff), techniques (Mesh, Nodal), concepts (Superposition, Source Transformation) and theorems (Thevenin, Norton). 3. **Develop** the understanding of AC steady state response of single-phase circuits and power in AC circuits. 4. **Introduce** students to poly-phase circuits as a practical arena of AC Circuits. 5. **Achieve** ability to familiarize the students with the working principle of semiconductor devices (Diodes, BJTs) as electronic circuit elements.			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcomes	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Capable to **interpret** circuit laws and **apply** their corresponding technique to find circuit quantities (Voltage and Current); also **justify selection** particular circuit concept(s) and	PO-1,2	C2 C5 C3	P1	-	K3	T, MT, F

	theorem(s) for simplifying complex circuits.						
CO2	Competent in **analyze** first-order and second-order circuits and **evaluate** the responses both in the presence and Absence of DC circuits.	PO-1	C4 C5	P1	-	K2 K3	T, MT, F
CO3	**Manage to outline** sinusoids and phasors in **explaining** circuit parameters and **analysing** AC power.	PO-1	C1 C2 C4	-	-	K1	F, ASG, MT
CO4	Able to **understand** the current voltage relation of 3 phase circuits for different configurations and **reproduce** knowledge of AC power to **analyze** real life power consumptions of Transmission lines.	PO-1,4	C1 C2 C4	P1	-	K3 K5	F, ASG, Pr
CO5	Be skilful to **explain** the operating principle of some fundamental electronic devices (Diodes, BJTs)	PO1	C2			1,3	F, ASG, Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

Direct current circuits: laws and theorems, DC network analysis, alternating current: AC quantities and sinusoidal waveforms, phasors, AC circuit analysis: series and parallel branches-RL, RC, and RLC balanced three-phase circuits. Semiconductor diode: operation, characteristics and applications, introduction to bipolar junction transistors (BJTs), characteristic, common-emitter (CE), common-base (CB), common-collector (CC), and amplifier configurations.

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Capable to **interpret** circuit laws and **apply** their corresponding technique to find circuit quantities (Voltage and	3	2										

	Current); also **justify selection** particular circuit concept(s) and theorem(s) for simplifying complex circuits.												
CO2	Competent in **analyze** first-order and second-order circuits and **evaluate** the responses both in the presence and Absence of DC circuits.	3											
CO3	Manage to **outline** sinusoids and phasors in **explaining** circuit parameters and **analysing** AC power.	3											
CO4	Able to **understand** the current voltage relation of 3 phase circuits for different configurations and **reproduce** knowledge of AC power to **analyze** real life power consumptions of Transmission lines.	3			1								
CO5	Be skilful to **explain** the operating principle of some fundamental electronic devices (Diodes, BJTs)	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	42
Self-Directed Learning	84
Formal Assessment	05
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1	
Class 1	Introduction to basic electrical circuit
Class 2	Basic laws and theorems of circuit.
Class 3	Ohm’s law, Resistor, Conductor, Insulator, Semi-conductor, Branch, Node, Loop, Mesh
Week 2	

Class 4	Series-parallel connection
Class 5	KCL, KVL, Analysis of equivalent resistance of electrical circuit
Class 6	Analysis of voltage, current and power
Week 3	
Class 7	Analysis of current in different branches
Class 8	Analysis of voltage in different parts of circuit
Class 9	Practice mathematical problems related to current divider and voltage divider rule.
Week 4	
Class 10	Introduction: Concept of phasor and complex impedance / admittance (Lec-01)
Class 11	Introduction: Concept of phasor and complex impedance / admittance (Lec-02)
Class 12	Theory of Active power, reactive power, apparent power (volt ampere)
Week 5	
Class 13	Mathematical Problems of Active power, reactive power, apparent power (volt ampere)
Class 14	Power factor and energy associated with these circuits
Class 15	Concept of complex power, Phasor diagram
Week 6	
Class 16	Impedance triangle and power triangle associated with complex circuits.
Class 17	Resonance in series and parallel circuits
Class 18	Q factor, half-power frequencies and bandwidth of resonant circuits.
Week 7	CT 3
Class 19	Transient response of RL,RC and RLC series and parallel circuits free response – step and sinusoidal responses
Class 20	Frequency: Damped Frequency
Class 21	Damping Factor and Logarithmic Decrement
Week 8	
Class 22	Response of circuits for non-sinusoidal periodic inputs
Class 23	Passive Filters
Class 24	Magnetically Couples Circuits
Week 9	
Class 25	Analysis of three phase circuits: Three phase supply
Class 26	Balanced and Unbalanced circuits, Power calculation (Lec-01)
Class 27	Balanced and Unbalanced circuits, Power calculation (Lec-02)
Week 10	CT 4
Class 28	Basics of semiconductor.
Class 29	p-n junction, forward bias and reverse bias concept.
Class 30	Basic structure of open-circuited p-n junction.
Week 11	

Class 31	The current components of p-n diode.
Class 32	Volt ampere characteristics of p-n junction.
Class 33	Diode resistance.
Week 12	
Class 34	p-n junction diode switching times.
Class 35	Breakdown voltage and characteristics of diode.
Class 36	Introduction to junction transistor.
Week 13	
Class 37	Basics of BJT
Class 38	Transistor characteristics components.
Class 39	Detailed study of the currents in the transistor.
Week 14	
Class 40	Common emitter, common-base and common-collector configuration of BJT
Class 41	Amplifier configuration of BJT.
Class 42	Cut-off and saturation region in different configuration in BJT.

ASSESSMENT STRATEGY

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (40%)	Test 1-3	20%	CO1	C2, C3, C5
			CO2	C4, C5
	Class Participation	5%	CO4	C1, C2, C4
			CO5	C2
	Mid term	15%	CO1	C1, C2, C4, C5
			CO2	C4, C5
			CO3	C1, C2, C4
Final Exam		60%	CO1	C2, C3, C5
			CO2	C1, C2, C4
			CO3	C1, C2, C4
			CO4	C1, C2, C4
			CO5	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT AND REFERENCE BOOKS

1. Fundamentals of Electric Circuit by C. K. Alexander & M. N. Sadiku
2. Introductory Circuit Analysis by R. L. Boylsted
3.Alternating Current Circuits by G. S. Corcoran & R. F. Kerchner
4. Electric Circuits by J. A. Edminister

5. Basic Engineering Circuit Analysis by J. D. Irwin & R. M. Nelms 6. Electric Circuits by James William Nilsson 7. Microelectronic circuit by Sedra Smith

COURSE INFORMATION			
Course Code Course Title	: EECE 172 : Basic Electrical and Electronic Circuits Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75

PRE-REQUISITE
None
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
This course of electrical engineering discipline aims to familiarize the students with implementation of basic electrical circuits in hardware domain. Designed for fresher students, experiments of this laboratory course will enable them to assemble beginner-level circuits to experimentally verify some fundamental circuit laws and theorems (KVL, KCL, Thevenin, Norton). This course also familiarizes the students with hardware implementation of AC circuits and measurement of ac quantities by oscilloscope. This sessional course is designed to teach the students about the concepts, principles and working of basic electronic devices and circuits by hand-held experiments.
OBJECTIVE
1. To enable the students to apply the fundamental circuit laws (KVL, KCL, Ohm's law) in hardware domain. 2. To develop students' skills to simplify complex electrical circuits into simpler circuits by Thevenin and Norton's theorem and verify them in hardware. 3. To teach the students the basic operation of oscilloscope to measure AC quantities (magnitude and phase). 4. To impart the students the skills of analogue filter design by RLC circuit. 5. To familiarize the students with input and output characteristics of different BJTs, FETs and also the operation of each device in terms of junction bias voltage and charge carrier movement.
COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcomes	Corresponding PO	Bloom's Taxonomy	KP	CP	CA	Assessment Methods
CO1	Be able to **assemble** electrical circuits that can **verify** fundamental electrical laws (KVL, KCL and Ohm's Law)	9, 10	P4, P5, A3	1,2,3	1		R, Q, T

CO2	Be adept to **set up** circuits to **justify** Thevenin’s law and Norton’s law in electrical circuits.	9, 10	P4, P5, A3	1,2,3	1		R, Q, T
CO3	Achieve ability to **produce** desired ac waves and **measure** amplitude and phase of ac waves in oscilloscope.	5, 9, 10	P3, P4	1,2	1		R, Q, T
CO4	Be adept to **design** analogue RLC filter that can produce desired frequency response.	3, 9 10	P6	1,2	1		R, Q, T

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

In this course students will get a hands on experience about electrical and electronic circuits. They will observe the uses of electrical circuits practically and can use this knowledge gained in EECE 171 course for future project works.

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **assemble** electrical circuits that can **verify** fundamental electrical laws (KVL, KCL and Ohm’s Law)									3	2		
CO2	Be adept to **set up** circuits to **justify** Thevenin’s law and Norton’s law in electrical circuits.									3	2		
CO3	Achieve ability to **produce** desired ac waves and **measure** amplitude and phase of ac waves in oscilloscope.					3				3	2		
CO4	Be adept to **design** analogue RLC filter that can produce desired frequency response.			3						3	2		

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical / Tutorial / Studio	28
Student-Centred Learning	42
Self-Directed Learning	
Preparation of Lab Reports	10
Preparation of Lab Test	10
Preparation of presentation	5
Preparation of Quiz	10
Engagement in Group Projects	20
Formal Assessment	
Continuous Assessment	14
Final Examination	1
Total	112

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method.

COURSE SCHEDULE

Week	Topic
1	Construction and operation of simple electrical circuits
3	Verification of KVL, Verification of KCL
5	Verification of Superposition Theorem, Verification of Thevenin's theorem
7	Verification of Norton's theorem, Familiarization with alternating current (ac) waves
9	Lab Test-01
11	Study of R-L-C series circuit, Different types of filters and its characteristics with different input frequency
13	Practice Lab, Lab Test-02
14	Quiz test, Viva

ASSESSMENT STRATEGY

Components		Grading	CO	Bloom's Taxonomy
		20%	CO1	P4, P5, A3
			CO2	P4, P5, A3

Continuous Assessment (75%)	Lab participation and Report		CO3	P3, P4
			CO4	P6
	Labtest-1 ,Labtest-2	30%	CO1	P4, P5, A3
			CO2	P4, P5, A3
			CO3	P3, P4
			CO4	P6
	Project and Presentation	25%	CO5	P7, A4
Lab Quiz		25%	CO1	P4, P5, A3
			CO2	P4, P5, A3
			CO3	P3, P4
			CO4	P6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT AND REFERENCE BOOKS

1. Introductory Circuit Analysis - R.L. Boylestad; Prentice Hall of India Private Ltd.
2. Introductory Circuits for Electrical & Computer Engineering - James. W. Nilson; Prentice Hall of India Private Ltd.
3. Basic Electrical Engineering – Fitzgerald; McGraw-Hill International.
4. Electricity and Magnetism - Mary Atwater; McGraw-Hill.
5. Introduction to Electrical Engineering – Robert P. Ward; Prentice Hall of India Private Ltd.
6. Introduction to Electric Circuits – Richard C. Dorf& James A. Svoboda; John Wiley & Sons Inc.

COURSE INFORMATION

Course Code	: EECE 271	Lecture Contact Hours	: 3.00
Course Title	: Electrical Machines and Electronics	Credit Hours	: 3.00

PRE-REQUISITE

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

To develop a strong foundation in the basic operating principle, constructions, characteristic features, applications etc. of AC and DC electrical machinery like DC generator, DC motor, synchronous generator, synchronous motor and three induction motors. The emphasis has been given on both physical insight and analytical techniques. The subject material covered here will provide the basis for understanding many real-world electric machinery applications as well as the foundation for advanced

courses in electric machinery design and control. It is targeted to provide a basic foundation for technology areas like electronics devices (operational amplifiers and silicon-controlled rectifiers) as well as instrumentation, control systems and various electronic circuit design.
OBJECTIVE
1. To develop a strong foundation on DC and AC electrical machines (DC motor, DC generator, synchronous machines, induction machines etc) with a special focus on operating principle, identification of parts and accessories, constructional features, types etc 2. To familiarize with advanced electronic circuits (operational amplifier and silicon-controlled rectifiers), their working principles, design criteria and applications. 3. To impart basic knowledge on the basic knowledge of different types of transducers with a view to know the fundamentals of instrument and control systems. 4. To develop a broad idea on application of electronics and electrical machines in practical industrial and domestic field.
COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcomes	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the fundamental operation, basic construction and classification of different AC and DC machines	PO1	C2			1, 2	T, F
CO2	**Interpret** and **analyze** the performance characteristics of different electrical machines e.g. transformers, DC and AC machines	PO2	C2, C4			1-3	T, F
CO3	**Analyze** electronic circuits consists of op-amps and SCRs and **know** the fundamentals of transducers and its application in instrument and control systems	PO2	C4			1-3	MT, F
CO4	D**esign** various electronic circuits using both passive and active components to solve the real-life engineering problems.	PO3	C6	1		3-5	ASG, Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)
COURSE CONTENT

Single phase transformer
DC Generator: Principles and applications
DC motor: principle and applications,
Three phase induction motor: principle and applications.
Alternator: Principles and operation, introduction to synchronous motors.
Introduction to operational amplifiers (OP-AMPs) and applications,
Silicon controlled rectifiers (SCR): operation and characteristics, power control using SCR
Transducers: strain, temperature, pressure, speed and torque measurements.

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** the fundamental operation, basic construction and classification of different AC and DC machines	3											
CO2	**Interpret** and **analyze** the performance characteristics of different electrical machines e.g. transformers, DC and AC machines		3										
CO3	**Analyze** electronic circuits consists of op-amps and SCRs and **know** the fundamentals of transducers and its application in instrument and control systems		3										
CO4	**Design** various electronic circuits using both passive and active components to solve the real-life engineering problems.			2									

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1	Single Phase Transformer: Principles, types	Class Test 1, Final
Week 2	Single Phase Transformer: Performances and characteristics.	
Week 3	DC generators: Principles, types	
Week 4	DC generators: Performances and characteristics.	Class Test 2, Final
Week 5	DC Motors: Principles, types	
Week 6	DC Motors: Performances and characteristics	
Week 7	Three phase induction motor: Principles and applications	
Week 8	Alternator: Principles and applications	Mid Term Final
Week 9	Introduction to operational amplifiers (OP-AMPs)	
Week 10	Applications of operational amplifiers (OP-AMPs)	
Week 11	Silicon controlled rectifiers (SCR): operation and characteristics	Class Test 3, ASG/ Pr Final
Week 12	Silicon controlled rectifiers (SCR): power control using SCR	
Week 13	Transducers: strain, temperature, pressure	
Week 14	Transducers: speed and torque measurements.	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1	C2
			CO2	C2, C4
			CO3	C4
	Class Participation	5%	-	-
	Mid term	15%	CO3	C4
Final Exam		60%	CO1	C2
			CO2	C2, C4
			CO3	C4
			CO4	C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT AND REFERENCE BOOKS

Text Books:

1. Electrical Machinery Fundamentals – Stephen J. Chapman
2. A textbook of Electrical Technology – B.L. Theraja and A.K. Theraja
3. Op Amps & Linear Integrated Circuits - James M. Fiore; Delmar Thomson Learing.

4. Operation Amplifiers and Linear Integrated Circuits- Robert F. Coughlin; Prentice Hall of India Private Ltd
5. Power Electronics: Device, Principles and Application –Muhammad H Rashid

COURSE INFORMATION			
Course Code Course Title	: EECE 272 : Electrical Machines and Electronics essional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
To help the students to explore various DC and AC machines and put theory in practice. Our mission is to expose students to the constructions of electrical machines and analyze their performance. This course is targeted to verify the properties of generator, motor etc. and relate them with their theoretical knowledge. This course is also designed to examine some electronic devices and observe their characteristics.			
OBJECTIVE			
1. Be able to familiarize the students with the basic electrical machines like transformer, dc generator, dc motor, synchronous machines, induction machines etc. **2.** Be able to calculate various parameters of machines like voltage regulation, efficiency etc., observe their behaviour under various load conditions and compare them. **3.** To develop skills of handling basic machinery equipment by engaging students in experiences with experimental processes and by growing the capability to give connection. **4.** Be able to impart practical knowledge on electrical machine crafting and develop collaborative learning skill. **5.** To develop communication as well as project management skills among the students through presentation and group projects.			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Be able to **compute** the voltage regulation and efficiency of electrical machine, like transformer, alternator, dc motor etc. and **justify** these	1	C3, C5		1	2	R, Q, LT

	characteristics under various loading condition.						
CO2	Be able to **identify** the characteristics of electrical machines like dc generator, dc motor etc. and **trace** various curves like armature voltage vs. armature current curve for dc generator or torque-speed curve of dc motor.	1, 2, 5	C1, P3	1	1	1,3,6	R, Q, LT
CO3	Be able to **compare** the starting and operating characteristics of various induction machines (squirrel cage induction motor, wound rotor induction motor etc.) by measuring the active power, reactive power, apparent power etc and plotting torque-speed curve.	1,5	C4	1	1	1,6	R, Q, LT
CO4	Developing collaborative nature bydiscussing and performing as a group and organize project tasks maintaining solidarity during the group projects and presentations.	8, 9, 10, 11	A1, A2, A3, A4		1	7	PR, Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

In this course, students will perform experiments to practically verify the theories and concepts learned in EECE 271 using different hardware equipment and simulation software.

CO-PO MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **compute** the voltage regulation and efficiency of electrical machine, like transformer, alternator, dc motor etc. and **justify** these characteristics under various loading condition.	3											
CO2	Be able to **identify** the characteristics of electrical machines like dc generator, dc motor etc. and **trace** various curves like armature voltage	3	3			2							

	vs. armature current curve for dc generator or torque-speed curve of dc motor.													
CO3	Be able to **compare** the starting and operating characteristics of various induction machines (squirrel cage induction motor, wound rotor induction motor etc.) by measuring the active power, reactive power, apparent power etc and plotting torque-speed curve.		2			2								
CO4	Developing collaborative nature by **discussing** and **performing** as a group and **organize** project tasks maintaining solidarity during the group projects and presentations.								3	3	3	3		

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Practical	 14 28 Total 42
Self-Directed Learning Preparation of Lab Reports Preparation of Lab Test Preparation of presentation Preparation of Quiz Engagement in Group Projects	 10 10 5 10 20
Formal Assessment Continuous Assessment Final Quiz	 14 1
Total	112

TEACHING METHODOLOGY

Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE

Week-1	Introduction to the lab equipments and safety measures
Week-3	Expt-01: Regulation of the Transformer in Various Loads. Expt-02: Study the properties of DC Separately Excited Shunt Generator
Week-5	Expt-03: Study the properties of DC Self-Excited Shunt Generator Expt-04: Study the properties of DC Shunt Motor

Week-7	Expt-05: Study the properties of Three-Phase Alternator in various loads Expt-06: Study the Three-Phase Alternator synchronizing process in power utility system.	
Week-9	Expt-07: Study the properties of Squirrel-Cage Induction Motor	
Week-11	Expt-08: Mathematical operation using operational amplifier (Adder and Subtractor) Expt-09: Mathematical operation using operational amplifier (Integrator ar Differentiator).	
Week-13	Practice Lab	
Week-14	Lab Test + Viva, Quiz test	

ASSESSMENT STRATEGY

Components		**Grading**	CO	Blooms Taxonomy
Continuous Assessment (40%)	Lab participation and Report	20%	CO 1	C3, C5
			CO 2	C1, P3
			CO 3	C4
	Labtest-1,Labtest-2	30%	CO 1	C3, C5
			CO 2	C1, P3
			CO 3	C4
	Project and Presentation	25%	CO4	A1, A2, A3, A4
Lab Quiz		25%	CO 1	C3, C5
			CO 2	C1, P3
			CO 3	C4
Total Marks		100%		
(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)				

TEXT AND REFERENCE BOOKS

1. Electrical Machinery Fundamentals – Stephen J. Chapman
2. A textbook of Electrical Technology – B.L. Theraja and A.K. Theraja
3. Op Amps & Linear Integrated Circuits - James M. Fiore; Delmar Thomson Learing.