



Sri Krishna College of Engineering and Technology
An Autonomous Institution, Affiliated to Anna University
Coimbatore - 641 008

DEPARTMENT OF MECHANICAL ENGINEERING



CURRICULUM AND SYLLABI
B.E. MECHANICAL ENGINEERING
(R2015)

Vision

The department aspires to produce academic leaders in mechanical engineering with moral values and desires to set up centers of excellence in innovative design and testing, composite materials, automation, automotive technology and green fuels.

Mission

To produce world class mechanical engineering graduates by promoting core technical competency blended with advanced computing skills, creative thinking and desire to upgrade continuously, so as to empower them to the expectation of the industries in our country and abroad and also to impart the interpersonal skills and make them realize the values of life.

Programme Educational Objectives (PEOs)

PEO 1: Provide strong foundation in the science and engineering fundamentals necessary to formulate, solve and analyze real time mechanical engineering problems.

PEO 2: Develop the ability to synthesize data and technical concepts for making decisions in an ethical manner considering the socio-economic scenario.

PEO 3: Enable to work as part of teams on multidisciplinary projects with good communication and interpersonal skills in the emerging areas like automation, composite materials, automotive technology, green fuels etc.,

PEO 4: Prepare for successful careers in industry that meet the needs of Indian and multinational companies and to inculcate the qualities of continuous learning and entrepreneurial skills.

Programme Outcomes (POs)

- a. An ability to apply knowledge of mathematics, science, and engineering fundamentals in order to solve mechanical engineering problems
- b. An ability to design and conduct experiments, as well as to analyze and interpret data using research based knowledge to give suitable conclusions
- c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and Sustainability
- d. An ability to function as an individual and as a member or leader in diverse teams, and in multidisciplinary settings
- e. An ability to identify, formulate, research literature and analyze complex engineering problems reaching substantiate conclusions using first principles of mathematics, sciences and engineering
- f. An understanding of professional and ethical responsibility and norms of the engineering practice
- g. An ability to communicate effectively on complex engineering activities with engineering and society communities and write reports, documentation and presentation effectively
- h. An ability to understand the impact of the professional engineering solutions in a societal and environmental context and demonstrate the knowledge of, need for sustainable development
- i. A recognition of the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
- j. A knowledge of contemporary issues (Our interpretation of this includes presenting students with issues such as the impact of globalization, the outsourcing of both engineering and other support jobs as practiced by modern international companies).
- k. An ability to create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- l. An ability to fabricate real time mechanical systems and test its worthiness.

CURRICULUM & SYLLABUS

Regulation R - 2015

SEMESTER I							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1	15UH101	Communication Skills - I	2/0/2	4	3	60/40	HS
2	15UH202	Engineering physics	3/0/0	3	3	60/40	BS
3	15UH203	Engineering chemistry	3/0/0	3	3	60/40	BS
4	15UH201	Mathematics - I	2/2/0	4	3	60/40	BS
5	15UC301	Fundamentals of computing and C programming	3/0/0	3	3	50/50	ES
6	15UA301	Engineering drawing	0/1/3	4	2	60/40	ES
7	15UH251	Physical science laboratory	0/0/3	3	2	60/40	BS
8	15UC351	Fundamentals of computing and C programming laboratory	0/0/3	3	2	60/40	ES
9	15UA351	Computer aided drafting and modeling laboratory	0/0/3	3	2	60/40	ES
Total				30	23	900	

SEMESTER II							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1	15UH102	Communication skills - II	2/0/2	4	3	60/40	HS
2	15UH204	Mathematics - II	2/2/0	4	3	60/40	BS
3	15UA302	Engineering mechanics	2/2/0	4	3	60/40	ES
4	15UA303	Machine drawing	2/0/2	4	3	60/40	ES
5	15UA304	Materials science and metallurgy	3/0/0	3	3	60/40	ES
6	15UA305	Manufacturing technology - I	3/0/0	3	3	60/40	ES
7	15UC302	Advanced C programming laboratory	0/0/3	3	2	60/40	BS
8	15UA352	Engineering practices and manufacturing processes laboratory	0/0/3	3	2	60/40	ES
9	15UA353	Computer aided machine drawing laboratory	0/0/3	3	2	60/40	ES
Total				31	24	900	

SEMESTER III							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1	15MA134	Fourier Analysis and Statistical Quality Control	3/2/0	5	4	60/40	BS
2	15ME304	Manufacturing Technology - II	3/0/0	3	3	60/40	PC
3	15ME305	Engineering Thermodynamics	3/2/0	5	4	60/40	PC
4	15ME306	Strength of Materials	2/2/0	4	3	60/40	PC
5	15CS206/ 15IT206	Objected Oriented Programming	3/0/3	6	5	40/60	ES
6	15CH003	Environmental Sciences	3/0/0	3	3	60/40	PC
7	15ME307	Manufacturing Technology Laboratory	0/0/3	3	2	40/60	PC
8	15ME308	Strength of Materials Laboratory	0/0/3	3	2	40/60	PC
9	15ME7ZZ	Mandatory Course-I	2/0/0	2	1	-	MC
Total				34	27	800	

SEMESTER IV							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1	15MA107	Theory of Probability and Mathematical Statistics	3/2/0	5	4	60/40	BS
2	15ME309	Fluid Mechanics and Machinery (with Lab)	3/0/2	5	4	40/60	PC
3	15ME310	Automobile Engineering - Industry Based Course + Project	2/0/3	5	4	60/40	PC
4	15ME311	Kinematics of Machinery	3/0/0	3	3	60/40	PC
5	15ME312	Thermal Engineering (with Lab)	3/0/2	5	4	40/60	PC
6	15ME313	Metrology and Instrumentation Laboratory Project based Lab	1/0/2	3	2	40/60	PC
7	15MT218	Electrical Electronics and Microprocessor Laboratory	1/0/2	3	2	40/60	ES
8	15ME7ZZ	Mandatory Course-II		2	1	-	MC
9	15ME601	Mini Project - I			2	40/60	PW
Total				30+2	26	800	

SEMESTER V							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1	15ME206	Internet of Things for Mechanical Engineers	3/0/0	3	3	60/40	ES
2	15ME314	Dynamics of Machinery	2/3/0	5	3	60/40	PC
3	15ME315	Design of Machine Elements Project based Course	2/3/0	5	3	60/40	PC
4	15ME316	Heat and Mass Transfer with Lab	1/2/3	6	4	40/60	PC
5	15ME4ZZ	Professional Elective-I	3/0/0	3	3	60/40	PE
6	15ME4ZZ	Professional Elective-II	3/0/0	3	3	60/40	PE
7	15ME317	CAD/CAM Laboratory (with Theory)	1/0/2	3	2	40/60	PC
8	15ME318	Dynamics Laboratory	0/0/3	3	2	40/60	PC
9	15ME7ZZ	Mandatory Course-III	2/0/0	2	1	0/100	MC
Total				33	24	900	

SEMESTER VI							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1	15ME319	Design of Transmission Systems Project Based Course + Project	3/0/2	5	4	60/40	PC
2	15ME320	Industrial Engineering and Operations Research	2/2/0	4	3	60/40	PC
3	15ME321	Computational Mechanics	3/2/0	5	4	60/40	PC
4	15ME4ZZ	Professional Elective-III	3/0/0	3	3	60/40	PE
5	15ME4ZZ	Professional Elective-IV	3/0/0	3	3	60/40	PE
6	15XX5ZZ	Open Elective-I	3/0/0	3	3	60/40	OE
7	15ME322	Simulation and Analysis Laboratory	0/0/3	3	2	40/60	PC
8	15ME323	Drives and Automation Laboratory + Project	1/0/2	3	2	40/60	PC
9	15ME7ZZ	Mandatory Course-IV	2/0/0	2	1	0/100	MC
10	15ME602	Mini Project - II	0/0/3	3	2	40/60	PW
Total				34	27	900	

SEMESTER VII							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1	15MG004	Engineering Management and Financial Accounting	3/0/0	3	3	60/40	HS
2	15ME324	Statistical Process Control and Quality Management	3/2/0	5	4	60/40	PC
3	15ME325	Production Management	3/0/0	3	3	60/40	PC
4	15ME207	Data Analytics	3/0/0	3	3	60/40	ES
5	15ME4ZZ	Professional Elective-V	3/0/0	3	3	60/40	PE
6	15ME4ZZ	Professional Elective - VI	3/0/0	3	3	60/40	PE
7	15ME208	Robotics, sensors and control Laboratory	1/0/2	3	2	40/60	ES
Total					23	21	800

SEMESTER VIII							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1	15ME603	Project Work	0/0/24	24	12	40/60	PW
Total					24	12	100

Employability Enhancement Skills

S. No	Name of the Course	L/T/P	Contact Hours/Wk	Credits
1.	Industrial Practice- (21 Days - 1 Credit)/ Publication in Journals(1 Credit) (National/International)	-	21 Days	2

SCHEME OF CREDIT DISTRIBUTION - SUMMARY

S. No	Stream	Credits/Semester								Credits	%	
		I	II	III	IV	V	VI	VII	VIII			
1.	Humanities (HS)	3	3					3		9	4.8	
2.	Basic Sciences(BS)	11	5	4	4					24	12.9	
3.	Engineering Sciences(ES)	9	16	5	2	3		5		40	21.5	
4.	Professional Core(PC) & Professional Soft Core(PSC)			17	17	14	15	7		70	37.6	
5.	Professional Electives(PE)					6	6	6		18	9.6	
6.	Open Electives(OE)						3			3	1.7	
7.	Project Work(PW)				2		2		12	16	8.6	
8.	Employability Enhancement Skills								2	2	1.1	
9.	Mandatory Courses			1	1	1	1			4	2.2	
Total		23	24	27	26	24	27	21	12	2	186	100

Typical Curriculum Structure for UG E&T Degree Programmes

S.No	Course Work - Subject Area	Range of Total Credits (%)		AICTE Suggested Breakdown of Credits (for Total=176)	% of credits at SKCET	
		Min	Max			
1.	Humanities and Social Sciences (HS), including Management;	5	10	14	9	4.8
2.	Basic Sciences(BS) including Mathematics, Physics, Chemistry, Biology;	15	20	30	24	12.9
3.	Engineering Sciences (ES), including Materials, Workshop, Drawing, Basics of Electrical/Electronics/Mechanical/Computer Engineering, Instrumentation;	15	20	30	40	21.5
4.	Professional Subjects-Core (PC), relevant to the chosen specialization/branch; (May be split into Hard (no choice) and Soft(with choice), if required;)	30	40	50	70	37.6
5.	Professional Subjects – Electives (PE), relevant to the chosen specialization/ branch;	10	15	20	18	9.6
6.	Open Subjects- Electives (OE), from other technical and/or emerging subject areas;	5	10	12	3	1.7
7.	Project Work, Seminar and/or Internship in Industry or elsewhere.	10	15	20	16	8.6
8.	Mandatory Courses (MC);	Non-Credit		8 units	4	2.2

ELECTIVES/AUDIT COURSES

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
OPEN/EMERGING ELECTIVES						
1.	15ME501	Industrial Safety	3/0/0	3	3	OE
2.	15ME502	MEMS/NEMS	3/0/0	3	3	OE
3.	15ME503	Total Quality Management	3/0/0	3	3	OE
4.	15ME504	Product Development	3/0/0	3	3	OE
5.	15ME505	Basics of Manufacturing Processes	3/0/0	3	3	OE

PROFESSIONAL ELECTIVES

Elective Stream I – Engineering Design						
1.	15ME401	Product Design and Development	3/0/0	3	3	PE
2.	15ME402	Tool Design	3/0/0	3	3	PE
3.	15ME403	Applied Hydraulics and Pneumatics	3/0/0	3	3	PE
4.	15ME404	Design for Manufacturing and Assembly	3/0/0	3	3	PE
5.	15ME405	Optimization Techniques in Engineering Design	3/0/0	3	3	PE
6.	15ME406	Industrial Robotics	3/0/0	3	3	PE
7.	15ME407	Mechanical Vibrations	3/0/0	3	3	PE
8.	15ME408	Composite Materials and Mechanics	3/0/0	3	3	PE
9.	15ME409	Modern Concepts of Engineering Design	3/0/0	3	3	PE
Elective Stream II - Thermal Engineering						
1.	15ME410	Renewable Energy Sources	3/0/0	3	3	PE
2.	15ME411	Refrigeration and Air Conditioning	3/0/0	3	3	PE

3.	15ME412	Alternate Energy Sources for IC Engines	3/0/0	3	3	PE
4.	15ME413	Thermal Turbo Machines	3/0/0	3	3	PE
5.	15ME414	Gas Dynamics and Jet Propulsion	3/0/0	3	3	PE
6.	15ME415	Power Plant Engineering	3/0/0	3	3	PE
7.	15ME416	Solar and Wind Energy	3/0/0	3	3	PE
8.	15ME417	Advanced Internal Combustion Engines	3/0/0	3	3	PE
9.	15ME418	Cryogenic Engineering	3/0/0	3	3	PE
Elective Stream III - Manufacturing /Industrial Engineering						
1.	15ME419	Composite Materials, Processing and Applications	3/0/0	3	3	PE
2.	15ME420	Industrial Layout, Ergonomics and safety engineering	3/0/0	3	3	PE
3.	15ME421	Rapid Prototyping and Modern Manufacturing Methods	3/0/0	3	3	PE
4.	15ME422	Six sigma and Agile Manufacturing	3/0/0	3	3	PE
5.	15ME423	Theory of Metal Cutting	3/0/0	3	3	PE
6.	15ME424	Entrepreneurship development	3/0/0	3	3	PE
7.	15ME425	Lean Manufacturing	3/0/0	3	3	PE
8.	15ME426	Plastic Technology	3/0/0	3	3	PE
9.	15ME427	Advanced Casting and welding processes	3/0/0	3	3	PE

MANDATORY COURSES

S.No	Course Code	Course Title	Category
1.	15MC701	Life Skills	MC
2.	15EN701	BEC Vantage	MC
3.	15MC702	Environmental Science	MC
4.	15MC703	Quantitative aptitude and soft skills	MC
5.	15MC704	Foreign Language	MC
6.	15MC705	Spoken Hindi	MC
7.	15MC706	Professional Ethics	MC
8.	15MC707	Massive Open Online Courses(MOOC)	MC

ONE CREDIT COURSES

S.No	Course Code	Course Title	Credits
1.	15ME801	Paper presentation certificate from institutes of National importance	1
2.	15ME802	Internship Training	1
3.	15ME803	Certification in Creo, ANSYS, CFD, etc.,	1
4.	15ME804	Any other certification from MNCs/OEMs, as approved by the department.	1
5.	15ME805	NSS	1
6.	15ME806	Sports	1
7.	15ME807	Lab view certification from National Instruments	1
8.	15ME808	Certification from Texas Instruments, Bosch, Rexroth	1
9.	15ME809	Geometric Dimensioning And Tolerancing	1
10.	15ME810	Total Productive Maintenance	1
11.	15ME811	Design Of Experiments Using Taguchi Approach	1

12.	15ME812	Human Resource Management	1
13.	15ME813	Organizational Behaviour	1
14.	15ME814	Artificial Intelligence	1
15.	15ME815	Internal Combustion Engine Design	1
16.	15ME816	Simulation of Internal Combustion Engines	1
17.	15ME817	Recent Development in Automotive Engineering	1
18.	15ME818	Automotive Electronics	1
19.	15ME819	Fuel Cells	1
20.	15ME820	Vehicle Dynamics	1
21.	15ME821	NDT	1
22.	15ME822	Die Design for Plastics	1
23.	15ME823	Nano Technology	1
24.	15ME824	Micromachining	1
25.	15ME825	Advances in Casting and Welding	1
26.	15ME826	PLC	1
27.	15ME827	FMEA in Design	1
28.	15ME828	Cryogenic Engineering	1
29.	15ME829	HVAC	1

Total credits=186

SEMESTER – I

15UH101

COMMUNICATION SKILLS I

2/0/2/3

Nature of Course : D (Theory application)

Pre requisites : Nil

Course Objectives:

- 1 To emphasis and develop language skills to satisfy the needs of work environment
- 2 To inculcate reading and listening habits and thereby improvising speaking and writing skills.
- 3 To familiarize students with business terms through BEC Preliminary examination

Course Outcomes:

Upon completion of the course, students shall have ability to

- C101.1 Understand the importance of language skills and able to cope up to the needs of work environment.
- C101.2 Understand and focus on increasing LSRW skills.
- C101.3 Apply the use of vocabulary in corporate environment.

Course Contents:

GENERAL INTRODUCTION Getting to know people- Introduction- Talking about job (Present simple)- Talking about working conditions(Adverb of frequency) Talking about company history and structure (Past simple, Prepositions of time)- Talking about company activities (Connectors of addition and contrast, Present Continuous)- Focus on language -Parts of Speech- Gerunds and Infinitives- Instructions. **WORD POWER** Vocabulary practice- Telephoning Leaving and taking messages)- Requests and obligation- Describing trends (Adjectives and adverbs)- Talking about company performance (Present perfect and past simple, Reasons and consequences)- Reading Test Practice- Describing products Dimensions, (Comparatives and superlatives, Question formation)- Talking about product development (Sequencing words, Present continuous and going to)- Articles- Prepositions- Synonyms-Antonyms- Recommendations.**ESP / ENGLISH FOR ENGINEERS** Talking about business equipment (Giving Instruction)- Letter Phrases-Writing Test Practice-Talking about hotel facilities (Asking for and giving direction)- Talking about traffic and transport (making predictions)-Tenses-Present-Past-Future-Forms of verbs- Word techniques-Formation-Prefixes-Suffixes. **PRESENTATION SKILLS AND EVENT MANAGEMENT** Talking about conference arrangement (Checking and confirming)- Talking about a conference before, after, when, until, etc. Listening Test Practice-Talking about production processes- passive- Talking about quality control Conditional 1 (real) (Making suggestions)-Itinerary- Jumbled Sentences. **ENGLISH FOR CORPORATE** Talking about call centers, insurance and changes in working practices (Future possibility/ Probability- Talking about banking-Speaking Test Practice. Talking about delivery services(prepositions of time)- Talking about trading (Tense review).Talking about recruitment Conditional 2 (hypothetical)-Talking about job applications (Indirect questions)- Reading, Writing and Listening Test- Job Application Letter and Resume Writing- Permission Letters.

Total Hours:45

Text Books:

1. Wood, Ian, Anne Williams with Anna Cowper Pass Cambridge BEC Preliminary, Cengage learning, Second Edition, 2013
2. Dr Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited,2005

Reference Books:

1. Whitby, Norman. Cambridge University Press- Students Book. 2013.
2. Jawahar, Jewelcy, Rathna P, English Work book, VRB Publications Pvt Ltd, 2006.
3. Gunasekaran S, 'A Text and Workbook of Technical English I', United Global Publishers, June 2010.

Web References:

1. <http://www.cambridgeindia.org>
2. <http://www.cambridgeenglish.org/exams/business-certificates/business>

Online Resources:

1. <https://www.coursera.org/specializations/business-english>
2. <http://www.academiccourses.com/Courses/English/Business-English/>

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level		Assessment Component	Marks
C101.1	Remember		Online Quiz	5
C101.2	Understand		Assignment	5
C101.3	Understand		Presentation	5
C101.2	Apply		Group Discussion	5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I	CIA-II	CIA III	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : D (Theory application)

Pre requisites : Nil

Course Objectives:

- 1 To impart the fundamental knowledge on acoustics
- 2 To understand the advanced technology of laser and optical fiber in the field of Engineering and medicine
- 3 To exposure the behavior of heat

Course Outcomes:

Upon completion of the course, students shall have ability to

- C202.1 Present a technical overview of architectural acoustics
 C202.2 Understand modern device and technology based on laser and optical fiber
 C202.3 Design the heat engine having greater efficiency

Course Contents:

ACOUSTICS Characteristics of musical sound – Loudness, Weber-Fechner law – decibel, absorption coefficient – reverberation time, Sabine’s formula, Acoustics of buildings, Ultrasonics: Production of ultrasonics using piezoelectric method, magnetostriction - Applications of ultrasonics: Sonogram, SONAR. **LASER** Introduction, Principle – Spontaneous emission, Stimulated emission, Population inversion, Pumping, Types of Laser, Nd-YAG, CO₂ Laser, Semiconductor Laser. Lasers in Microelectronics: Thermal Effect Drilling, Welding, Cutting, Medical Field, Holography **FIBER OPTICS** Principle, modes of propagation numerical aperture, acceptance angle and fractional index change of an optical fiber, Classification based on materials, refractive index profile and modes, Fabrication techniques: Rod & Tube method, Crucible-Crucible technique, Splicing, losses in optical fiber, light sources for fiber optics, detectors: PIN, Avalanche photo diode. Application: Fiber optical communication links and endoscope. **HEAT AND THERMODYNAMICS** Thermal Conductivity, Forbe’s method, Lees disc method, Radial flow of heat, Thermal conductivity of rubber and glass, Laws of thermodynamics - Concepts of entropy, Carnot cycle, heat engine and refrigerator, Carnot theorem, ideal otto and diesel engines. **QUANTUM PHYSICS** Inadequacy of classical mechanics: Black body radiation, photoelectric effect, Dual nature, de-Broglie concept of matter waves, electron diffraction, Davisson-Germer experiment – Heisenberg’s uncertainty principle, Schrodinger wave equation, time dependent and time independent, Application of Schrodinger wave equation (particle in one dimensional box), Electron microscope - SEM and TEM

Total Hours:45

Text Books:

1. R.K. Gaur and SL Gupta “Engineering Physics” Dhanpat Rai Publications 2014
2. Rajendran “Engineering Physics” Tata McGraw-Hill Education, New Delhi – 2011

Reference Books:

1. Arthur Beiser “Concepts of Modern Physics” Tata McGraw Hill, New Delhi – 2010
2. M.N. Avadhanulu and PG Kshirsagar “A Text Book of Engineering physics” S. Chand and Company ltd., New Delhi 2005
 Dr. G. Senthilkumar “Engineering Physics – I” VRB publishers Pvt Ltd., 2013

Web References:

1. <http://nptel.ac.in>
2. www.wikipedia.com
3. www.hyperphysics.com

Online Resources:

1. <http://nptel.ac.in>

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C202.1	Remember	Online Quiz		5
C202.2	Understand	Assignment		5
C202.3	Understand	Seminar		5
C202.2	Apply	Case Study		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I	CIA-II	CIA III	
Remember	40	30	20	20
Understand	50	60	40	40
Apply	10	10	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : E (Theory skill based)

Pre requisites : NIL

Course Objectives:

1. To impart knowledge on the role of chemistry in everyday life along with the basic nature, types, preparation and uses of polymers.
2. To demonstrate the principle and working of electrochemistry, corrosion science and to impart knowledge on various analytical techniques used in the field

Course Outcomes:

Upon completion of the course, students shall have ability to

C203.1	List the different materials, its properties and importance in everyday life	[R]
C203.2	Understand the different types of polymers, its properties, preparation and uses	[U]
C203.3	Examine the properties and uses of electrochemicals and corrosive agents	[A]
C203.4	Understand the principle, working and applications of different	[U]

Course Contents:

CHEMISTRY IN EVERYDAY LIFE Chemicals in medicines-analgesics, antiseptics, antacids, disinfectants-chemicals in food preservatives-artificial sweetening agents, Characteristics of water-hardness-types and estimation by EDTA method. Problems based on EDTA method, Domestic water treatment-disinfection methods (chlorination, ozonation, UV treatment)-demineralisation process-desalination-reverse osmosis **CHEMISTRY FOR ENGINEERING PLASTICS** Introduction-monomers and polymers-classification of polymers Polymerisation--mechanism of addition polymerization(free radical mechanism) Plastics- classification -preparation, properties and uses of PVC, Teflon, Nylon 6,6, moulding methods Rubber-vulcanisation of rubber-synthetic rubber (Butyl rubber and SBR) **NON-CONVENTIONAL ENERGY SOURCES AND STORAGE DEVICES** Nuclear energy-fission and fusion reaction Light water nuclear reactor for power generation (block diagram only)- breeder reactor Solar energy conversion-solar cells-wind energy Fuel cells-hydrogen oxygen fuel cells Batteries-alkaline batteries-lead acid, nickel cadmium and lithium batteries. **ELECTROCHEMISTRY AND CORROSION SCIENCES** Electrochemical cells-single electrode potential-measurement of emf Reference electrode-SHE-calomel electrode-glass electrode and measurement of pH. Ion selective electrode Corrosion-chemical corrosion-electrochemical corrosion-galvanic corrosion-differential corrosion Protective coatings-electroplating of gold-electroless plating of Nickel. **ANALYTICAL TECHNIQUES** Laws of absorption-Principles Colorimetry-Estimation of Iron by colorimetry Instrumentation and applications-UV-Visible spectroscopy-IR spectroscopy Flame photometry-Estimation of sodium by flame photometry Atomic absorption spectroscopy-Estimation of Nickel by atomic absorption spectroscopy.

Total Hours: 60

Text Books:

- 1 Dara S.S, Umare S.S, "Engineering Chemistry", S. Chand & Company Ltd., New Delhi 2013.
- 2 N.Krishna murthy, Vallinayagam D., "Engineering Chemistry" PHI Learning Pvt Ltd., 2014
- 3 R.V.Gadag, A.Nithyananda Shetty "Engineering Chemistry" 3rd edition PHI Learning Pvt Ltd., 2014

Reference Books:

- 1 Shikha Agarwal., "Engineering Chemistry and Applications", Cambridge University press, 2016.

- 2 Liliya.,Bazylak.I.,Gennady.E.,Zaikov.,Haghvi.A.K.,”Polymers and Polymeric Composites” CRC Press,2014.
- 3 Lefrou.,Christine.,Fabry.,Pierre.,Poignet.,Jean-claude.,”Electrochemistry - The Basics, with examples” 2012 ., Springer.
- 4 Zaki Ahmad, Digby Macdonald, “Principles of Corrosion Engineering and Corrosion Control”, Elsevier Science, 2nd Edition 2012.
- 5 Perez, Nestor,”Electrochemistry and Corrosion Science”, Springer, 2016.
- 6 Ghazi A.Karim. “Fuels, Energy and the Environment”, CRC Press, Taylor and Francis group, 2012.

Web References:

- 1 <http://www.analyticalinstruments.in/home/index.html>
- 2 www.springer.com > Home > Chemistry > Electrochemistry
- 3 <https://www.kth.se/.../electrochem/welcome-to-the-division-of-applied-electrochemistry>
- 4 www.edx.org/
- 5 <https://www.ntnu.edu/studies/courses>
- 6 www.corrosionsource.com/

Online Resources:

- 1 nptel.ac.in/courses/105104102/hardness.htm
- 2 <https://ocw.mit.edu/courses/chemistry>
- 3 nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf
- 4 <https://alison.com> - Spectroscopic technique, Colorimetry
- 5 <https://ocw.mit.edu/courses/chemistry>
- 6 nptel.ac.in/courses/113108051

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C203.1	Remember	Online Quiz		5
C203.2	Understand	Assignment		5
C203.3	Apply	Case Study		5
C203.4	Understand	Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I	CIA-II	CIA III	
Remember	30	30	30	20
Understand	60	50	40	50
Apply	10	20	30	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course J (Problem analytical)

Pre requisites Basics of differentiation

Course Objectives:

- 1 To have a well founded knowledge on Eigen values and Eigen vectors to handle problems that arises in Engineering and Scientific fields.
- 2 To emphasize the applications of Differential and Integral calculus for solving different kinds of Mathematical modeling problems.
- 3 To give adequate exposure in applying numerical methods in predicting missing data.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C201.1 | Recall the concepts of matrices, ordinary and partial derivatives | [R] |
| C201.2 | Express a square matrix in the diagonal form | [U] |
| C201.3 | Apply the concepts of Eigen values and vectors in the field of theory of vibration, Robotic Engineering, Image Processing etc. | [AP] |
| C201.4 | Apply differentiation and integration techniques to solve engineering problems. | [AP] |
| C201.5 | Apply numerical methods to evaluate single and double integrals, interpolation of numerical data. | [AP] |

Course Contents:

MATRICES - Characteristic Equation – Eigen values and Eigen vectors of a real matrix – Properties – Cayley-Hamilton theorem (excluding proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation – Nature of Quadratic forms. **INTERPOLATION AND APPROXIMATION**

Difference Operators: Forward and Backward difference operators – Interpolation with equal intervals of arguments : Newton’s forward and backward interpolation – central interpolation using Bessel formula – Divided differences – Newton’s divided difference formula – Lagrangian Polynomials.

APPLICATIONS OF DIFFERENTIAL CALCULUS - Limits and Continuity – Differentiation of standard functions (concepts only) - Curvature in Cartesian co-ordinates – Centre of curvature – Radius of curvature – Circle of curvature - Evolutes of standard curves – Envelopes of curves in one and two parameters. **DEFINITE INTEGRALS** - Even and Odd functions – Properties of the definite integrals – simple problems – Integration by parts and Extension - Numerical Integration : Trapezoidal rule – Simpson’s 1/3 and 3/8 rules - Two and Three point Gaussian Quadrature formulae (derivations not included) . **MULTIPLE INTEGRALS** - Double integration – Cartesian and Polar coordinates – Change the order of integration – Triple integration in Cartesian coordinates – Area as double integral – Volume as triple integral (cartesian co-ordinates) – Double integrals using Trapezoidal and Simpson’s rules.

Total Hours: 60

Text Books:

- 1 Ramana B.V, “Higher Engineering Mathematics”, Tata McGraw Hill Publishing Company, New Delhi, 2011.
- 2 Jain, M.K., Iyengar, S.R.K and Jain R.K., ‘Numerical Methods for Scientific and Engineering Computation’, New Age international Publishers, New Delhi, 2012.

Reference Books:

- 1 Grewal, B. S., Higher Engineering Mathematics, 42nd Edition, Khanna Publishers, New Delhi, 2014.

- 2 Veerarajan, T., Engineering Mathematics, Tata Mc. Graw Hill Publishing Company, New Delhi, 2011.
- 3 Bali.N.P and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications, New Delhi, 2011.

Web References:

- 1 <http://www.nptel.ac.in/courses/111105035>
- 2 <http://www.nptel.ac.in/courses/122104017>
- 3 <http://nptel.ac.in/courses/122102009>
- 4 <http://nptel.ac.in/courses/111107063>

Online Resources:

- 1 <https://www.coursera.org/learn/linearalgebra2>
- 2 <https://www.coursera.org/learn/differentiation-calculus>
- 3 <https://www.coursera.org/learn/single-variable-calculus>
- 4 <https://alison.com/courses/Algebra-Functions-Expressions-and-Equations>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C201.1	Remember	Classroom or Online Quiz		5
C201.2	Understand	Class Presentation/Power point presentation		5
C201.3	Apply	Group Assignment		5
C201.4 & C201.5	Apply	Group activities		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: K (Problem Programming)

Course Objectives:

1. Extrapolate the basics about Computer and Computational Thinking.
2. Applying Systematic approach for problem solving with emphasis for Design skills
3. Understand the basics and features of Structured Programming
4. Understand the Syntax and Usage of Arrays, Strings, Functions, Pointers, Structures and unions in C.
5. Write C programs using the concepts Arrays, Strings, Functions, Pointers Structures and Unions

Course Outcomes

Upon completion of the course, students shall have ability to

C301.1 Recall syntax of various C constructs	[R]
C301.2 Select techniques to solve real world problems	[U]
C301.3 Solve problems using C constructs	[AP]
C301.4 Use pointers and arrays in programs	[AP]
C301.5 Write functions and structures in C	[AP]

Course Contents

Computational Thinking: Introduction to Computational Thinking - History of Computation and Computational Thinking – Computer Systems – Computing Environments. How Real World Information Becomes Computational Data: Information and data Converting Information into Data - Data Capacity – Data Types and Data Encoding. **Solving Problems:** Problem Definition – Logical Reasoning. System /Software Development Life Cycle: Program Development – Analysis – Design: (Algorithm - Flow Chart - Pseudo Code) – Coding – Testing – Documentation. Case Study: Raptor and Scratch Tools – Installation – Programming Environment - **INTRODUCTION TO C PROGRAMMING** - Computer Languages – Overview of C – Creating and Running Programs. Character Set – C Tokens: (Keywords -Identifiers – Constants – Strings - Operators – Special Symbols) – Data Types. Expression – Precedence and Associativity– Evaluating Expression – Type Conversion. Input and Output: Unformatted Input and Output – Formatted Input and Output. **CONTROL FLOW CONSTRUCTIONS** - Decision Making and Branching: Simple if – if else – Nested if – if else if – Conditional Expression – Switch case. Programming Examples Decision Making and Looping: for – while – do while – Nested Loop Programming Examples Jumps in Loops: goto – Continue – break - Programming Examples - **ARRAYS AND STRINGS** - Arrays: Introduction – Declaration and Initialization of Single Dimensional Arrays – Array Application -Declaration and Initialization of Two Dimensional Arrays – Multidimensional Arrays Programming Examples Character Arrays and Strings: Declaring and Initialising Strings – Reading and Writing Strings – String Manipulation Functions – Array of Strings Programming Examples - **POINTERS AND FUNCTIONS** - Pointers – Introduction – Pointer Constants – Pointer Values – Pointer Variables – Accessing Variables through Pointers – Pointer Declaration and Definition – Declaration Versus Redirection – Initialization of Pointer Variables Functions – Introduction – Needs of Function – Elements of Function – Category of Function – Recursion. **Structures** – Introduction – Declaring and Defining Structure Variables – Accessing Structure Members – Structure Initialization – Array of structure – Unions

Total Hours 45

Text Books:

1. David Riley and Kenny Hunt, “Computational Thinking for the Modern Problem Solver”, Chapman & Hall/CRC, 2014.
2. E Balagurusamy, “Programming in ANSI C”, 6E, TMH, 2012.

Reference Books:

1. Behrouz A. Forouzan & Richard F. Gilberg, “A Structured Programming Approach Using C”, 3E, Cengage Learning, 2008.
2. Ashok N. Kamthane, “Programming in C”, 2E, Pearson Education, 2012.
3. Yashavant P. Kanetkar. “Let Us C”, BPB Publications, 2011.

Web References:

1. <http://raptor.martincarlisle.com/>
2. <https://scratch.mit.edu/>

Tentative Assessment Method				
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [40 Marks]
	CIA1 [6 Marks]	CIA2 [6 Marks]	Term End Assessment [8 Marks]	
Remember	30	30	20	20
Understand	70	50	30	40
Apply	0	20	50	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: G (Theory analytical)

Pre Requisites: General Drawing

Course Objectives:

1. To develop skills for communication of concepts, ideas and design of engineering products.
2. To expose them to existing national standards related to technical drawings.

Course Outcomes

Upon completion of the course, students shall have ability to

- C301.1: Recall the basic concepts of engineering drawing. [R]
 C301.2: Interpret and Sketch the basic and intermediate geometries. [U, AP]
 C301.3: Analyse and sketch the orientation of 3D objects in 2D diagrams. [AN, AP]
 C301.4: Visualize and sketch the 3D diagram from 2D diagrams. [AP]
 C301.5: Imagine the parametric features of new products. [C]

Course Contents

Concepts and conventions: Use of drafting instruments, BIS conventions and specifications – Size, layout and folding of drawing sheets, Lettering and dimensioning. General principles of orthographic projection, First angle projection – Layout of views. **(Not for examination)**

General Plane Curves: Conic curves: ellipse, parabola and hyperbola by eccentricity method. Drawing normal and tangents to these curves, Involute- Circle, Triangle, Square, Pentagon and Hexagon, Simple Cycloid. **Projection of points, Projection of straight lines** located in the first quadrant. Determination of true lengths and true inclinations. **Projection of planes-** parallel to any one reference plane, perpendicular to any one reference plane, Inclined to any one reference plane and inclined to both reference planes.

Projection of solids (Change of position method) - Prisms, pyramids, cylinder and cone, axis perpendicular to any one reference plane. Axis parallel to both the planes. Axis inclined to any one reference plane. **Sectioning of solids-** Prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane. Obtaining the true shape of section. **Development of lateral surfaces of solids** (Prism and cylinder). Development of lateral surfaces of truncated solids (Prism and cylinder).

Orthographic projection- Conversion of isometric/pictorial in to orthographic views. Isometric drawing of simple solids- Prisms, pyramids, cylinder and cone and combined solids.

Total Hours 45

Text Books:

1. Varghese P. I., “Engineering Drawing”, McGraw Hill Education Pvt. Ltd., 2015.
2. Shah M.B. and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2010.

Reference Books:

1. Bhatt N.D and Panchal, “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2014.
2. Venugopal K. and Prabhu Raja V, “Engineering Graphics”, New Age Int. (P) Limited, 2011.

Web References:

1. [http://nptel.ac.in/courses/112103019/Engineering drawing](http://nptel.ac.in/courses/112103019/Engineering%20drawing)
2. <http://pioneer.netserv.chula.ac.th/~kjiapon/self-practice.html>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C301.1	Remember	Quiz	4	
C301.2	Understand	Group Assignment	4	
C301.3	Apply	Group Assignment	4	
C301.4	Analyze	Simulation	4	
C301.5	Create	Group Assignment	4	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 6 marks	
Remember	30	0	10	10
Understand	30	30	20	20
Apply	40	40	40	50
Analyse	0	30	30	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course :M (Practical applicaton)

Co requisites :Nil

Course Objectives:

- 1 To provide exposure to the students with hands-on experience on scientific equipment's.
- 2 Enhancement of student in developing analytical skills through instrumental analysis.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|-----|
| C251.1 | The students will be conversant with hands-on knowledge in the quantitative chemical analysis of water quality related parameters | [U] |
| C251.2 | handle physics instruments like spectrometer, travelling microscope and solar cell | [U] |

Course Contents:

Lab Component

- | | | |
|----|--|-----|
| 1 | i. Determination of laser parameters – Wavelength and angle of divergence | [E] |
| | ii. Particle size determination using diode laser. | |
| | iii. Determination of acceptance angle in an optical fiber | |
| 2 | Determination of Band gap of a Semi conducting material. | [E] |
| 3 | Determination wavelength of mercury spectrum - spectrometer | [E] |
| 4 | Determination of thermal conductivity of a bad conductor – Lee's disc method. | [E] |
| 5 | Determination of coefficient of viscosity of liquid – Poiseuille's Method | [E] |
| 6 | Determination of Young's modulus by cantilever method | [E] |
| 7 | Determination the specific resistance of the given coil – Carey Foster Bridge. | [E] |
| 8 | Determination of efficiency of a solar cell. | [E] |
| 9 | Determination of Young's modulus of the materials – Uniform bending | [E] |
| 10 | Determination of lattice constant X-ray powder photograph. | [E] |
| 11 | Determination of Rigidity modulus of a wire - Torsion Pendulum | [E] |
| 12 | Determination the dispersive power of a prism – Spectrometer. | [E] |
| 13 | Determination of strength of given acid by pH meter. | [E] |
| 14 | Conductometric titration of strong acid with strong base. | [E] |
| 15 | Determination of strength of acids in a mixture (HCl&CH ₃ COOH) using conductivity meter. | [E] |
| 16 | Potentiometric titration of Ferrous ion using Potassium dichromate. | [E] |
| 17 | Determination of Single Electrode Potential of an electrode. | [E] |
| 18 | Estimation of Iron (II) content by Spectrophotometer. | [E] |
| 19 | Determination of hardness of water by EDTA method | [E] |
| 20 | Estimation of Calcium ions and Magnesium ions by EDTA method. | [E] |
| 21 | Estimation of alkalinity of water sample. | [E] |
| 22 | Determination of Chloride in water by Argent metric method. | [E] |

- 23 Determination of Dissolved Oxygen in waste water using Winkler's titrimetry method. [E]
- 24 Estimation of Copper content of the given solution by EDTA method. [E]

Total Hours: 60

Reference Books:

- 1 Dr. G. Senthilkumar "Physics Laboratory Manual I and II (2008 & 2013)" VRB publishers Pvt Ltd., 2013
- 2 Dr. V. Veeraiyan "Chemistry Laboratory manual I and II (2011) VRB publishers Pvt Ltd.,
- 3 Dr. Magudeswaran, PN Dr. R. Ramachandran "Engineering chemistry laboratory Manual" 2004

Web References:

- 1 <http://nptel.ac.in/courses>
- 2 www.iitg.ernet.in/scifac
- 3 vlab.co.in

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [40 marks] (in %)	End Semester Examination [60 marks] (in %)
Remember	20	20
Understand	70	70
Apply	10	10
Analyse	0	0
Evaluate	0	0
Create	0	0

Nature of Course:**Course Objectives:**

1. Be exposed to problem solving techniques and to generate flow charts using Raptor Tool.
2. Be exposed to Animation, gaming and application creation using Scratch Tool
3. Be Familiar with Programming in C
4. To apply the various features of C

Course Outcomes

Upon completion of the course, students shall have ability to

- | | |
|---|------|
| C351.1 Understand the flow charts using raptor tool. | [U] |
| C351.2 Select appropriate data types and control structures for solving a given problem. | [AP] |
| C351.3 Apply and practice logical ability to solve simple problems. | [AP] |
| C351.4 Demonstrate 'C' programs using arrays, strings. | [AP] |
| C351.5 Illustrate the representation of Pointers, Functions and Structure. | [AN] |

List Of Experiments

1. Draw Flowchart using Raptor Tool
 - Simple Flow Chart
 - Using Decision Making
 - Using Pre Test Loop
 - Using Post Test Loop
2. Create Animation / Gaming /Application using Scratch Tool
3. Program to process Data types, formatting inputs and outputs.
4. Program using Operators and Expression Evaluation
5. Program using Decision Making
6. Program using Looping Statements
7. Program using Single and Two Dimensional Arrays
8. Program for String manipulation
9. Program using Call by Value and Call by Reference.
10. Program using Recursive Function.
11. Program using Array of Structures

Total Hours 30

Text Books:

1. David Riley and Kenny Hunt, "Computational Thinking for the Modern Problem Solver", Chapman & Hall/CRC, 2014.
2. E Balagurusamy, "Programming in ANSI C", 6E, TMH, 2012.

Reference Books:

1. Behrouz A. Forouzan & Richard F. Gilberg, "A Structured Programming Approach Using C", 3E, Cengage Learning, 2008.
2. Ashok N. Kamthane, "Programming in C", 2E, Pearson Education, 2012.

Web References:

1. <http://raptor.martincarlisle.com/>
2. <https://scratch.mit.edu/>

Tentative Assessment Method				
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [40 Marks]
	CIA1 [6 Marks]	CIA2 [6 Marks]	Term End Assessment [8 Marks]	
Remember				
Understand	20	20	20	20
Apply	40	40	40	40
Analyse	20	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

15UA351 COMPUTER AIDED DRAFTING AND MODELING LABORATORY**0/0/3/2****Nature of Course:** M (Practical application)**Co Requisites:** Basic drawing and Computer Knowledge**Course Objectives:**

1. To impart fundamental knowledge and basic skills to the students in drafting and modelling techniques.
2. Ability to create 2D and 3D models in relevance to the given drawing using modelling software.

Course Outcomes

C351.1: Describe CAD softwares and its usage.[R, U]

C351.2: Apply and practice the software packers for drafting and modelling.[Ap]

C351.3: Ability to create 2D and 3D models of engineering components.[Ap]

Course Contents

1.	Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.	R, U
2.	Drawing of a Title Block with necessary text and projection symbol.	Ap
3.	Drawing of curves like parabola, spiral, involutes using B- spline or cubic spline.	Ap
4.	Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.	Ap
5.	Drawing front view, top view and side view of objects from the given pictorial views	Ap
6.	(eg. V-block, Base of a mixie, Simple stool, Objects with hole and curves).	Ap
7.	Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.)	Ap
8.	Drawing of a simple steel truss.	Ap
9.	Drawing isometric projection of simple objects.	Ap
10.	Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.	Ap

Total Hours 45**Reference Books:**

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2014.
2. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2010.
3. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2012.

Web References:

1. <http://nptel.ac.in/courses/112102101/>
2. www.solidworks.com

Blooms Taxonomy based Assessment Pattern:

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks](in %)	End Semester Examination [40 marks](in %)
Remember	30	30
Understand	30	30
Apply	40	40
Analyze	0	0
Evaluate	0	0
Create	0	0

SEMESTER – II

15UH102

COMMUNICATION SKILLS II

2/0/2/3

Nature of Course : D (Theory application)

Pre requisites : Nil

Course Objectives:

- 1 To develop the prominence of listening and reading practices using authentic business vocabulary.
- 2 To instil analytical thinking and logical reasoning to use LSRW skills in Business related situations.
- 3 To urge the need of effective communication in corporate sector with Business English.

Course Outcomes:

Upon completion of the course, students shall have ability to

- C102.1 Remember LSRW skills and employ cross-cultural communication using authentic business vocabulary.
- C102.2 Understand and apply business English in working environment.
- C102.3 Analyse and apply business English effectively.

Course Contents:

IMPROVING COMMUNICATION- Introduction- Talking about teamwork- Making Arrangements- Improving Communication in spoken Language. Taking and Leaving Voice mail messages (Present Tenses, Past Tense and Present Perfect)-Talking about Business Hotel (Speaking Activity). Talking about Corporate Hospitality – Formal and Informal Language- Making accepting and declining invitations (Auxiliary Verbs, Countable or Uncountable Nouns). Focus on language –Definitions-Extended Definitions. **INTERPERSONAL COMMUNICATION-**Talking about orders – Clarity in Written Language- Phone and Letter Phrases. Talking about Company Finances- Conditional 1 and 2- Managing Cash Flow (Intention and arrangements. Conditional 1 and 2)- Talking about Brands and Marketing – Ethical Banking. Talking about Public Relations – Organizing a PR Event- Describing Duties and Responsibilities (Future Tense and Articles). Reported speech-Modal verbs. Active and Passive, impersonal passive voice. **BUSINESS ENGLISH-** Talking about relocation- Report Phrases- Talking about Similarity and Difference. Giving Directions – Asking for Information and Making Suggestions- Talking about Location (Comparatives and Superlatives, Participles) - Talking about Company Performance- Describing Trends- Describing Cause and Effect. Talking about Environmental Impact- Discussing Green Issues- Language of Presentations (Adjectives and Adverbs, Determiners). Homophones- Homonyms- Acronyms- Abbreviations- British and American words.

CORPORATE COMMUNICATION Talking About Health and Safety- Expressing Obligation- Discussing Regulations.Talking about personnel Problems- Passives- Talking about Problem at Work (Modal Verbs, Passives). Talking about Expenses Claims- Talking about Air Travel (Relative Pronouns, Indirect Questions)-

Transcoding.

WORK

ENVIRONMENT-

Talking about Staff Benefits- Talking about Appraisal Systems (Gerunds and Infinitives, Reported Speech).Talking about Marketing Disasters- Expressing hypothetical Situations- Talking about entering Foreign Markets(Conditional 3 , Grammar review).Letter for calling quotations, Replying for quotations- Placing an order and complaint.

Total Hours:45

Text Books:

1. Wood, Ian,Paul Sanderson, Anne Williams with Marjorie Rosenberg, Pass Cambridge BECVantage, Cengage learning. Second Edition. 2014.
2. Dr Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited,2005

Reference Books:

1. Whitby, Norman. Cambridge University Press- Students Book. 2013.
2. Jawahar, Jewelcy, Rathna P, English Work book, VRB Publications Pvt Ltd,2006.
Gunasekaran S, 'A Text and Workbook of Technical English I', United Global Publishers, June 2010.

Web References:

1. <http://www.cambridgeindia.org>
2. <http://www.cambridgeenglish.org/exams/business-certificates/business-vantage>

Online Resources:

1. <https://www.coursera.org/specializations/business-english>
2. <http://www.academiccourses.com/Courses/English/Business-English>

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C102.1	Remember	Online Quiz		5
C102.2	Understand	Presentation		5
C102.3	Apply	Group Discussion		5
C102.2	Apply	Debate		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I	CIA-II	CIA III	
Remember	30	20	20	20
Understand	30	30	30	30
Apply	40	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course J (Problem analytical)
Pre requisites Basics of differentiation

Course Objectives:

- 1 To understand the concept of Differential and Integral calculus for Vector valued and Complex valued functions and its applications.
- 2 To understand Laplace transforms techniques.
- 3 To understand various Numerical techniques for solving Transcendental and Algebraic equations.

Course Outcomes:**Upon completion of the course, students shall have ability to**

- | | | |
|--------|---|------|
| C204.1 | Recall the concepts of ordinary and partial derivatives | [R] |
| C204.2 | Solve Ordinary Differential Equations analytically and numerically, which are very useful in wave and heat equations, fluid flow problems in Engineering. | [U] |
| C204.3 | Apply the concept of Green's, Gauss and Stokes's theorems which arise in Fluid mechanics, Thermal Engineering and Aerodynamics. | [AP] |
| C204.4 | Apply problem solving techniques in differential calculus, which come across in wide range of Engineering and Scientific problems. | [AP] |
| C204.5 | Apply Laplace transform as a tool for solving Engineering problems. | [AP] |

Course Contents:

ORDINARY DIFFERENTIAL EQUATIONS - Higher order linear differential equations with constant coefficients – Cauchy's and Legendre's linear equations – Finite difference solution of second order ordinary differential equations by Euler and Modified Euler's methods – fourth order Runge-Kutta methods for solving first order differential equations. **VECTOR CALCULUS** - Gradient of a scalar point function – Angle between the surfaces – Directional derivatives – Divergence and Curl of a vector point functions – Irrotational and Solenoidal vector fields – Vector integration: Green's theorem in a plane – Gauss divergence theorem – Stokes' theorem(excluding proofs) – Simple Applications involving cubes and rectangular parallelepiped. **COMPLEX VARIABLES** - Functions of complex variable – Analytic functions – Necessary and sufficient conditions – Harmonic Function – construction of Analytic functions by Milne – Thomson method – Laurent's Series and Singularities – Cauchy's theorem – Cauchy's integral formula (Concept only) – residues – Calculus of Residues – Cauchy residue theorem. **LAPLACE TRANSFORM** - Laplace transform – Conditions for existence – Transform of elementary functions – First shifting theorem – Laplace transforms of $tf(t)$ and $\frac{f(t)}{t}$ - Transform of derivatives and integrals – Inverse Laplace transforms by Method of Partial fractions – Inverse Laplace transforms by Convolution Method – Laplace transforms of Periodic functions. **NUMERICAL SOLUTION OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS** - Solution of non linear equations by Regula-Falsi Method – Newton-Raphson method – solution of linear systems of equations by direct methods – Gauss Elimination and Gauss-Jordan Methods – Indirect method – Gauss-Seidel Method – Eigen values by Power Method – Jacobi Method.

Total Hours: 60

Text Books:

- 1 Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2011.
- 2 N.P.Bali, Dr. Manish Goyal, 'Engineering Mathematics' Eighth Edition, Laxmi Publications (P) Ltd, 2011.

Reference Books:

- 1 Grewal, B. S., Higher Engineering Mathematics, 42nd Edition, Khanna Publishers, New Delhi, 2014.
- 2 Veerarajan, T., Engineering Mathematics, Tata Mc. Graw Hill Publishing Company, New Delhi, 2011.
- 3 Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2006.

Web References:

- 1 <http://www.nptel.ac.in/courses/111105035>
- 2 <http://www.nptel.ac.in/courses/122104017>
- 3 <http://nptel.ac.in/courses/122102009>
- 4 <http://nptel.ac.in/courses/111107063>

Online Resources:

- 1 <https://www.coursera.org/learn/linearalgebra2>
- 2 <https://www.coursera.org/learn/differentiation-calculus>
- 3 <https://www.coursera.org/learn/single-variable-calculus>
- 4 <https://alison.com/courses/Algebra-Functions-Expressions-and-Equations>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C204.1	Remember	Classroom or Online Quiz		5
C204.2	Understand	Class Presentation/Power point presentation		5
C204.3	Apply	Group Assignment		5
C204.4	Apply	Group activities		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: G (Theory analytical)

Pre Requisites: Fundamentals of Basic mathematics and Physics.

Course Objectives:

1. To make the students understand the vector and scalar representation of forces and Moments and the static equilibrium of particles and rigid bodies.
2. To understand the effect of friction on equilibrium, laws of motion, kinematics of motion and the interrelationship.
3. To make the students understand the properties of surfaces and solids, prediction of behaviour of particles and rigid bodies under motion.

Course Outcomes

Course Outcomes

Upon completion of the course, students shall have ability to

C302.1. Define and illustrate the basic concepts of force system [R][U]

C302.2. Identify the resultant force, moment and geometrical properties of 2D and 3D objects [AP]

C302.3. Examine the resistance force of particles and objects for Impending Motion [A]

C302.4. Determine the Displacement, velocity and acceleration of particles and objects. [E]

Course Contents with Course Outcomes/Blooms Taxonomy/Tentative Assessment

Method

Basics and Equilibrium of Particles : Introduction-Units and Dimensions-Laws of Mechanics- Parallelogram Law of forces - principle of transmissibility Resolution and Resultant of Coplanar concurrent Forces Equilibrium of a particle in two dimensions- Free Body Diagram- Lamis Theorem. Forces In Space-Resultant and Equilibrium of particles in space (vector approach).

Equilibrium of rigid bodies & Frictional force : Moment of a force -Varignon's theorem - Equivalent system of forces - Reduction of system of forces into single force and couple Free body diagram and type of supports and reaction - Equilibrium of rigid bodies in two dimensions

Properties of Surfaces and Solids : Centroid of Common Shapes of Area-Centroid And Area Moment of Inertia of Composite Areas (Rectangle, triangle, circle, quarter and semicircle) by using Standard formula. Pappus - Guldinus Theorem only - Centre of gravity of 3D composite bodies by using standard formula Parallel axis theorem and perpendicular axis theorem, Polar moment of inertia - Mass Moment of Inertia of Composite Bodies (Prismatic, Cylindrical and conical solids only).

DYNAMICS OF PARTICLES : Displacements, Velocity and acceleration of uniform and uniformly accelerated rectilinear motion of particles , Motion of particles under Gravity - Relative motion analysis Curvilinear motion- Tangential and normal components of acceleration - Motion of projectile Newton's laws of motion- D'Alembert's Principle - Work Energy Equation- Impulse and Momentum Impact of elastic bodies- Direct central impact.

Dynamics of Rigid Bodies: Types of Friction- Coulombs Law of Dry Friction - Impending motion, Angle of repose - Simple contact friction Ladder friction. Kinematics of rigid bodies - Translation and Rotation of Rigid Bodies - Fixed axis rotation- Velocity - General Plane motion - absolute and relative velocity and acceleration of sliding rod and slider crank mechanism.

Total Hours 45

Text Books:

1. F.P. Beer, and Jr. E.R Johnston, Vector Mechanics for Engineers – Statics and Dynamics, McGraw Hill Education, New Delhi, 2015.
2. A.K Dhiman, P.Dhiman, D.C. Kulshreshtha, Engineering Mechanics-Statics and Dynamics, McGraw Hill Education, 2015.

Reference Books:

1. N.Kottiswaran, Engineering Mechanics - Statics and Dynamics, Sri Balaji Publications- 2013.
2. S. Rajasekaran and G. Sankarasubramanian, Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt. Ltd., New Delhi, 2009.
3. J. L. Meriam and Craige, “Engineering Mechanics statics and dynamics”, John Willey and Son’s publication 8th edition.2011
4. D.S.Kumar, “Engineering Mechanics”, S.K.Kataria& Sons Publications-2012.
5. Irving H. Shames, Engineering Mechanics - Statics and Dynamics, Pearson Education Asia Pvt. Ltd., 2011.
6. Timoshenko.S, “Engineering Mechanics”, McGraw Hill Education, 2008.

Web References:

1. [http://nptel.ac.in/courses/112103019/Engineering drawing.](http://nptel.ac.in/courses/112103019/Engineering%20drawing)
2. <http://pioneer.netserv.chula.ac.th/~kjiapon/self-practice.html>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C201.1	Remember/ Understand	Quiz		5
C201.2	Apply	Group Assignment		5
C201.3	Analyze	Tutorial		5
C201.4	Evaluate	Group Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 6 marks	
Remember	30	0	10	10
Understand	30	30	20	20
Apply	40	40	40	50
Analyse	0	30	30	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : M (Theory)
Pre requisites : 15 ME 101 Engineering Drawing
Course Objectives:

- 1 To provide the knowledge of drawing practices for common machine components,
 - 2 blue prints and assembly drawings.
- To impart fundamental knowledge about Geometric Dimensioning and Tolerance

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|------|
| C303.1 | Remember the conventional representations | [R] |
| C303.2 | Understand the concept of Component Drawing and Machine drawing | [U] |
| C303.3 | Sketch the representations of fasteners . | [AP] |
| C303.4 | Imagine and draw the assembled views | [C] |

Course Contents:

MACHINE DRAWING CONVENTIONS AND SCREWS Introduction to machine drawing. Code of practice for engineering drawing-conventional representation of details, Conventional representation of machine components- leaf spring, leaf spring with eyes, coil spring (tension and compression), disc spring, spiral spring, splined shaft, serrated shaft, square end of shaft, ball and roller bearing, spur gearing, bevel gearing ,worm and worm wheel, straight knurling, diamond knurling. Drawing hexagonal nut and square nut, hexagonal headed bolt, square headed bolt and washer.

PERMANENT FASTENINGS Rivets: Riveted Joint- Form and properties of snap or cup head rivet, dimensions of rivet joint, Type of riveted joints, single riveted lap joint, double riveted (chain) lap joint ,double riveted (zigzag) lap joint, single riveted (single strap) butt joint, single riveted (double straps) butt joint. Welds: Types of welds and welded joints, edge preparation, specifications, and representation of welds on drawings.

FITS/TOLERANCES AND SURFACE FINISH SYMBOLS Limits, fits and tolerances-need, types, representation of tolerances on drawing, calculation of minimum and maximum clearances and allowances, Geometric tolerance-uses, types of form and position tolerances, symbols, method of indicating geometric tolerances on part drawings. Surface finish symbols- methods of indicating the surface roughness. Blue print reading exercises **SECTIONAL VIEW AND FORM REPRESENTATION** Introduction, cutting plane line, type of sectional views-full section, half section, partial or broken section, revolved section, removed section, offset section, sectioning conventions-spokes, web, rib, shaft, pipes, different types of holes, hatching or section lines, conventions of section lines for different metals and materials, Representation of - Straightness, flatness, circularity, cylindricity, parallelism, perpendicularity, angularity, concentricity and coaxiality, symmetry, radial run out and axial run out. **ASSEMBLY CONCEPTS AND DRAWINGS** Methods and concepts of assemblies-assembly requirements, Bill of materials. Methods of arresting motion of a member in an assembly. Assembly and dismantling exercise of a typical assembly with emphasis on assembly sequence and appropriate fits. Preparation of assembly drawing and bill of materials of following assemblies from its disassembled views: Cotter joint-Sleeve & Cotter Joint, Socket and Spigot joint, Knuckle joint, Foot step bearing, Plummer block, Flange coupling, Screw Jack.

Total Hours: 60

Text Books:

- 1 N. D. Bhatt, V.M. Panchal "Machine Drawing" charotar Publishing House. 2015.
- 2 K. R. Gopalakrishnan, "Machine Drawing", Subhas Publication, 2014

Reference Books:

- 1 K.L. Narayana, P.Kannaiah, & K.Venkata Reddy, "Machine Drawing", New Age International Publishers, 2013.
- 2 Ajeet Singh, "Machine Drawing" Tata Mc-Graw- Hill, 2012

Web References:

- 1 <http://www.nptel.ac.in>
- 2 <http://www.sigmetrix.com>

Online Resources:

- 1 <https://www.universalclass.com/i/crn/8683.htm>
- 2 <https://www.machinedesignonline.com>

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	25	25
Apply	40	40
Analyse	0	0
Evaluate	0	0
Create	25	25

Nature of Course : C (Theory concepts)

Pre requisites : Engineering Physics

Course Objectives:

- 1 To impart knowledge on phase diagrams, use of phase diagrams and application of phase diagrams.
- 2 To understand the heat treatment processes and makes use of it to improve the materials properties.
- 3 To demonstrate the various testing of materials.
- 4 To impart knowledge on various metals and non-metals and its applications

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C304.1 | List the different materials and its properties, application | [R] |
| C304.2 | Understand the phase diagrams, phase rule and lever rule | [U] |
| C304.3 | Apply the heat treatment processes to modify the properties | [AP] |
| C304.4 | Examine the properties of materials | [Ap] |

Course Contents:

INTRODUCTION AND CRYSTAL STRUCTURE- Introduction to materials science – classification of engineering materials- selection of materials - Levels of structure. Crystal structure – fundamental concepts - unit cells – crystal systems – SC, BCC, FCC and HCP- Structure determination by X-Ray diffraction.- Crystal defects – point, line and surface defects- Grains and grain boundaries - Grain size measurement -ASTM grain size number- Metallography - Preparation of specimen for micro examination- Metallurgical microscopes – Scanning electron microscope- **CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS-** Constitution of alloys – solid solutions. Phase diagrams – cooling curves- phase rule- binary phase diagrams - Isomorphous, eutectic, eutectoid and peritectic reactions with examples- micro structural changes during cooling – Lever rule – application of lever rule- Iron and iron carbide phase diagram- structures-critical temperatures- cooling of steel- Classification of steel- effect of Si, Mn, P and S. **HEAT TREATMENT OF STEEL-** Definition – Full annealing, stress relief, recrystallisation and spheroidizing –normalising, hardening and tempering of steel- Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram, CCR, Austempering and martempering- Hardenability, Jominy end quench test- Case hardening - carburising, nitriding, cyaniding, carbonitriding, flame and induction hardening. **MECHANICAL PROPERTIES AND TESTING-** Elastic and plastic (mechanical) properties of materials - deformation - plastic deformation - slip and twinning- tensile test - stress –strain curve for ductile and brittle materials - hardness tests- Brinell, Vickers and Rockwell fracture - types of fracture - impact test - Izod and Charpy, Fatigue test - creep test. **METALS AND NON METALS-** Ferrous materials – steel – alloy steel - effect of alloying elements on steel (Ni, Cr, Mo, V, Ti & W) stainless steel- tool steels – HSLA - maraging steels. Cast Irons - Grey, White malleable, spheroidal – Graphite, Alloy cast irons. Non ferrous materials - Copper and Copper alloys - Brass, Bronze and Cupronickel Aluminum and Al alloys –Al-Cu alloys, Al-Si-Mg alloys, Al-Zn alloys, Bearing alloys – introduction to polymer, ceramics and composites.

Total Hours: 45

Text Books:

- 1 Sidney.H Avner , “Introduction to Physical Metallurgy”, McGraw Hill international edition 1974.
- 2 R.Balasubramanian , “Callister’s Material science and engineering”, Wiley india pvt.ltd, 2013

Reference Books:

- 1 Askeland, Fulay, Wright, Balani , “The science of Engineering and Materials”, Cengage learning, 2012
- 2 Kenneth G Budinski and Michael K Budinski , “Engineering materials properties and selection”, PHI learning private limited, 2012.

Web References:

- 1 nptel.iitm.ac.in/courses/113105028/
- 2 www.sciencedaily.com/articles/m/metallurgy.html

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	Bloom's Level	Assessment Component	Marks
C304.1	Remembering	Quiz	4
C304.2	Understand	Assignment	6
C304.3	Apply	Seminar	5
C304.4	Apply	Seminar	5
Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	Continuous Assessment		End Semester Examination [60 marks]
	CIA1 [10 marks]	CIA2 [10 marks]	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	0	0	0
Evaluate	0	0	0
Create	0	0	0

Nature of Course: G (Theory analytical)

Pre Requisites: Basics of Physics and Chemistry

Course Objectives:

- To make the students learn various techniques available to make shapes and design in various Materials
- To make students understand requirements and methodologies to be followed in casting, fabrication and forming of engineering materials

Course Outcomes

Upon completion of the course, students shall have ability to

C305.1: Recall the concepts of basic manufacturing processes like casting, welding, forming and Plastic moulding [R] .

C305.2: Elaborate the working principles and properties of arc, gas, solid state and resistance welding processes [U]

C305.3: Explore the defects in various manufacturing processes [Ap]

C305.4 : Compare the characteristics of various manufacturing processes [A]

Course Contents

METAL CASTING PROCESSES

Sand casting – Sand moulds - Type of patterns –Pattern materials – Pattern allowances – Types of Moulding sand – Properties - Core making, Methods of Sand testing – Moulding machines – Types of moulding machines, Melting furnaces –Cupola – Electric furnaces, Importance of Special casting processes – Shell, Investment casting – Pressure die casting – Centrifugal casting, Sand Casting defects – Inspections methods.

FABRICATION PROCESSES

Fusion welding processes – Types of Gas welding – Equipments used – Flame characteristics – Filler and Flux materials - Arc welding equipments - Electrodes – Coating and specifications – Principles of Resistance welding – Spot/butt, seam welding – Gas metal arc welding – Flux cored – Submerged arc welding – Tig welding, Principle and application of special welding processes - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding, Weld defects- Brazing and soldering process.

BULK DEFORMATION PROCESSES

Hot working and cold working of metals – Forging processes – Open and close die forging – Characteristics of the process- Types of Forging Machines – Typical forging operations- Rolling of metals – Flat strip rolling – Types of Rolling mills – Shape rolling operations – Tube piercing – Defects in rolled partsm Principles of Extrusion – Types of Extrusion –Principle of rod and wire drawing – Equipments used.

SHEET METAL FORMING PROCESSES

Sheet metal characteristics - Typical shearing operations, bending and drawing operations – Stretch forming operations, Formability of sheet metal – Test methods, Working principle and application of special forming processes - Hydro forming – Rubber pad forming – Metal spinning – Explosive forming – Magnetic pulse forming –Peen forming – Super plastic forming–Process characteristics

FORMING AND SHAPING OF PLASTICS

Types of plastics - Characteristics of the forming and shaping processes, Moulding of Thermoplastics – Working principles and typical applications of - Injection moulding – Plunger and screw machines – Blow moulding – Rotational moulding, Extrusion - Typical industrial applications, Thermoforming – Processing of Thermosets – Working principles and typical applications - Compression moulding – Transfer moulding – Bonding of Thermoplastics – Fusion and solvent methods.

Total Hours 45

TEXT BOOKS:

- A. Hajra Choudhury, "Elements of Workshop Technology", Vol. I & II, Media Promoters Pvt Ltd., 2009.
- B. P. N. Rao, "Manufacturing Technology vol I", Tata-McGraw-Hill Publishing Limited, 2010.

REFERENCES:

- C. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson Education, Inc. 2009 (Second Indian Reprint).
- D. Begman, "Manufacturing Process", John Wiley & Sons, VIII Edition, 2005.
- E. Radhakrishnan, "Manufacturing Technology I", Scitech Publications Pvt Ltd, 2010

Web References:

1. www.nptel.ac.in
2. www.sme.org
3. <https://www.coursera.org/learn/3d-printing-revolution>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C305.1	Remember	Group Assignment		5
C305.2	Understand	Group Assignment		5
C305.3	Apply	Technical seminar		5
C305.4	Analyze	Technical seminar		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 6 marks	
Remember	40	40	40	40
Understand	50	50	40	40
Apply	0	0	10	10
Analyse	10	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course:**Course Objectives:**

1. Revisiting the C Basics
 2. Study the basic concepts of Pointers and its advanced usage.
 3. To understand the concepts of Structures and Files
- Understand the Preprocessor, Command Line Arguments and Variable Length Argument List.

Course Outcomes

Upon completion of the course, students shall have ability to

- | | | |
|---------------|---|------|
| C302.1 | Understand the basics of C Programming Constructs and Apply C Program for Problems. | [R] |
| C302.2 | Apply Pointers for effective memory access. | [U] |
| C302.3 | Illustrate the concepts of Structures, Unions and Bit Fields | [AP] |
| C302.4 | Apply Sequential and Random File Access. | [AP] |
| C302.5 | Understand and illustrate the concepts of Preprocessors, Command Line | [AP] |

Course Contents

RECAP OF C BASICS :Overview of C Fundamentals - Input and Output - Decision Making and Branching - Decision Making and Looping - Jumps in Loops – Arrays - Character Arrays and Strings – Functions. **POINTERS** : Pointers – Introduction – Pointer for Inter Function Communication – Pointers to Pointers – Compatibility – Lvalue and Rvalue Arrays and Pointes – Pointer Arithmetic and Arrays – Passing an Array to a Function – Array of Pointers Functions Returning Pointers - Pointer to an Array - Pointers and Strings – Array of Pointers to Strings - Null Pointer –Dangling Pointer Pointer to void – Pointer to Function – Type Qualifier – constants – volatile – restrict Memory Allocation: Static Memory Allocation – Dynamic Memory Allocation - Dynamic Memory Allocation Functions. **STRUCTURES**: The Type Definition (typedef) – Enumerated Types – Structure – Structure Type Definition Initialization – Accessing Structures. Operation on Structures – Complex Structures Structures and Functions – Sending the Whole Structure – Passing Structure Through Pointers – Self Referential Structure Unions – Bit Fields Programming Application. **FILE MANAGEMENT**: Introduction –Text versus Binary Streams – State of a File - Defining and Opening a File – Closing a File Input/output Operations on Files – Error Handling During I/O Operations Standard Library Functions for Files Random Access to Files File Program Examples. **ADVANCED FEATURES** Bitwise Operators: Exact Size Integer Types – Logical Bitwise Operators – Shift Operators – Masks. Preprocessor Commands – File Inclusion – Macro Definition – Conditional Compilation – Other Commands. Command Line Arguments: Defining Command Line Arguments – Using Command Line Arguments. Variable Length Argument List Program Development.

Total Hours 45

Text Books:

1. Behrouz A. Forouzan & Richard F. Gilberg, “A Structured Programming Approach Using C”, 3E, Cengage Learning, 2008.
2. E Balagurusamy, “Programming in ANSI C”, 6E, TMH, 2012.

Reference Books:

1. Yashavant Kanetkar, “Understanding Pointer in C”, 3E, BPB Publication, 2011..
2. Stephen G. Kochan “Programming in C”,Fourthedition,Addison Wesley publishing ,August 2014.

Web References:

1. <http://www.cprogramming.com/tutorial/c/lesson17.html>
2. http://www.tutorialspoint.com/cprogramming/c_memory_management.htm
3. <http://www.c4learn.com/c-programming/c-dangling-pointer-causes/>

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [40 Marks]
	CIA1 [6 Marks]	CIA2 [6 Marks]	Term End Assessment [8 Marks]	
Remember	30	30	20	20
Understand	70	50	30	40
Apply	0	20	50	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: M (Laboratory Application)

Pre Requisites: NIL

Course Objectives:

1. To learn the use of basic hand tools and
2. To know the need for safety in work place
3. To gain hands on experience on Carpentry, Fitting, Sheet metal, Plumbing, Arc welding, Foundry, basic electrical devices, meters and Electronics devices and meters.

Course Outcomes

C352.1: Make simple components like tray, cylinder, funnel etc.

C352.2: Make simple lap, butt and tee joints using arc welding equipments.

C352.3: Prepare simple wooden joints using wood working tools.

C352.4: Prepare pipe connections and identify the various components used in plumbing.

C352.5: Learn to make green sand mould and simple operation in hot forging.

C352.6: Learn to make plastic caps and machining process

Course Contents with Course Outcomes/Blooms Taxonomy/Tentative Assessment Method

Sheet metal forming, Arc, TIG and MIG Welding, carpentry. **(C304.1,C304.2, C304.3/App/ Term Review)**

Plumbing, Sand moulding, forging and Plastic forming process. **(C304.4 ,C304.5,C304.6/ App, C, R/Term Review)**

Name of the Experiment	Course Outcome	Level of Bloom's Taxonomy	
Forming of simple objects using sheet metal.	C01	Apply	
Making Butt Joints, Lap Joints and Tee Joints using Arc welding.	C02	Apply	
Making carpentry joints by using power tools.	C03	Apply	
Making a connection from a main pipe line to a wash basin using PVC pipes, this includes valves and taps.	C04	Create	
Demonstration of green sand mould using solid pattern.	C05	Remember	
Demonstration of simple bending operation using hot forging operation.	C05	Remember	
Study of making bottle caps using thermoplastic forming	C01	Remember	
Study of introduction to Turning and Drilling process	C01	Remember	
	Total Hours		60

Text Books:

1. Workshop Technology W. A. J. Chapman , CBS, 2007
2. Elements of Workshop Technology, S. K. Hajra Choudhury, Media Promoters & Publishers Ltd

Reference Books:

1. Basics of Workshop Practice, R. S. Kurumi, J. K. Gupta, S.Chand publishing, 2011
2. Workshop Technology, S. K. Garg, Laxmi Publications, 2009

Web References:

1. nptel.ac.in
2. <http://www.tech.plym.ac.uk>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)**Blooms Taxonomy based Assessment Pattern:**

Bloom's Category	Continuous Assessment Tests		Semester End Examination
	Mid Sem Review	Term Review	
Remember	0	10	10
Understand	0	0	0
Apply	100	70	70
Analyse	0	0	0
Evaluate	0	0	0
Create	0	20	20

Nature of Course: M (Practical application)

Co Requisites: Engineering drawing and Computer Knowledge

Course Objectives:

1. To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modelling software's.
2. Ability to assemble these parts in industry-standard plan form and produce plotted hardcopies ready for distribution..

Course Outcomes

- C353.1: Describe CAD Introduction. [R]
 C353.2: Recall the basic syntax and commands of CAD software and engineering drawing. [R]
 C353.3: Construct the given component in 3D modelling by using Extrude, Revolve, Sweep, etc and Variation sweep, Loft, etc . [Ap]
 C353.4: Prepare Surface modeling, Feature manipulation, Assembly and Drafting Layouts. [Ap]

Course Contents

- | | |
|--|------|
| 1. Introduction to 2D and 3D drawings. | R, U |
| 2. Engine Parts like Stuffing box /Cross head /Connecting rod | Ap |
| 3. Machine tool parts like Tool post / Tail-Stock / Machine vice | Ap |
| 4. Valves like Gate valve / Non-Return valve | Ap |
| 5. Joints like Spocket and spigot joint / Knuckle joint | Ap |
| 6. Couplings like Universal coupling / Flange coupling | Ap |
| 7. Bearing blocks like Plummer block / Swivel bearing /Foot step bearing | Ap |
| 8. Other related parts like Screw jack , Simple eccentric, etc | Ap |

Total Hours 45

Reference Books:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2014.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2010.
3. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2012.

Web References:

1. <http://nptel.ac.in/courses/112102101/>
2. www.solidworks.com

Blooms Taxonomy based Assessment Pattern:

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks](in %)	End Semester Examination [40 marks](in %)
Remember	20	20
Understand	20	20
Apply	60	60
Analyze	0	0
Evaluate	0	0
Create	0	0

SEMESTER – III

15MA134 FOURIER ANALYSIS AND STATISTICAL QUALITY CONTROL 3/2/0/4
(Common to MECH, CIVIL and MCT)

Nature of Course J (Problem analytical)
Pre requisites 15UH201- Mathematics I
 15UH204- Mathematics II

Course Objectives:

- 1 To study the concept of mathematical formation of certain practical problems in terms of partial differential equations and solving for physical interpretation.
- 2 To understand the different possible forms of Fourier series and also the frequently needed practical harmonic analysis that an engineer may have to make from discrete data
- 3 To understand the concepts of Fourier transform and its inverse, their properties and the possible special cases with attention to their applications.
To study the concept of fitting a curve of best fit to the given numerical data and to calculate the deviation of the expected value from the observed value.

Course Outcomes:

Upon completion of the course, students shall have ability to

C134.1	Recall the concepts of integration	[R]
C134.2	Solve the engineering problems using PDE	[U]
C134.3	Find Fourier series solution to the engineering problems	[AP]
C134.4	Fit a curve to the given numerical data	[AP]

Course Contents:

PARTIAL DIFFERENTIAL EQUATIONS - Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Lagrange's linear equations - Linear homogeneous partial differential equations of second and higher order with constant coefficients. **FOURIER SERIES** - Dirichlet's conditions - General Fourier Series – Odd and Even Functions - Half range sine series- Half range cosine series – Change of Interval - Parseval's Identity- Harmonic analysis. **FOURIER TRANSFORM** - Complex form of Fourier Transform – Properties - Fourier sine and cosine transforms-Properties- Transforms of simple functions - Convolution theorem and Parseval's Identity (excluding proof) Evaluation of integrals using Parseval's Identity. **CURVE FITTING AND REGRESSION ANALYSIS** - Empirical laws and curve fitting – linear law– principle of Least squares - Method of group averages-fitting straight line, fitting parabola and exponential curve - Covariance-Correlation coefficient-properties-Regression lines-properties. **STATISTICAL QUALITY CONTROL** - Quality control charts -quality variations-Variables and attributes-basics of control charts-warning limits – control charts for variables - $\bar{X} - R$ chart control charts for attributes - C chart - p- chart for fractional defectives - np chart -Advantages of control charts.

Total Hours: 60

Text Books:

- 1 Grewal. B.S, "Higher Engineering Mathematics", 43th Edition, Khanna Publications, Delhi, 2014.
- 2 Gupta, S.C, and Kapur, J.N., "Fundamentals of Applied Statistics", Sultan Chand, 10th Edition, New Delhi,2000

Reference Books:

- 1 Kreyszig. E, "Advanced Engineering Mathematics", Eighth Edition, John Wiley and Sons (Asia) Limited, Singapore, 2011.
- 2 P.Kandasamy, K.Thilagavathy, K.Gunavathy, "Probability, Statistics and Queuing Theory",2008th edition ,S.Chand publications.

Web References:

- 1 <http://www.nptel.ac.in/courses/111105035>
- 2 <http://www.nptel.ac.in/courses/122104017>
- 3 <http://nptel.ac.in/courses/122102009>
- 4 <http://nptel.ac.in/courses/111107063>

Online Resources:

- 1 <http://nptel.ac.in/video.php?subjectId=122107037>
- 2 <http://nptel.ac.in/courses/112106064>
- 3 <http://nptel.ac.in/courses/111105042>
- 4 <http://nptel.ac.in/courses/110105039/22>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C134.1	Remember	Classroom or Online Quiz		5
C134.2	Understand	Class Presentation/Power point presentation		5
C134.3	Apply	Group Assignment		5
C134.4 & C134.5	Apply	Group activities		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course:D (Theory application)

Pre Requisites: 15ME301 **Manufacturing Technology I**

C

Course Objectives:

1. To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.

Course Outcomes:

Upon completion of the course, students shall have ability to

C304.1	Study of basics of metal cutting processes and various tool materials	[R]
C304.2	Expose the tools and accessories for various machines	[AP]
C304.3	Discuss the working principle of various metal cutting machines	[U]
C304.4	Compare the features of various mechanisms involved	[AP]
C304.5	Fabricate and validate an industry based prototype model.	[C]

Course Contents:

THEORY OF METAL CUTTING: Metal removal processes -Types of machine tools - theory of metal cutting, Merchant's circle, chip formation, orthogonal cutting, and oblique cutting, cutting tool materials, standards and specifications, tool wear, tool life, surface finish, cutting fluids, **CENTRE LATHE AND SPECIAL PURPOSE LATHES:** Centre lathe, constructional features, cutting tool geometry, various operations, taper turning methods, thread cutting methods, special attachments, , machining time and power estimation. Capstan and turret lathes – Automats – single spindle, Swiss type, **Reciprocating and Milling Machines:** shaper, planer, slotter, Milling machines, - types, milling cutters and Operations. Drilling machines types - upright sensitive drill press, upright drill press, and radial arm drill press. Operations - drilling, boring,reaming and tapping, **ABRASIVE PROCESS AND SAWING:** Abrasive processes: grinding wheel – specifications and selection, types of grinding process, process – cylindrical grinding, surface grinding, centreless grinding. Internal Grinding, Finishing processes – honing, lapping, super finishing, polishing and buffing. Abrasive jet machining, Sawing machine - hack saw, band saw, circular saw, **BROACHING AND GEAR CUTTING:** Broaching machines: broach construction – push, pull, surface and continuous broaching machines. Gear cutting: forming, generation, shaping, hobbing, Gear finishing.

Total Hours: 45

Text Books:

- 1 SeropeKalpakjian, “Manufacturing Engineering and Technology”, Pearson India, 4th edition. 2014
- 2 HMT – “Production Technology”, McGraw-Hill Education, 2014.

Reference Books:

- 1 Rao, P.N. “Manufacturing Technology”, Metal Cutting and Machine Tools, McGraw – Hill Education, New Delhi, 2013.
- 2 Hajra Choudhury, “Elements of Workshop Technology”, Vol. I & II, Media Promotors Pvt Ltd., 2011.

Web References:

- 1 www.nptel.ac.in
- 2 www.sme.org

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)					
Formative assessment based on Capstone Model (Max. Marks:20)					
Course Outcome	Bloom's Level	Assessment Component			Marks
C304.1	Remember	Quiz			4
C304.2	Understand	Group Technical Presentation			4
C304.3	Apply	Assignment			4
C304.4	Analyze	Case Study			4
C304.5	Create	Application Development/Mini Project			4
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	Continuous Assessment			End Semester Examination	
	CIA1	CIA2	Term End Assessment		
Remember	30	30	30	20	
Understand	30	30	40	20	
Apply	20	20	30	20	
Analyse	20	20	0	10	
Create	0	0	0	30	

Nature of Course : C (Theory concepts)
Pre requisites : Fundamentals of Basic Mathematics

Course Objectives:

- 1 To understand the thermodynamic laws and their applications
To know about the properties of steam and the use of steam tables and Mollier Chart
- 2 Chart
- 3 To develop a clear understanding about thermodynamic relations

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|-------|
| C305.1 | Discuss about the concepts of continuum, system, control volume, thermodynamic properties, thermodynamic equilibrium, work and heat, entropy | [R,U] |
| C305.2 | Solve the laws of thermodynamics to analyze boilers, refrigerators, heat engines, compressors and nozzles | [AP] |
| C305.3 | Discriminate the properties of gas mixtures and thermodynamic relations | [A] |
| C305.4 | Calculate the performance of boilers and refrigerators | [A] |

Course Contents:

Basic Concepts and First Law: Review of basic concepts of thermodynamics- System, Surrounding, Property, State and Equilibrium, Process and Cycle, Work, Temperature, Heat and Other forms of energy, Internal energy, Specific heat capacities, Macroscopic approach and Microscopic approach - Quasi static process, Zeroth law of thermodynamics, First law of thermodynamics, Application of First law to non- flow system, Steady and **unsteady** flow energy equation and its application to various thermal equipments.

Second Law: Second law of Thermodynamics – Kelvin’s and Clausius statements of Second law, Reversibility and Irreversibility, Heat reservoirs - Refrigerator and heat pump, Carnot theorem, Carnot cycle, Reversed Carnot cycle, Efficiency, COP, Thermodynamic temperature scale, Clausius inequality, Concept of entropy, Entropy of ideal gas, and Principle of increase of entropy.

Properties of Pure Substance And Vapour Power Cycle: Properties of pure substances – Thermodynamic properties of pure substances in solid, liquid and vapour phases, Phase rule, P-V, P-T, T-V, T-S, H-S (Mollier chart) diagrams, PVT surfaces, Specific properties of steam -Use of Steam Tables & Mollier chart, Calculations of work done and heat transfer in non-flow and flow processes, Standard Rankine cycle (Analytical), Reheat and Regenerative cycle (Descriptive).

Gas Mixtures and Thermodynamic Relations: Gas mixtures – Properties of ideal and real gases, Equation state, Avagadro’s law, Vander waal’s equation of state, Compressibility factor, Compressibility chart, Dalton’s law of partial pressure, Exact differentials, TdS relations, Maxwell’s relations, Clausius clapeyron equations, Joule –Thomson coefficient.

Refrigeration: Refrigeration – definition - terminology used, desirable properties of refrigerant, classification of refrigerants, selection of refrigerant, types of refrigeration systems, Ideal vapour compression refrigeration cycle, Vapour absorption refrigeration cycle (Descriptive), Brayton refrigeration cycle (Descriptive).

Total Hours: 60

Text Books:

- 1 Nag. P.K, “Engineering Thermodynamics”, 5th Edition, McGraw Hill Education, New Delhi, 2014
- 2 Yunus. N.J, Cengel. A and Michael Boles. A, “Thermodynamics- An Engineering Approach” 8th Edition, McGraw Hill Education, New Delhi, 2016

Reference Books:

- 1 Mahesh M. Rathore, "Thermal Engineering", Mc Graw Hill Education private limited, Reprint 2016.
- 2 Michael Moran.J, and Howard Shapiro.N, "Fundamentals of Engineering Thermodynamics", 4th Edition, John Wiley & Sons, New York, 2014

Web References:

- 1 <http://nptel.ac.in/courses/112103016/>
- 2 <http://nptel.ac.in/courses/112105128/>

Online Resources:

- 1 <http://booksite.elsevier.com/balmer/thermodynamicresources.php>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C305.1	Remember/ Understand	Online Quiz		5
C305.2	Apply	Problem Solving		5
C305.3	Analyze	Group Assignment		5
C305.4	Analyze	Case Study		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination (60 Marks)
	CIA1 (6 Marks)	CIA2 (6 Marks)	Term End Assessment (8 Marks)	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	30	30	30	30
Analyse	30	30	30	30
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: G (Theory analytical)

Pre Requisites: Material science , Engineering Mechanics

Course Objectives:

1. To impart knowledge on simple stresses, strains and deformation in components due to different loads.
2. To understand the concepts of beam , column and shafts
3. To understand the importance of Principal stresses
4. To get the basic knowledge of design courses.

Course Outcomes

Upon completion of the course, students shall have ability to

C306.1: Define the basic concepts of strength of materials.	[R]
C306.2: Demonstrate the terminologies of material properties	[U]
C306.3: Solve the problems and analyze various structural members (like bar, beam, shaft and column)	[Ap]
C306.4: Examine the effect of strain energy	[A]
C303.5 : Estimate the two dimensional stresses	[E]

Course Contents

STRESS, STRAIN AND DEFORMATION OF SOLIDS :Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses and Strains; Tensile, Compressive and Shear – Hooke’s law – Stress-strain diagram for ductile and brittle materials – Poisson’s ratio – Elastic constants – relationship between elastic constants and poisson’s ratio – Deformation of simple and compound bars under axial load – Thermal stress - Strain energy and unit strain energy – Strain energy in uniaxial loads.

BEAMS – LOADS AND STRESSES :Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams due to Point and Uniformly Distributed loads – Stresses in beams – Theory of simple bending. Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced – Shear stresses in beams. **TORSION** :Analysis of torsion of circular bars – Shear stress distribution – Bars of Solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts – Application to close-coiled helical springs – Maximum shear stress in spring section – Deflection of helical coil springs under axial loads – Design of helical coil springs – stresses in helical coil springs under torsion loads.. **BEAM DEFLECTION AND COLUMNS:**Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method and Macaulay Method – Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns.

ANALYSIS OF STRESSES IN TWO DIMENSIONSbiaxial state of stresses – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells – Biaxial stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr’s circle for biaxial stresses – Maximum shear stress

Total Hours 60

Text Books:

1. Beer F. P. and Johnston R, “Mechanics of Materials”, McGraw-Hill Book Co, 7th Edition, 2014.
2. R.K.Bansal, “Strength of Materials”, LaxmiPublication , 6th Edition , 2015.

Reference Books:

1. Nash W.A, “Theory and problems in Strength of Materials”, Schaum Outline Series, McGraw-Hill Book Co, New York, 1995
2. D. Kazimi S.M.A, “Solid Mechanics”, Tata McGraw-Hill Publishing Co, New Delhi, 1981

3. E. Popov E.P, "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi, 1997.

Web References:

1.nptel.ac.in/courses/Webcoursecontents/.../strength%20of%20materials/homepage.htm

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C306.1	Remember	Quiz/Test		4
C306.2	Understand	Quiz/Test/Assignment		4
C306.3	Apply / Analyze	Assignment/Poster Presentation / Test		4
C306.3	Analyze	Test		4
C306.5	Evaluate	Group Assignment		4
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			
	CIA1 [6 Marks]	CIA2 [6 Marks]	Term End Assessment [8 Marks]	End Semester Examination (60 Marks)
Remember	20	20	20	20
Understand	20	20	20	20
Apply	40	40	30	30
Analyse	20	20	30	30
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course :

Pre requisites : Problem Solving Techniques and C Programming

Course Objectives:

- 1 To understand Object Oriented programming concepts like data abstraction, encapsulation
- 2 To analyze different kinds of constructor, Inheritance and polymorphism
- 3 To understand and apply streams and File concepts
- 4 To implement collection frame work and strings in solving real world problems

Course Outcomes:**Upon completion of the course, students shall have ability to**

- | | |
|--|------|
| C206.1 Create C++ programs using Object Oriented concepts | [U] |
| C206.2 Evaluate the concepts of friend function and virtual functions | [U] |
| C206.3 Implement I/O functionality to read and write files. | [U] |
| C206.4 Design, write and debug Package, multithreading and interface concepts using java programs | [AP] |
| C206.5 Create C++ programs using Object Oriented concepts | [C] |

Course Contents:

INTRODUCTION TO OOP : Introduction: Object Oriented Programming features - Merits and demerits of object oriented methodology. An overview of C++ - Data types- variables - Constants -operators - expressions. Selection statements-Iteration statements-Jump statements. Functions -Function Arguments - Recursion -Function prototype.Arrays - single dimensional arrays - Passing single dimensional arrays to functions .Multidimensional arrays - pointers - pointer variables pointer expressions. **PROGRAMMING IN C++ :** Classes and objects -Friend Functions -Friend class - constructor, Default constructor-parameterized constructor - copy constructor - destructors, operator overloading -unary-Binary - Operator overloading using friend function, Inheritance -single-multilevel-multiple-hierarchical - Virtual base class - virtual functions- pure virtual functions - Abstract classes. **C++ STREAMS AND FILE HANDLING :** C++ Streams -Stream classes - Formatted I/O, File -File classes - Opening and Closing of files-Reading and writing a Text file, Unformatted and Binary I/O -Characters vs Bytes -put() and get() - read() and write(),getline() - Detecting EOF -Random Access File- File pointers. **JAVA PROGRAMMING:** The Byte code -Java Features -Simple java program -Java Keywords, Data types, variables, Literals and arrays- operators- control statements, classes-objects-methods -constructor, overloaded constructor-Object as Arguments -Returning objects, Inheritance-Basics - Super keyword-Method overriding, **PACKAGES,INTERFACE ,COLLECTION FRAMEWORK :** Packages - Defining a package - Access protection -importing a packages, Interfaces-Defining an interface-implementing interface - applying an interface - Extending an interface, Multithreaded programming - Java Thread Model, creating a thread - implementing a thread - extending thread, String-String operations - Collection framework - collection -List - Set -Queue-Deque.

SELF STUDY: Class Template ,Function Template, STL, Applet Programming, AWT**Total Hours:****75**

LIST OF EXPERIMENTS

1. Simple C++ Programs to Implement Various Control Structures.
 - a. If statement
 - b. Switch case statement and do while loop
 - c. For loop
 - d. While loop
 2. Program to understand Inline Functions & Function overloading.
 3. Programs to implement Constructors & Destructors.
 4. Programs to Implement Inheritance and Function Overriding.
 - a. Multiple inheritance –Access Specifiers
 - b. Hierarchical inheritance – Function Overriding/Virtual Function.
 5. Programs to Implement Inheritance and Function Overriding.
 - a. Multiple inheritance –Access Specifiers
 - b. Hierarchical inheritance – Function Overriding/Virtual Function
 6. Programs to Understand Friend Function & Friend Class.
 - a. Friend Function
 - b. Friend class.
- JAVA
7. Simple Java applications using
 - a. Data types
 - b. Class & object
 - c. Constructor
 8. Implementation of Inheritance concepts
 - a. Single inheritance using super keyword
 - b. Multilevel inheritance
 9. Creation of simple package and access
 10. Developing user-defined interfaces and implementation

Text Books:

1. Herbert Schildt." *The Complete Reference C++*" Fourth Edition, TMH, 2003 .(Unit –I Chapter 2,3,4,5,6 Unit –II Chapters 12,14,15,16,17 Unit III Chapters 20,21)
2. Herbert Schildt, "Java : The Complete Reference", Ninth edition, TMH, 2014.(Unit – IV Chapter 1-8), Unit –V Chapter 9,11,16,17)

REFERENCE BOOKS:

- 1 K.R.Venugopal, Rajkumar Buyya, T.Ravishankar, "Mastering C++", TMH, 2003
- 2 Bjarne Stroustrup, "The C++ programming language" Addison Wesley, fourth edition 2000
- 3 John R.Hubbard, "Programming with C++", Schaums outline series, TMH, Third Edition 2003
- 4 H.M.Deitel, P.J.Deitel, "Java : How to program", Ninth edition, PHI private limited. 2000

Web References:

- 1 <http://www.nptel.ac.in>
- 2 <http://www.javaworld.com>
- 3 <http://www.ocw.mit.edu>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	Rubric based CIA [40 Marks]	
Remember	0	0	0	0	0
Understand	20	40	40	0	0
Apply	80	60	60	60	60
Analyse	0	0	0	0	0
Evaluate	0	0	0	0	0
Create	0	0	0	40	40

Nature of Course: G (Theory)

Pre Requisites: Basics of environmental sciences

Course Objectives:

1. To study the integrated themes on various natural resources.
2. To acquire knowledge about the various aspects of ecosystem and biodiversity.
3. To gain knowledge on the type of pollution and its control methods.
4. To understand the current environmental issues and the impacts of human population on environment.

Course Outcomes

Upon successful completion of the course, students shall have ability to

CO03.1: Understand the importance of Natural resources. [U]

CO03.2: Analyse the various types of ecosystem and biodiversity. [A]

CO03.3: Execute the gained knowledge to prevent pollution. [E]

CO03.4: Apply the knowledge gained about the interrelation between human and Environment in various environmental issues and sustainable development. [Ap]

Course Contents

Natural Resources - Introduction-Forest resources: Use and abuse, case study-Major activities in forest-Water resources-over utilization of water, dams-benefits and problems. Mineral resources- Use and exploitation, environmental effects of mining- case study-Food resources. Energy resources -Renewable and non-renewable energy sources. Land resources- Soil erosion and desertification – Role of an individual in conservation of natural resources.

Ecosystems and Biodiversity - Concept of an ecosystem – structure and function of an ecosystem– producers, consumers and decomposers - Carbon cycle and Nitrogen cycle. Energy flow in the ecosystem–ecological Pyramid –Types of Ecosystem. Introduction to biodiversity definition: genetic, species and ecosystem diversity – value of biodiversity-Hot-spots and threats–Endangered and endemic species – conservation of biodiversity.

Environmental Pollution - Definition – causes, effects and control measures of: a. Air pollution- Acid rain-Green house effect-Global warming- Ozone layer depletion – case study- Bhopal gas tragedy. Water pollution- Soil pollution - Solid waste management: causes, effects and control measures of municipal solid wastes-Noise pollution- Thermal pollution-Nuclear hazards-case study-Chernobyl nuclear disaster-Role of an individual in prevention of pollution.

Social Issues and Green Approaches - Sustainable development-water conservation, rain water harvesting- Watershed management – resettlement and rehabilitation of people; its problems and concerns- case study -Wasteland reclamation. Environmental ethics: 12 Principles of green chemistry-Scheme of labelling of environmental friendly products (Eco mark) – Emission standards – ISO 14001 standard.

Human Population and Environment- Population growth, variation among nations – population explosion – family welfare programme – environment and human health- Human rights– value education – HIV / AIDS- Woman and child welfare Role of information technology in environment and human health–Case study.

Total Hours : 45

Text Books:

1. Anubha Kaushik and C P Kaushik ‘Perspectives in Environmental Studies’4thEdition, New Age International (P) Limited, Publisher Reprint 2014. New Delhi.
2. Benny Joseph, ‘Environmental Science and Engineering’, Tata McGraw-Hill, New Delhi, 2008.

Reference Books:

1. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', Third Edition, Pearson Education, 2009.
2. Tyler Miller, Jr., 'Environmental Science, Brooks/Cole a part of Cengage Learning, 2014.
3. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press 2015.

Web References:

1. <http://nptel.ac.in/courses/104103020/20>
2. <http://nptel.ac.in/courses/120108002>
3. <http://nptel.ac.in/courses/122106030>
4. <http://nptel.ac.in/courses/120108004/>
5. <http://nptel.ac.in/courses/122102006/20>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C003.1	Remember	Quiz		5
C003.2	Understand	Group Assignment		5
C003.3	Apply	Group Assignment		5
C003.4	Analyze	Seminar		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 6 marks	
Remember	30	30	30	30
Understand	30	30	30	30
Apply	20	20	20	20
Analyze	20	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

15ME307

MANUFACTURING TECHNOLOGY LABORATORY

0/0/3/2

Nature of Course

M (Practical application)

Co requisites

15ME301 Manufacturing Technology I

Course Objectives:

To provide hands-on experience to the students on various manufacturing processes using general and special purpose machines.

Course Outcomes:

Upon completion of the course, students shall have ability to

- C307.1 Make a component using Lathe, Milling, Shaper, Slotter and Drilling machines. [AP]
- C307.2 Finish accuracy after the Grinding operation. [AN]
- C307.3 Interpret the machining time and Cost. [AN]

Course Contents:

LATHE:

1. Carryout the basic machining operations like Facing, Step turning, Taper turning and Thread cutting operations. (Optional - Kunrling).

SPECIAL PURPOSE MACHINES MACHINING PRACTICES:

2. Machine the slot and pocket milling on the given workpiece
3. Shape the component in order to achieve the perfect linear motion by internal / external dovetail cutting
4. Make a slot to transmit the rotary motion of a shaft to other elements
5. Improve the surface finish of the given component which has flat surface and cylindrical surface
6. Fasten the two different plates using drilling, reaming and tapping processes
7. Make a spur gear using indexing mechanism
8. Make a helical gear using hobbing machine

Total Hours: 45

Reference Books:

- 1 "Manufacturing Engineering and Technology", Pearson India, 4th edition. 2014,
- 2 HMT – "Production Technology", McGraw-Hill Education, 2014.
- 3 Hajra Choudhury, "Elements of Workshop Technology", Vol. I & II, Media Promoters Pvt Ltd., 2011.

Web References:

- 1 <http://nptel.iitm.ac.in>

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	-
Understand	20	20
Apply	20	30
Analyse	10	30
Evaluate	20	10
Create	20	10

Nature of Course M (Practical application)

Co requisites Nil

Course Objectives:

1. To supplement the theoretical knowledge gained in Mechanics of Solids with practical testing for determining the strength of materials under externally applied loads. This would enable the student to have a clear understanding of the design for strength and stiffness

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C308.1 | Identify the various testing equipment. | [R] |
| C308.2 | Understand the concepts of stress and strain at a point as well as the stress- strain relationships for homogenous, isotropic materials. | [U] |
| C308.3 | Demonstrate various tests on mechanical properties of materials. | [AP] |
| C308.4 | Determine the behavior of ferrous and nonferrous metals subjected to normal, bending and shear stresses by meansof experiments. | [AN] |
| C308.5 | Prepare sample for various testings. | [C] |

Course Contents:

1. Tension test on a mild steel rod to determine the percentage of elongation, yield, ultimate and breaking stress on mild steel rod
2. Double shear test on Mild steel and Aluminium rods to determine the shear strength.
3. Torsion test on mild steel rod to determine the modulus of rigidity
4. Impact test on metal specimen to determine the impact strength and toughness - Izod's and Charpy's test.
5. Hardness test on metals to determine Brinnell and Rockwell Hardness Number of Aluminium, Brass and Mild Steel
6. Deflection test on beams to determine the young's modulus of the given beam (Steel & Aluminium)
7. Compression test on open coil helical springs to determine the deflection and stiffness.
8. Compression test on wood to determine the compression strength
9. Compare the theoretical and experimental strain of mild steel using digital strain indicator
10. Effect of hardening- Improvement in hardness and impact resistance of steels.
 - (i) Unhardened specimen
 - (ii) Age hardened specimen
 - (iii) Quenched Specimen and
 - (iv) Quenched and tempered specimen
11. Study of Microstructure of
 - (i)Hardened samples and
 - (ii) Hardened and tempered samples

Total Hours: 45

Reference Books:

- 1 R.K.Bansal, "Strength of Materials", Laxmi Publication, 6th Edition, 2015.
- 2 S S Rattan , " Strength of Materials" , McGrawHill Education, 3rd Edition, 2011
- 3 Strength of Materials Laboratory Manual prepared by SKI, Mechanical Department Faculties

Web References:

- 1 <http://sm-nitk.vlabs.ac.in>
- 2 <https://eerc01-iiith.vlabs.ac.in>

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	30	30
Evaluate	0	0
Create	10	10

SEMESTER – IV

15MA107 THEORY OF PROBABILITY AND MATHEMATICAL STATISTICS 3/2/0/4
(MECH/MCT)

Nature of Course J (Problem analytical)
Pre requisites Basic Probability concepts

Course Objectives:

- 1 To study the basic probability concepts
- 2 To acquire skills in handling situations involving more than one random variable
- 3 To understand and have a well – founded knowledge of standard distributions which can be used to describe real life phenomena
- 4 To analyze data, interpret results and write technical reports
- 5 To learn the concept of testing of hypothesis using statistical analysis

Course Outcomes:

Upon completion of the course, students shall have ability to

C107.1	Recall basic probability and integration concepts	[R]
C107.2	Understand to handle situations involving single random variable	[U]
C107.3	Use distribution in cluster analysis of similar binary variables	[AP]
C107.4	Derive the inference for engineering problems using testing of hypothesis	[AP]
C107.5	Design and conduct an experiment.	[AP]

Course Contents:

Probability - Probability concepts-Addition and Multiplication law of probability – Conditional probability - Total probability theorem, Bayes theorem(statement) – Problems-**Random Variables**- One dimensional random variable - Probability mass function - Probability density function – Discrete and continuous random variables – **Standard distributions**-Discrete distributions - Binomial – Poisson – Geometric – Continuous distributions - Uniform – Exponential - Normal distributions – MGF- Simple problems- **Testing of Hypothesis** –Large sample - Z test-Test of significance - Proportions- Mean - Standard deviation- Small sample test – t test and F test for single mean–difference of means and variance - Chi-square test for goodness of fit and independence of attributes- **Design of Experiments**- Analysis of variance - One way and two way classifications -Completely randomized design -Randomized block design.

Total Hours: 60

Text Books:

- 1 Peebles Jr. P.Z., –Probability Random Variables and Random Signal Principles, Tata McGraw-Hill Publishers, Fourth Edition, New Delhi, 2010
- 2 Palaniammal, S., –Probability and Random Processes, Prentice hall of India, New Delhi, 2014,Reprint 2015.
- 3 Grewal. B.S, “Higher Engineering Mathematics”, 43rd edition, Khanna Publications, Delhi, 2014.
- 4 Gupta, S.C., &Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & sons, 2000,Reprint 2014.

Reference Books:

- 1 Ross, S., –A First Course in Probability, Sixth edition, Pearson Education, Delhi, 2014.
- 2 Henry Stark and John W. Woods –Probability and Random Processes with Applications to Signal Processing, Pearson Education, Fourth Edition, Delhi, 2011
- 3 Veerarajan., T –Probability, Statistics and Random Processes, Tata McGraw-Hill, Second Edition, New Delhi, 2010.
- 4 N.P.Bali and Dr.Manish Goyal,“A Text book of Engineering Mathematics Sem-III/IV” 4th edition Laxmi publications ltd, reprint 2012.

Web References:

- 1 <http://nptel.ac.in/courses/111104079/>
- 2 <http://www.nptelvideos.in/2012/12/probability-random-variables.html>
- 3 <http://freevidelectures.com/Course/3028/Econometric-Modelling/22>
- 4 <http://freevidelectures.com/Course/2311/Digital-Communication/4>
- 5 <http://nptel.ac.in/syllabus/111105041/>

Online Resources:

- 1 <https://www.coursera.org/learn/probability-intro>
- 2 <https://ocw.mit.edu/courses/.../18-440-probability-and-random-variables-spring-2014/>
- 3 <https://www.coursera.org/learn/wharton-introduction-spreadsheets-models/lecture/Y3bCF/3-1-random-variables-and-probability-distributions>
- 4 http://nptel.ac.in/upcoming_courses.php

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C107.1	Remember	Classroom or Online Quiz		2
C107.2	Understand	Class Presentation/Power point presentation		4
C107.3	Apply	Group Assignment		7
C107.4 & C107.5	Apply	Group activities		7
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

15ME309 FLUID MECHANICS AND MACHINERY WITH LAB

3/0/2/4

Nature of Course: G (Theory and Practical)**Pre Requisites:** Basic Mathematics and Engineering Physics**Course Objectives:**

1. To enable the students:
2. To understand the structure and the properties of the fluid.
3. To analyze and appreciate the complexities involved in solving the fluid flow problems.
4. To study the mathematical techniques and apply them to the solutions of practical flow Problems.
5. Learn to apply conservation of laws to flow through pipes.

Course Outcomes

Upon completion of the course, students shall have ability to

- | | |
|--|-----|
| CO309.1: Understand the basic properties of fluid. | [R] |
| CO309.2: Interpret the methods available for fluid property measurement. | [U] |
| CO309.3: Compute the behaviour of boundary layer flows. | [A] |
| CO309.4: Analyse the dependent and independent dimensionless parameters. | [A] |
| CO309.5: Evaluate the performance of fluid Machinery. | [E] |

Course Contents with Course Outcomes/Blooms Taxonomy/Tentative Assessment Method

Basic Concepts and Properties Fluid Properties - density, specific weight, specific volume, specific gravity, viscosity, compressibility, capillary, surface tension and buoyancy - forces on submerged bodies, stability of floating bodies; control volume analysis of mass, momentum and energy- fluid acceleration - differential equations of continuity and momentum. Measurement of Pressure: Pascal's law and Hydrostatic equation - concept of fluid static pressure, Measurement of Pressure using Manometers Fluid Dynamics Euler's equation - Bernoulli's equation - applications. Turbulent flow - Darcy Weisbach formula. Major and minor losses of flow in circular pipes. Pipes in series and in parallel. Boundary Layer Boundary layer thickness and boundary layer separation Dimensional Analysis Dimension and Units- Buckingham π theorem, Introduction to computational fluid dynamics. Self study : Theory of different types of pumps and water turbines.

Lab Component

- | | |
|--|-----|
| 1. Determination of the Coefficient of discharge of given Orifice meter. | [E] |
| 2. Determination of the Coefficient of discharge of given Venturi meter. | [E] |
| 3. Calculation of the rate of flow using Rotameter. | [E] |
| 4. Determination of friction factor for a given set of pipes. | [E] |
| 5. Conducting experiments and drawing the characteristic curves of submergible Pump. | [E] |
| 6. Conducting experiments and drawing the characteristic curves of centrifugal pump. | [E] |
| 7. Conducting experiments and drawing the characteristic curves of reciprocating pump. | [E] |
| 8. Conducting experiments and drawing the characteristic curves of Gear pump. | [E] |
| 9. Conducting experiments and drawing the characteristic curves of Pelton wheel. | [E] |
| 10. Conducting experiments and drawing the characteristics curves of Francis turbine. | [E] |
| 11. Conducting experiments and drawing the characteristic curves of Kaplan turbine. | [E] |
| 12. Study of Hydro Electric Power Plant | [U] |

Total Hours 60**Text Books:**

1. Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", McGraw-Hill Education, 2010.
2. Rajput, R.K., "Fluid Mechanics and Hydraulic Machines", S.Chand Publishers, 2008.
3. Yunus Cengel and John Cimbala, Fluid Mechanics Fundamentals and Application, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi 2009.

Reference Books:

1. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2010
2. Bansal, R.K. "Fluid Mechanics and hydraulic Machines", Laxmi Publications (P) Ltd., New Delhi, 2015.
3. Introduction to Fluid Mechanics, Robert W. Fox, Philip J. Pritchard, Alan T. McDonald. Wiley India Edition. (Wiley Student Edition Seventh 2011).

Web References:

1. <http://www.nptel.ac.in>
2. <http://www.creativeworld9.com>

Online Resources:

1. https://www.reddit.com/r/.../fluid_mechanics_online_andor_textbook_resources
2. www.efluids.com

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	Rubric based CIA [40 Marks]	
Remember	25	0	10	0	20
Understand	25	25	20	10	20
Apply	50	40	40	30	30
Analyse	0	35	30	20	30
Evaluate	0	0	0	40	0
Create	0	0	0	0	0

Nature of Course: Theory Technology (H)

Pre Requisites: Thermodynamics, Thermal Engineering

Course Objectives:

1. To enable the students to understand the working of various automobile systems
2. To prepare the students to apply technical skills sets in various automobile systems
3. To allow students to design and fabricate various automobile systems

Course Outcomes

Upon completion of the course, students shall have ability to

- | | |
|--|--------|
| C310.1: Describe the fundamental concepts of automobile engineering. | [R] |
| C310.2: Discuss the various mechanisms involved in automobile systems. | [U] |
| C310.3: Explore the advanced mechanisms in current vehicles. | [Ap] |
| C310.4: Diagnose the various systems of the vehicle. | [A] |
| C301.5: Design and fabricate the automotive systems. | [E][C] |

Course Contents with Course Outcomes/Blooms Taxonomy/Tentative Assessment

Method

CHASSIS AND IC ENGINES: Types of automobile – Chassis Layout – Types of frame - Types of vehicle body. Classification of engine, Engine components - Cooling and Lubrication systems. **FUEL AND ELECTRICAL SYSTEM:** Layout of petrol and diesel fuel feed system, Drawbacks of simple and modern carburettor, MPFI and CRDI. VVTI, CCVTI, PGMFI, DTSI - Automobile electrical circuits and their systems, Types of starting drive and Ignition systems, Applications of various sensors in automobiles - Trouble shooting. **TRANSMISSION LINES AND AXLES:** **Power train:** Clutch types, Gear box types, gear changing mechanism types **Drive Line:** Universal joints and Propeller shaft types, **Rear axle:** types of rear axle, **Final Drive Differential:** Differential unit, Differential Lock, LSD –Trouble shooting. **VEHICLE CONTROL SYSTEMS:** **Front axle:** Types of front axle **Steering System:** Ackermann principle, Wheel geometry, Steering gears types, Type power steering- **Suspension system:** Types of suspension systems - **Brake system:** braking system types - **Wheels and Tyres:** Types of wheels, Tyres and tubes - Trouble shooting. **EMISSION CONTROL AND ALTERNATE FUELS:** **Emission control techniques:** SI and CI Engine emission and its control, Emission Norms and standard (BS5), Non-exhaust and exhaust emission (SCR) – supercharger and turbo charger. **Alternate fuels:** Alternate fuels for petrol and diesel engines – natural gas, LPG, alcohol, gasohol, biodiesel, hydrogen, electricity vehicle, hybrid vehicle, fuel cells - Engine modification requirements in alternate fuels.

Total Hours 60

Text Books:

1. Anil chhikara, "Automobile engineering Vol-1 &2 Tech India Publications, New Delhi, Reprint Edition 2012.
2. Kirpal Singh, "Automobile Engineering", Vol. 1&2, Standard Publishers, Delhi, 13th Edition, 2014.

Reference Books:

1. Crouse and Anglin, "Automotive Mechanics", 9th Edition, McGraw Hill Education, 2010.
2. Julian Happian-Smith "Introduction to Modern Vehicle Design", Publisher: Society of Automotive Engineers Inc. 2nd Edition, 2012.

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (Max.Marks: 20)			
Course Outcome	Bloom's Level	Assessment Component	Marks
C310.1	Remember	Quiz	2
C310.2	Understand	Writing Skill	2
C310.3	Apply	Poster Presentation	3
C310.4	Analyze	Case Study	3
C310.5	Evaluate & Create	Project	10

Blooms Taxonomy based Assessment Pattern:

Bloom's Category	Continuous Assessment Tests			Semester End Examination
	CIA1	CIA2	Term Examination	
Remember	25	20	10	20
Understand	25	40	45	30
Apply	50	40	45	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : G (Theory analytical)

Pre requisites : 15ME201 - Engineering Mechanics , 15ME305- Strength of Materials

Course Objectives:

- 1 To impart students with the knowledge about the basics of Mechanisms and understand the geometry of motion at any point in a link of a mechanism
- 2 To facilitate students to understand the types of cam and follower, motion and profile drawing of cam
- 3 To give awareness to students on the phenomenon of direction of rotation and speed determination for simple, compound and planetary gear systems
- 4 To enable students to understand the effects of friction in motion transmission and in machine components.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|---------|
| C311.1 | Define the basic terminologies of kinematics. | [R] |
| C311.2 | Demonstrate and apply the principles of kinematics. | [U& Ap] |
| C311.3 | Analyse and determine the parameters involved in the various kinematic elements | [A&E] |
| C311.4 | Discover the effects of friction in mechanical element | [A] |
| C311.5 | Calculate the Position, velocity and acceleration of simple planar mechanisms. | [C] |

Course Contents:

Basics of mechanisms: Basic concepts, Inversions of mechanisms , Description of some common mechanisms – Straight line generators, Ratchets and Escapements, *Structural error*, **Cam and followers:** Basics of cam and follower, Construction of Cam Profile for a Radial Cam – Pressure angle and undercutting. **Gears & gear train :** Spur gear terminology, Law of gearing, Analysis of compound , reverted gear trains. **Friction elements:** Friction in clutches, Friction in Flat and V-belt drives.. **Velocity and acceleration analysis:** Velocity and acceleration analysis of four bar and single slider Mechanisms (Graphical Method Only). Complex curve synthesis, Roberts’s Chebvshec theorem, Frudenstine’s Equation.

Total Hours: 60

Text Books:

- 1 Rattan, S.S, “Theory of Machines”, 3rd Edition, Tata McGraw-Hill, 2009.
- 2 Dr.R.K.Bansal and Dr.J. S. Brar, “A Text book of Theory of Machines”, Laxmi publications, 2011.

Reference Books:

- 1 Ambekar A.G., “Mechanisms and Machine Theory”, Prentice Hall of India, New Delhi, 2007.
- 2 Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 3rd Edition, Oxford University Press, 2009.

Web References:

- 1 nptel.ac.in/courses/Webcourse-contents/.../Kinematics%20of%20Machine/index.html
- 2 nptel.ac.in/courses/112104121/1

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C311.1	Remember	Quiz		4
C311.2	Understand	Poster presentation		4
C311.3	Apply & Analyse	Group Assignment		4
C311.3	Analyse	Technical Presentation		4
C311.5	Analyse	Group Assignment		4
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination (60 Marks)
	CIA1 (6 Marks)	CIA2 (6 Marks)	Term End Assessment (8 Marks)	
Remember	20	10	10	20
Understand	20	10	20	20
Apply	40	50	40	50
Analyse	20	30	30	10
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : D (Theory applications)

Pre requisites : Engineering thermodynamics and Mathematics

Course Objectives:

- 1 To study the fuel properties, performance of I.C Engines
- 2 To study the performance of air compressors
- 3 To study the psychrometric processes and air conditioning systems

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|----------|
| C312.1 | Identify and describe air standard cycles for air standard efficiencies | [R, U] |
| C312.2 | Illustrate the nomenclature, fuels used and analyze the performance of engine | [AP,A] |
| C312.3 | Compare and calculate the performance of reciprocating and rotary equipmetn | [U,A] |
| C312.4 | Classify, solve and calculate the psychrometry processes and air conditioning systems performance | [U,AP,A] |

Course Contents:

Gas Power Cycles: Terminology used in IC engine, Air standard analysis - Carnot cycle - Otto cycle - Diesel cycle - Dual cycle - Lenoir and Stirling cycle

IC Engines: Classification- Principle and working of four stroke and two stroke petrol and diesel engines

Combustion Engineering and Testing: Combustion process- Knocking, Detonation, Cetane and Octane numbers Combustion in SI and CI engines, Testing of IC engines- Constant speed and variable speed tests, Methods of estimating indicated power, brake power, volumetric efficiency, Heat balance test

Air Compressors: Single stage reciprocating compressor- Working principle, Effect of clearance on volumetric efficiency, Multistage reciprocating compressors: Working principle - Inter-cooler Performance of multi-stage compressor. Rotary compressor: Vane compressor, **Screw compressor** and lobe compressor

Psychrometry and Air Conditioning: Psychrometry and Psychrometric charts, Psychrometric process – Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, Evaporative cooling, Requirements for comfort and industrial air-conditioning - Summer and winter air conditioning systems, Air handling and distribution system, **Self cleaning / Electro static precipitation in Air conditioning**

Self-study: HVAC system

Lab Components:

S.No	List of Experiments	BT	CO Mapping
1.	Experimental study on valve timing diagram in 4-stroke engine cut model and port timing diagram in 2-stroke engine cut model	A	C312.2
2.	Performance and Heat balance test on a twin cylinder diesel engine with electrical dynamometer (Alternator)	A	C312.2
3.	Performance characteristics of a centrifugal blower test rig	A	C312.3
4.	Air compressor test rig (Two stage)	A	C312.3
5.	Performance and combustion test on computerized Kirloskar TV1 engine with eddy current dynamometer. (In diesel mode)	A	C312.2
6.	Experiments on air-conditioning system	A	C312.4
7.	Determination of flash and fire point by open cup apparatus	A	C312.2
8.	Determination of viscosity – Redwood viscometer	A	C312.2
9.	Determination of COP of the refrigeration setup	A	C312.2

Total Hours: 60

Text Books:

- 1 Mahesh M. Rathore, "Thermal Engineering", Mc Graw Hill Education private limited, Reprint 2016.
- 2 Kothandaraman.C.P, Domkundwar.S, AnandDomkundwar, "A Course in Thermal Engineering", Dhanpat Rai & Co. (P) Ltd., 2010

Reference Books:

- 1 Rudramoorthy R, Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2011
- 2 Ganesan V, Internal Combustion Engine; Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2012
- 3 Arora C.P. "Refrigeration and Air Conditioning" Tata McGraw Hill, 2008

Web References:

- 1 <http://nptel.ac.in/courses/112104033/>
- 2 <http://nptel.ac.in/courses/112105128/>

Online Resources:

- 1 <https://ocw.mit.edu/courses/mechanical-engineering/>

Tentative Assessment Method & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	Rubric based CIA [40 Marks]	
Remember	20	20	20	0	20
Understand	20	20	20	10	20
Apply	30	30	30	30	30
Analyse	30	30	30	20	30
Evaluate	0	0	0	40	0
Create	0	0	0	0	0

Nature of Course :M (Practical Application)

Co requisites :16PH103 Engineering Physics for Mechanical Engineering with Lab

Course Objectives:

1. To learn the usage of different measuring equipments and use of this industry for quality inspection
2. To know the various optical testing equipments for checking various parameter
To understand the principles of virtual instrumentation and learn the basics for creating
3. virtual instruments

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|-------|
| C313.1 | Recognize the basic measuring instruments | [R] |
| C313.2 | Interpret the units of measurement into standard system of unit | [U] |
| C313.3 | Perform experiments to check linear and angular dimensions | [Ap] |
| C313.4 | Compare the dimensions obtained using Comparators | [A] |
| C313.5 | Evaluate and plan the various VI (Virtual Instrumentation) Principles to perform certain applications like temperature alarm, Boolean operation etc., | [E,C] |

Course Contents:

Generalized measuring system- Linear measuring instruments - Comparators- Angular measuring Instruments-Surface finish, straightness, flatness and roundness measurements -Precision instruments based on laser principles-Basics of Virtual Instrumentation (VI)-Creating VI for simple applications. Study – Coordinate measuring machine, Tool maker's microscope, Floating carriage micrometer.

- | | | |
|-----|---|------|
| 1. | To measure the bore diameter using micrometer | [AP] |
| 2. | To measure the height of the given component using vernier height gauge | [AP] |
| 3. | To measure gear tooth thickness using gear tooth vernier callipers | [AP] |
| 4. | To locate the work piece using sine bar | [A] |
| 5. | To check the dimension of the component using comparator | [A] |
| 6. | To inspect the dimension of the component using autocollimator | [A] |
| 7. | Study of Virtual Instrumentation (VI) | [U] |
| 8. | To create virtual instrumentation for simple applications | [AP] |
| 9. | To perform basic arithmetic and logic operations using VI | [AP] |
| 10. | To develop temperature alarm using VI | [C] |

Total Hours: 45

Reference Books:

- 1 R.K Jain, 'Engineering Metrology', 20th edition, Khanna Publishers, 2012
- 2 I.C Gupta, 'Engineering Metrology', 5th edition, Danapat rai & Co, 2010
- 3 Alsutko, Jerry D Faulk, 'Industrial Instrumentation', 4th edition, Cengage asia Private Ltd., 2011
- 4 Sanjay Gupta and Joseph john, "Virtual Instrumentation using Labview", McGraw Hill Education India Private Ltd., 2010

Web References:

- 1 <https://en.wikipedia.org/wiki/Metrology>
- 2 nplindia.org/metrology-society-india

Online Resources:

- 1 <http://nptel.ac.in/courses/112106138/>
- 2 <http://www.ni.com/labview/>

Tentative Assessment Method & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	30	30
Apply	30	30
Analyse	10	10
Evaluate	10	10
Create	10	10

Nature of Course : M (Practical application)

Pre requisites :

Course Objectives:

- 1 To impart understanding of characteristics of Electrical Drives.
- 2 To impart practical knowledge on basics of microprocessor programming and interfacing

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C218.1 | Identify the various electrical machines and components of Electric. | [R] |
| C218.2 | Understand the working of Electrical machines, drives and microprocessors. | [U] |
| C218.3 | Compare the characteristics and specifications of various Electrical drives and Microprocessors. | [AN] |
| C218.4 | Choose Electrical drives and Microprocessors for various applications. | [E] |

Course Contents:

Current, Voltage, Kirchhoff's laws, Ohm's law, AC power, Transformers, Three phase power for balanced loads, Types of Electric Drives, factors influencing the choice of electrical drives, classes of duty, Drive motors and their speed torque characteristics, Speed control concepts for DC shunt motor and Three phase induction motor, Converter, chopper fed DC motors and inverter, AC voltage controller fed induction motors, Applications of AC and DC drives; Introduction to electronics, Semiconductors, P-N junction diode, Transistors, Introduction to Digital electronics, Binary Numbers, Logic gates, Introduction to 8085 microprocessor, architecture, addressing modes, instruction set, timing diagram, interrupts, Mechanical applications of microprocessors/microcomputers.

Lab Component

- | | | |
|----|---|------|
| 1. | Comparing the performance of D.C. shunt and series motor. | [AN] |
| 2. | Assessing the characteristics of methods of speed control of D.C. shunt motor. | [AN] |
| 3. | Validation of slip and torque-speed characteristics of three-phase induction motor. | [AN] |
| 4. | Comparing the different types of D.C. motor and induction motor starters.(study experiment) | [U] |
| 5. | Performing simple arithmetic operations using 8085: addition/subtraction/multiplication/division. | [E] |
| 6. | Using control instructions to perform operations such as: Increment/decrement, Ascending/Descending order, Maximum/Minimum of numbers, code conversion. | [E] |
| 7. | Understanding how to interface 8085 microprocessor with: | [E] |
| | 1. ADC | |
| | 2. DAC | |
| | 3. Stepper motor | |

Total Hours:

45

Text Books:

- 1 Vedam Subrahmaniam, “Electric Drives (concepts and applications)”, Tata McGraw-Hill, 2001
- 2 Edward Hughes, “Electrical and Electronic Technology”, 10th edition, Pearson Education Limited, 2008
- 3 Ramesh Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085”, Penram International Publishing (India) Private Limited, Sixth Edition, 2016.

Reference Books:

- 1 Krishna Kant “Microprocessor and Microcontrollers”, Eastern Company Edition, Prentice – Hall of India, New Delhi , 2007
- 2 Vedam Subramanyam, “ Electric Drives: Concepts and Applications”, Tata McGraw hill Pvt. Ltd, New Delhi, 2002

Web References:

- 1 <http://nptel.ac.in/courses/108104011/>
- 2 <http://nptel.ac.in/courses/108107029/>

Online Resources:

- 1 <http://www.electrical4u.com/electrical-drives/>
- 2 https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.htm

Tentative Assessment Method & Levels (based on Bloom’s Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom’s Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	0	0
Understand	30	30
Apply	30	30
Analyse	30	30
Evaluate	10	10
Create	0	0

1. Students could join (maximum 3) together, form a small team and execute a simple project in the area of Design, Analysis, Fabrication, and Thermal Engineering relevant to Mechanical Engineering field.
2. Every team shall have a guide who is the member of the faculty of the institution. Identification of faculty guide has to be completed within a week from the day of beginning of semester.
3. The students has to identify and select the problem to be addressed as his/her project work; make through literature survey and finalize a comprehensive aim and scope of his/her work to be done.
4. A project report (of the phase-I) to this effect has to be submitted by each student.
5. One mid semester review and another end semester review of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member of the faculty team.
6. At the end of semester exam, one internal examiner and one external examiner, appointed by the COE will examine the project done by the students.

SEMESTER V

15ME206

INTERNET OF THINGS FOR MECHANICAL ENGINEERS

3/0/0/3

Nature of Course : C (Theory Application)

Pre requisites : Problem Solving Techniques and C Programming
Electrical Drives and Microprocessor Laboratory

Course Objectives:

1. To get acquainted with the building blocks of Internet of Things (IoTs), Characteristics and taxonomy of IoT levels.
2. To gain Knowledge on the real world application of IoT.
3. To know about various packages, frameworks and cloud services.
4. To understand IoT Design Constraints, Industrial Automation and Commercial Building Automation in IoT.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|------|
| C206.1 | Understand the main components composing the Internet of Things. | [U] |
| C206.2 | Select the tools and technologies (e.g., RFID/NFC, sensors, embedded systems, and smart phones) are used to create new Internet of Things solutions | [Ap] |
| C206.3 | Apply IoT in Industrial manufacturing processes, enable new and efficient ways to operate production plants, reduce operational cost. | [A] |
| C206.4 | Analyse and provide solution with the approach of IoT. | [A] |
| C206.5 | Design and Create IoT based systems for real applications. | [C] |

Course Contents:

Introduction to IoT: Introduction, History of IoT, About objects/things in the IoT, The identifier technologies of IoT, Enabling technologies of IoT , About the Internet in IoT. **Technologies behind the IoT:** Challenges and Issues, Security Control Units, Components in IoT -Sensors, Communication modules, Power Sources, Communication Technologies, RFID, Bluetooth, Zigbee, Wifi, Rfinks, Mobile Internet, Wireless Communication, Arduino boards.

Value Creation for Industry: IoT Applications for Industry, Value Creation and Challenges, Future Factory Concepts .Brownfield IoT- Technologies for Retrofitting, IoT for Oil and Gas Industry.

IoT for Automotive: Vehicle Utility control, Navigation, Tracking and Self driving cars, Smart parking, Connected cars, Next generation cars, Intelligent transport system, Monitoring Driving Habits using smart phones, e-Call system, Electric Toll collection, and Smart signals. **Application :** Smart Energy, Smart Factory , Smart Objects, Environment- Weather Monitoring system, Air Pollution Monitoring , Forest Fire Detection, Smart Irrigation.

Total Hours: 45

TEXT BOOKS:

- 1 Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective" -- CRC Press-2012.
- 2 Arshdeep Bahga, Vijay Madiseti, "Internet of Things (A Hands-On-Approach)", VPT, 2014.

REFERENCE BOOKS:

- 1 Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things - key applications and Protocols", Wiley,2012.
- 2 Luigi Atzori, Antonio Lera, Giacomo Morabito, "The Internet of Things: A Survey", Journal on Networks, Elsevier Publications, October, 2010.
- 3 Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.

Web References:

- 1 <http://www.theinternetofthings.eu/what-is-the-internet-of-things>
- 2 <http://www.internet-of-things-research.eu>

Online Resources:

- 1 <https://www.coursera.org/specializations/Internet-of-things>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C206.1	Understand	Quiz		4
C206.2	Apply	Technical Presentation/ Assignment		4
C206.3	Analysis	Case Study/ Group Assignment		8
C206.4	Analysis			
C206.5	Create	Mini Project		4
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	50	40	40	40
Apply	40	40	40	40
Analyse	10	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : G (Theory analytical)
: ENGINEERING MECHANICS, STRENGTH OF MATERIALS

Pre requisites

Course Objectives:

1. To enable the students understand the principles and method of static force analysis and dynamic force analysis of mechanisms.
2. To provide an insight to the undesirable effects of unbalance in rotors and engines.
3. To introduce the concept of vibratory systems and damping methods.
4. To enable the students understand the principles of governors and gyroscope applications

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C314.1 | Determine the forces acting on machines and mechanisms such as cams, flywheels, and engines. | [Ap] |
| C314.2 | Perform static and dynamic balancing calculations for rotating and reciprocating machinery. | [A] |
| C314.3 | To evaluate the various types of vibrations and to impart knowledge in calculating natural frequency and forces caused by unbalance. | [E] |
| C314.4 | Understand the various types of governor's principle and their efficiency and determine gyroscopic couple on Motorized Gyroscope both experimentally and analytically. | [A] |

Course Contents:

FORCE ANALYSIS AND FLYWHEELS: Static force analysis of mechanisms – D'Alembert's principle - inertia force and inertia torque – principle of superposition. Dynamic force analysis - dynamic analysis in reciprocating engines - crank shaft torque – engine shaking forces - turning moment diagrams. Flywheels of engines. **BALANCING:** Static and dynamic balancing - balancing of rotating masses - balancing of single cylinder engine – primary and secondary unbalanced forces - balancing of multi-cylinder engines – partial balancing of uncoupled locomotive engines.

VIBRATION: Basic features of vibratory systems - single degree of freedom, free vibration - equations of motion - natural frequency. Types of damping - damped free vibration. Transverse vibration – whirling of shafts and critical speed. Torsional vibration - natural frequency of two rotor, three rotor systems. Response to periodic forcing - harmonic forcing - forced caused by unbalance - support motion – force transmissibility and amplitude transmissibility - vibration isolation.

MECHANISMS FOR CONTROL: Governors - types - centrifugal governors – Watt, porter and Proell governors – characteristics - effect of friction - controlling force – quality of governors. Gyroscopes – gyroscopic couple - gyroscopic stabilization - gyroscopic effects in automobiles, airplanes and ships.

Total Hours: 60

TEXT BOOKS:

1. Rattan S.S., "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2014.
2. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 2013.

REFERENCE BOOKS:

1. Shigley J.E and Uicker J.J, "Theory of Machines and Mechanisms", McGraw-Hill, Inc., 2008.

- Sadhu Singh, "Theory of Machines", Pearson Education, 2012.

Web References:

- nptel.iitm.ac.in/video
- www.journals.elsevier.com/mechanism-and-machine-theory

Online Resources:

- <https://www.edx.org/course/dynamics-mitx-2-03x>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C314.1	Apply	Quiz/ Assignment		5
C314.2	Analyze	Tutorial / Assignment		5
C314.3	Evaluation	Poster presentation/ Assignment		5
C314.4	Analyze	Test/ Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	0	0	0	0
Apply	50	50	50	50
Analyse	30	30	30	30
Evaluate	20	20	20	20
Create	0	0	0	0

Nature of Course : G (Theory analytical)

Pre requisites : KINEMATICS OF MACHINERY

Course Objectives:

1. To familiarize the various steps involved in the Design Process
2. To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
3. To encourage the usage of standard practices and standard data.

Course Outcomes:

Upon completion of the course, students shall have ability to

C315.1	Understand the concept of various process involved in machine design	[U]
C315.2	Elucidate the variety of stresses induced in machine components to resolve the design process	[Ap]
C315.3	Familiarize with standard design data and select the appropriate mechanical components.	[A]
C315.4	Summarize the results of a design assignment by means of drawing and design report.	[E]
C315.5	Design and make a model of the learnt concepts	[C]

Course Contents:

Steady and Variable Stresses in Machine Elements: Introduction To The Design Process, Direct, Bending And Torsional Stress Equations, Eccentric Loading, Impact And Shock Loading, Calculation Of Principle Stresses For Various Load Combinations, Theories Of Failure, Design of Curved Beams – Crane Hook and C Frame, Stress Concentration And Design For Variable Loading, Soderberg, Goodman And Gerber Relations.

Design of Shafts and Couplings: Design Of Solid And Hollow Shafts, Design Of Keys and Couplings.

Design of Temporary and Permanent Joints: Threaded Fasteners, Design Of Bolted Joints under Eccentric Loading, Design Of Welded Joints, and Design of Riveted Joints for Structures.

Design of Springs and Bearings: Design Of Helical, Leaf springs and Belleville springs, Design Of Bearings, Sliding Contact, Design of Journal Bearing and Rolling Contact bearing, Selection of Rolling contact bearings.

Total Hours: 60

TEXT BOOKS:

1. Shigley J.E and Mischke C. R., “Mechanical Engineering Design”, 10th Edition, McGraw-Hill, 2014
2. Bhandari V.B, “Design of Machine Elements”, 4th Edition, McGraw-Hill Book Co, 2016.

REFERENCE BOOKS:

1. R.S.Khurmi and J.K.GUPTA " A Text Book of Machine Design", S.Chand Publications, 2005
2. Orthwein W, “Machine Component Design”, 2nd Jaico Publishing Co, 2016
3. Spotts M.F., Shoup T.E “Design of Machine Elements” 8th edition, Pearson Education, 2006.

Web References:

1. <https://www.machinedesignonline.com/>
2. <http://ocw.mit.edu/courses/mechanical-engineering/2-72-elements-of-mechanical-design-spring-2009/>

Online Resources:

1. <https://www.coursera.org/learn/machine-design1>
2. <https://ocw.mit.edu/courses/mechanical-engineering/2-75-precision-machine-design-fall-2001/>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C315.1	Understand	Class presentation/Quiz		2
C315.2	Apply	Poster presentation/ Assignment		2
C315.3	Analyse	Case study/ Assignment		6
C315.4	Evaluate	Term Paper/Tutorial/Mini Project		10
C315.5	Create			
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	30	30	30	30
Apply	30	30	30	30
Analyse	20	20	20	20
Evaluate	20	20	20	20
Create	0	0	0	0

Nature of Course : A (Problem analytical & experimental)
Pre requisites : Engineering Thermodynamics, Thermal Engineering.
Course Objectives:

- 1 To enable the students to apply various laws of heat transfer in engineering applications.
- 2 To impart knowledge on the theoretical and analytical concepts to analyse the modes of heat transfer.
- 3 To enable the students to analyse heat exchangers using LMTD and NTU methods.
- 4 To interpret the concepts underlying the types of mass transfer.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|------|
| C316.1 | Summarize the basics of different modes and laws of heat transfer. | [U] |
| C316.2 | Compute heat transfer and temperature distribution in steady-state, unsteady-state heat conduction and extended surfaces. | [Ap] |
| C316.3 | Interpret and analyse forced and free convection heat transfer. | [A] |
| C316.4 | Analyse the heat exchangers using LMTD and NTU methods. | [A] |
| C316.5 | Analyse the different modes of mass transfer. | [A] |
| C316.6 | Evaluate the thermal properties of a surface and effectiveness of heat exchangers. | [E] |

Course Contents:

Conduction: Mechanism of Heat Transfer – Conduction, Convection and Radiation, Fourier Law of Conduction, General Differential equation of Heat Conduction- Cartesian and Cylindrical Coordinates, 1-D Steady State Heat Conduction through Plane Wall, Cylinders and Spherical systems, Composite Systems (Simple problems), Conduction with Internal Heat Generation, Extended Surfaces (Simple problems), Unsteady Heat Conduction – Lumped Analysis – Use of Heisler’s Chart

Forced and Natural Convection: Heat Transfer Coefficients – Boundary Layer Concept, External Flow – Flow over Plates, Cylinders and Spheres, Internal Flow, **Phase Change Heat Transfer:** Nusselt's theory of condensation, Pool boiling, Flow boiling, Regimes of boiling

Heat Exchangers: Overall Heat Transfer Coefficient, Fouling Factors including conduction and convection resistances, Heat Exchanger Analysis – LMTD & NTU methods **Radiation:** Laws of Radiation, Black and Grey body radiation, shape factor algebra, Electrical Analogy, Radiation Shields. **Mass transfer:** Diffusion Mass Transfer – Fick’s Law of Diffusion, Steady state Molecular Diffusion, Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy

Total Hours:60

Lab Component

1. Thermal conductivity measurements by guarded plate method
2. Natural convection heat transfer from a vertical cylinder.
3. Forced convection inside tube.
4. Heat Transfer from Pin-fin (Natural & Forced convection modes).
5. Effectiveness of parallel and counter flow heat Exchanger
6. Determination of Stefan- Boltzmann constant and Emissivity of a grey surface
7. Thermal conductivity of pipe insulation by using lagged pipe apparatus

TEXT BOOKS:

- 1 Yunus.A.Cengel, Afstin J.Ghajar, “Heat and Mass Transfer – Fundamentals and Applications”, McGraw Hill, Fifth Edition, 2016.
- 2 Incropera, F. P. and De Witt, D. P., “Fundamentals of Heat and Mass Transfer”, 5th Edition, John Wiley and Sons, New York, 2011

REFERENCE BOOKS:

- 1 Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer" New Age International, 2010
- 2 Nag P.K, "Heat and Mass Transfer", McGraw-Hill, 2011.
- 3 Holman J.P "Heat and Mass Transfer", McGraw-Hill, 2010.
- 4 Kothandaraman C.P "Fundamentals of Heat and Mass Transfer" New Age International, New Delhi, 2012

Web References:

- 1 www.academia.edu/.../Frank_P_Incropera_Fundamentals_of_heat_and_mass_transfer
- 2 <http://165.165.123.124:444/Mechanical%20Engineering%20%2825%29/Heat%20and%20Mass%20Transfer/>

Online Resources:

- 1 https://onlinecourses.nptel.ac.in/noc16_me06

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	Continuous Assessment			Practical	End Semester Examination (Theory) [40 marks]
	Theory				
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	Rubric based CIA [40 Marks]	
Remember	0	0	0	0	0
Understand	40	40	40	50	40
Apply	40	40	40	30	40
Analyse	20	20	10	10	10
Evaluate	0	0	10	10	10
Create	0	0	0	0	0

Nature of Course : M (Practical application)

Co requisites : Machine Drawing and Engineering Tolerance

Course Objectives:

- 1 To understand and interpret drawings of machine components for the preparation of assembly drawings using standard CAD packages.
- 2 To gain practical experience in handling 3D modelling software systems
- 3 To understand and interpret program codes for manufacturing different machine components using standard CAM packages.

Course Outcomes:

Upon completion of the course, students shall have ability to

C317.1	Recall the basics of computer applications in design and manufacturing	[R]
C317.2	Understand the fundamentals of computer packages	[U]
C317.3	Sketch model the machine components and assemblies before their actual fabrication	[Ap]
C317.4	Prepare part programming and program generation from a CAD model	[Ap]
C317.5	Infer a computer aided manufacturing (CAM) model and generate the machining codes automatically using the CAM system	[A]
C317.6	Create 3D components using RPT machine	[C]

Course Contents:

Recent trends in CAD/CAM, features of solid modelling packages, CNC technology, codes for part programming, MRP I, MRP II, 3D Printing

1. 3D Modelling of simple components like V Block, corner bracket etc
2. 3D Modelling and assembly of Screw jack
3. 3D Modelling and assembly of Plummer block
4. 3D Modelling of a real time engineering component
5. Exercise on Full/Step/Taper turning Cycle
6. Exercise on Multiple Threading Cycle
7. Exercise using Linear and Circular Interpolation
8. Exercise using Mirror Imaging
9. Exercise on circular pocketing, and rectangular pocketing
10. Exercise on Component Modelling and NC code generation using automated programming software
11. 3D printing of a real time engineering component

Total Hours: 45

REFERENCE BOOKS:

- 1 Ibrahim Zeid, 'CAD-CAM Theory and Practice', McGraw-Hill Publishing Co.Ltd., 2015.
- 2 N.D. Bhatt, 'Machine Drawing', Charotar Publishing House Pvt. Limited., 2012.
- 3 Gopalakrishnan, K.R, 'Machine drawing', Subash publishers., 2014.
- 4 YoramKoren, 'Computer Control of Manufacturing Systems', McGraw-Hill Book Company, 2005.

Web References:

- 1 www.nptel.ac.in/video.php?subjectId=112102101

Online Resources:

1 <http://www.mastercam.com/en-us/Support/Training/Certification>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	30	30
Understand	30	30
Apply	20	20
Analyse	10	10
Evaluate	0	0
Create	10	10

Nature of Course : M (Practical application)
Co requisites : DYNAMICS OF MACHINERY

Course Objectives:

1. To enable the students acquire the practical knowledge from the principles learnt in kinematics and dynamics of machinery.
2. To make the students understand how certain measuring devices are used for dynamic testing.

Course Outcomes:**Upon completion of the course, students shall have ability to**

- | | | |
|--------|--|------|
| C318.1 | Determine the forces acting on machines and mechanisms for specific applications such as, cams, gears, flywheels, and balancing. | [A] |
| C318.2 | Perform static and dynamic balancing calculations for rotating machinery | [Ap] |
| C318.3 | Determine the natural frequency of various types of vibrations | [A] |
| C318.4 | Estimate gyroscopic couple on Motorized Gyroscope both experimentally and analytically. | [Ap] |
| C318.5 | Conduct experiments of Governors to prepare performance characteristic Curves, and to find stability & sensitivity. | [E] |

Course Contents:

1. Determination of Mass moment of inertia of flywheel
2. Cam analysis – cam profile and jump- speed characteristics
3. Determination of Mass moment of inertia of compound pendulum
4. Determination of Mass moment of inertia using bifilar suspension
5. Balancing of shaft using dynamic balancing machine
6. Balancing of rotating and reciprocating masses
7. Governors - Determination of characteristics for Watt, Porter, Proell and Hartnell governors.
8. Motorised Gyroscope-Verification of laws -Determination of gyroscopic couple.
9. Determination of torsional natural frequency of single and double rotor system
10. Whirling of shaft-Determination of critical speed of shaft with concentrated loads.

Total Hours: 45

REFERENCE BOOKS:

1. Rattan S.S., "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2014.
2. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 2013.

Web References:

- 1 www.journals.elsevier.com/mechanism-and-machine-theory
- 2 www.minecraftforum.net

Online Resources:

- 1 www.nptel.iitm.ac.in/video

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	0	0
Understand	0	0
Apply	40	40
Analyse	40	40
Evaluate	20	20
Create	0	0

SEMESTER – VI

15ME319

DESIGN OF TRANSMISSION SYSTEMS (Project Based Course + Project)

3/0/2/4

Nature of Course: G (Theory analytical)

Pre Requisites: Design of Machine Elements

Course Objectives:

1. To understand the different types of flexible transmission systems
2. To understand the terminology, geometry and basic kinematic concepts of gears.
3. To learn the design of brakes, clutches & gear box.
4. To allow the students to design real time transmission system elements.

Course Outcomes

Upon completion of the course, students shall have ability to

C319.1	Recall the basic design concepts of transmission systems	[R]
C319.2	Select standard data's from design data book and manufacturers catalog.	[U]
C319.3	Calculate the stresses in the transmission elements	[A]
C319.4	Apply the standard design procedure and design transmission elements	[Ap]
C319.5	Design, fabricate and evaluate a model of the transmission system	[C]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

Design Of Transmission Systems of Flexible Elements: Belt Drives, Selection of V belts and pulleys, flat belts and pulleys, Introduction to toothed belts, design of chain drives and sprockets.

Spur Gears And Helical Gears: Spur gear – Design of spur gear based on strength and wear considerations. Parallel axis helical gears - force, beam strength, wear strength and design of helical gear.

Bevel and Worm Gears: Straight bevel gear – Beam strength, wear strength, tooth force analysis, design of bevel gears. Worm Gear - forces and stresses, thermal capacity, estimating the size of the worm gear pair. **Design Of Gear Boxes:** step ratio, ray diagram, kinematics layout. Design of sliding mesh gearbox, constant mesh gear box, multi speed gear box.

Design of Clutches And Brakes Clutches, Design of clutches. Brakes – Design of block brake, internal expanding brake, band brakes, disk brakes.

Total Hours 60

TEXT BOOKS:

1. Bhandari, V.B., "Design of Machine Elements", Third Edition, Tata McGraw-Hill Publishing Company Ltd., 2010.
2. Juvinall R. C., Marshek K.M., "Fundamentals of Machine component Design", 5th Edition, John Wiley & Sons Third Edition, 2011.

REFERENCE BOOKS:

1. Shigley J.E and Mischke C. R., "Mechanical Engineering Design", Sixth Edition, Tata McGraw-Hill, 2011.
2. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000,
3. Norton R.L, "Design of Machinery", 4th Edition, McGraw-Hill Book co, 2011.
4. Hamrock B.J., Jacobson B., Schmid S.R., "Fundamentals of Machine Elements", 2nd Edition, McGraw-Hill Book Co., 2014.

Web References:

1. www.nptel.ac.in
2. <http://mechanicaldesign.asmedigitalcollection.asme.org>

Online Courses:

1. Machine Design Part - I (Coursera)
2. Precision Machine Design (MIT open courseware)

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C319.1	Remember	Technical Presentation/ Assignment/Quiz		6
C319.2	Understand			
C319.3	Analyze	Group Assignment		4
C319.4	Apply			
C319.5	Create	Mini Project		10
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	10	10	10	10
Understand	30	20	20	20
Apply	40	50	50	40
Analyse	20	20	20	30
Evaluate	0	0	0	0
Create	0	0	0	0

Design projects: Design project of significant length will be required during the semester. Each student or group of students will be responsible for the complete design of mechanical devices or systems.

Nature of Course: G (Theory analytical)

Pre Requisites: Fundamentals of Mathematics

Course Objectives:

1. To provide an insight to basic concepts of Industrial Engineering.
2. To enable the students to understand and apply operations research techniques for industrial operations.
3. To enable the students to apply network concepts to practical problems.
4. To develop model processes of complex real world problems by means of inventory, queuing theory, waiting line models.

Course Outcomes

Upon completion of the course, students shall have ability to

- C320.1: Demonstrate knowledge on theory concepts of work study [U]
 C320.2: Determine the standard time to perform the job by the preferred method [Ap]
 C320.3: Formulate a real world problem into a mathematical formulation [U]
 C320.4: Solve the mathematical formulation of models for managerial decision problems and to be solve by simplex method, transportation and assignment models. [Ap]
 C320.5: Solve network models and determining critical path analysis and programming evaluation review techniques for timely project scheduling and timely completion. [A]
 C320.6: Solve problems facing by business managers in decision environments by analytic techniques and computer packages [Ap]

Course Contents

Concepts of Industrial Engineering: Applications- Work study -concept and need, Method study procedure, Therbligs, Standard Time calculation: Stop-watch time study. Comparison of work measurement techniques. **Linear Programming problems:** Formation of an LP model-graphical solution and Simplex algorithm. Transportation models: Feasible and Optimal solution. Assignment problem- Hungarian method.

Network problems: Shortest route – minimal spanning tree - maximum flow models Project networks- PERT and CPM -critical path scheduling. **Inventory Systems:** Costs involved in inventory control. EOQ and EBQ Models without shortage. Inventory level of perishable items under probabilistic condition. Inventory management-ABC analysis.

Queuing and Simulation models: Queuing models –queuing systems and structures –single server models - Simulation-Introduction, Event type simulation - Monte-Carlo technique.

Total Hours 60

TEXT BOOKS:

1. Taha H.A, "Operation Research: An Introduction", Pearson Education 9th Edition, 2013.
2. Martand Telsang, "Industrial Engineering and Operations Management", S Chand Publications, 2nd Edition, 2006.

REFERENCE BOOKS:

1. Paneerselvam R., Operations Research, Prentice Hall of India, 2nd Edition, 2006.
2. Hira and Gupta "Operations Research", S.Chand and Co Ltd, 6th Edition,2007.
3. Sankara Iyer P, "Operational Research", McGraw Hill Education, 1st Edition, 2008.

Web References:

1. [http:// nptel.ac.in/courses/112106131/1/Fundamentals of Operations Research](http://nptel.ac.in/courses/112106131/1/Fundamentals_of_Operations_Research)
2. [http:// freevideolectures.com](http://freevideolectures.com) > Mechanical > IIT Madras > Operations Research
3. <http://home.ubalt.edu/ntsbarsh/opre640a/partviii.htm>

Online Courses:

1. Introduction to operations management @ www.coursera.org

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C320.1 C320.2 C320.3 C320.4	Understand Apply	Group Assignment/Quiz		10
C320.5	Analyze	Case study		5
C320.6	Apply	Software simulation		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	80	60	60	60
Apply	20	20	20	20
Analyse	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : J (Problem analytical)
Pre requisites : Integral Calculus and Laplace Transform
 Strength of materials
 Fluid mechanics and machinery with lab
 Heat and Mass Transfer with lab
 Design of Machine Elements
 Design of Transmission System

Course Objectives:

- 1 To enable the students to understand the principle involved in discretization and the purpose of stiffness matrices and force vectors
- 2 To enable the students to understand the applications of Finite element analysis in engineering applications by the concepts of virtual work/ equilibrium approach, variational and weighted residual methods for solving engineering problems
- 3 To create confidence to solve complex problems in the field of heat transfer and fluid flow using computers.

Course Outcomes:

Upon completion of the course, students shall have ability to

- C321.1 Summarise governing equations for continuum and implementation aspects of FEA and CFD. [U]
- C321.2 Numerically solve for stresses, strains and deformation of a structural component due to axial load, torsion, and bending, acting individually or in combination. [Ap]
- C321.3 Apply various discretization methods and technologies in finite element methods for solving time-dependent and/or non-linear problems. [E]
- C321.4 Analyse the heat transfer problems using finite difference, finite volume methods and compressible flow problems using SIMPLE algorithm. [A]

Course Contents:

Introduction to Finite Element Method :Historical background, application to the continuum, governing equations for continuum, discretization, matrix algebra, techniques in FEM(weighted residual method, Ritz method)

One Dimensional and Two Dimensional Continuum :Finite element modelling, coordinates and shapes functions, quadratic shape functions, Galerkin's approach, finite element equations, applications to plane trusses, Triangular Elements, Temperature effects (only for 1D). **Isoparametric elements for two dimensional continuum:** Isoparametric elements, four node quadrilateral element, shape functions, element stiffness matrix and force vector, numerical integration, stiffness integration.

Introduction to CFD: Governing equations of fluid dynamics, finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, finite difference application in convective heat transfer, solution of Navier-Stokes equations for 2d, laminar, incompressible flows using SIMPLE algorithm.

Total Hours: 60

TEXT BOOKS:

1. Logan D.L, "A First Course in the Finite Element Method", Thomson Learning, Fifth Edition, 2011.Cengage learning India pvt ltd.
2. Muralidhar.K, Sundararajan.T, "Computational fluid flow and heat transfer", Second edition 2014,Narosa publishers.

REFERENCE BOOKS:

1. Robert D Cook, David S, and Malkucs Michael E Plesha, "Concepts and Applications of Finite Element Analysis", Wiley, 4th Ed., 2003
2. John D. Anderson, Jr, " Computational fluid dynamics," Indian Edition, McGraw Hill Education, 2012

Web References:

1. <http://textofvideo.nptel.iitm.ac.in/video.php?courseId=112106135>
2. <http://www.nptel.ac.in/courses/105105041/1>
3. <http://nptel.ac.in/courses/112105045/>

Online Resources:

1. A Hands-on Introduction to Engineering Simulations
<https://www.edx.org/course/hands-introduction-engineering-cornellx-engr2000>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C321.1	Understand	Online Quiz		5
C321.2	Apply	Simulation Exercise		5
C321.3	Evaluate	Group Assignment		5
C321.4	Analyze	Poster Presentation/ Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	20	20	20	20
Understand	40	50	40	40
Apply	30	20	30	30
Analyse	20	20	20	20
Evaluate	10	10	10	10
Create	0	0	0	0

Nature of Course :L (Problem experimental)
Co requisites : Problem solving Techniques and C programming
 Computational Mechanics

Course Objectives:

- 1 To provide knowledge on creating model for a given component using software
- 2 To impart knowledge to perform stress analysis for any given component and various mechanical loading conditions
- 3 To enable the students to simulate and analyse engineering components under various thermal loading conditions.
- 4 To enable the students to verify the simple 2D flow using numerical coding.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C322.1 | Modelling of 3D machine components. | [AP] |
| C322.2 | Solve the simple structural problems using ANSYS software. | [A] |
| C322.3 | Analyse and Evaluate the given component under thermal condition using ANSYS software. | [E] |
| C322.4 | CFD analysis to validate simple flow problem | [E] |
| C322.5 | Develop MAT Lab program to simulate Mechanical system. | [C] |

Course Contents:

1. Stress analysis of L bracket
2. Stress analysis of Plate with Hole
3. Stress analysis of axisymmetric component.
4. Stress analysis in Beam
5. Thermal stress Analysis in 2D components
6. Conductive and convective heat transfer analysis
7. Flow analysis for velocity and pressure distribution in simple 2D flow over flat plate
8. Verification and Validation of Laminar Pipe Flow using ANSYS Fluent
9. Simulation of Air conditioning system with condenser temperature and evaporator temperatures as Input to get COP using C /MAT Lab
10. Simulation of Hydraulic / pneumatic cylinder using C / MAT Lab
11. Simulation of Cam and Follower mechanism using C / MAT Lab

Total Hours: 45

REFERENCE BOOKS:

- 1 Tadeusz Stolarski , Y. Nakasone, S. Yoshimoto , “ Engineering Analysis with ANSYS Software”, 1st Edition ,Elsevier,2007.
- 2 Sham Tickoo “ANSYS Workbench 14.0 for Engineers & Designers: A Tutorial Approach”, Dreamtech Press, 2012.
- 3 K.Muralidhar ,T.Sundarajan, “ Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 2014.
- 4 Soumitra Kumar Mandal, “Basic Electronics”, McGraw Hill Education India Private Ltd., 2013
- 5 S.R.Otto,J.P.Danier. “ An Introduction to Programming and Numerical Methods in MATLAB”,Springer,2005

Web References:

- 1 <http://nptel.ac.in/courses/105103140/40>
- 2 <http://nptel.ac.in/courses/112105045/>
- 3 <http://www.mece.ualberta.ca/tutorials/ansys/>
- 4 <http://su2.stanford.edu/training.html>

Online Resources:

- 1 <https://www.nafems.org/e-learning/>
- 2 <https://www.coursera.org/learn/matlab>
- 3 <https://www.edx.org/course/hands-introduction-engineering-cornellx-engr2000x>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	0	0
Understand	0	0
Apply	30	30
Analyse	30	30
Evaluate	20	20
Create	20	20

Nature of Course : M (Practical application)

Co requisites : Fluid Mechanics and Machinery

Course Objectives:

- 1 To provide comprehensive introduction to fluid power including both hydraulics and pneumatics.
- 2 To understand the simulation of hydraulic, pneumatic and electrical circuits
- 3 To gain practical experience in applying knowledge obtained in the course through a hands-on project

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C323.1 | Recall the fundamentals of hydraulic and pneumatic system | [U] |
| C323.2 | Apply the fundamental concepts of hydraulic / pneumatic systems for a given scenario. | [AP] |
| C323.3 | Model and simulate the electrical, hydraulic and pneumatic systems using simulation software | [C] |
| C323.4 | Design, analyze and implement the hydraulic and pneumatic circuits for industrial applications | [C] |

Course Contents:

Elements of hydraulic and pneumatic system, hydraulic vs pneumatic system – cylinders and its types – compressor and its types – pumps - control valves – pressure control valve, flow control valve and direction control valve – Filter – regulator – lubricator - Automatic cylinder reciprocating circuit both hydraulic and pneumatic system - Pneumo hydraulic system

Lab Components

Design and Simulation of

1. Pneumatic circuit for actuating single and double acting cylinder
2. Logical functions (AND,OR) for control of double acting cylinder
3. Metering-in and metering-out circuits
4. Parallel and series circuits
5. Pneumatic circuit for single cycle automation of multi cylinder in sequence of A+B+A-B-
6. Pneumatic circuit for single cycle automation of multi cylinder in sequence of A-B+A+B-
7. Pneumatic circuit for single cycle automation of multi cylinder in sequence of A+B+B-A- using cascade method
8. Electro pneumatic circuit for single cycle automation of multi cylinders in the sequence of A-B+A+B- using PLC Interface
9. Electro pneumatic circuit for single cycle automation of multi cylinders in the sequence of A+B+A-B- using PLC Interface
10. Measurement and control of temperature, pressure and flow using sensors in process station
11. Mini project

Total Hours: 45

REFERENCE BOOKS:

- 1 Anthony Esposito, 'Fluid Power with Applications', 7th Edition, Pearson Education, 2014.
- 2 Majumdar S.R., 'Pneumatic systems – Principles and maintenance', McGraw Hill, 2014
- 3 Andrew Parr, 'Hydraulic and Pneumatics', 3rd Edition, Jaico Publications House, 2011

Web References:

- 1 <http://www.nfpa.com>
- 2 <http://14.139.160.15/courses/112102011/2>

Online Resources:

- 1 <https://www.coursera.org/learn/fluid-power>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	0	0
Understand	40	40
Apply	40	30
Analyse	0	10
Evaluate	0	0
Create	20	20

1. Students could join (maximum 3) together, form a small team and execute a simple project in the area of Design, Analysis, Fabrication, and Thermal Engineering relevant to Mechanical Engineering field.
2. Every team shall have a guide who is the member of the faculty of the institution. Identification of faculty guide has to be completed within a week from the day of beginning of semester.
3. The students has to identify and select the problem to be addressed as his/her project work; make through literature survey and finalize a comprehensive aim and scope of his/her work to be done.
4. A project report (of the phase-I) to this effect has to be submitted by each student.
5. One mid semester review and another end semester review of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member of the faculty team.
6. At the end of semester exam, one internal examiner and one external examiner, appointed by the COE will examine the project done by the students.

SEMESTER – VII

15MG004 ENGINEERING MANAGEMENT AND FINANCIAL ACCOUNTING 3/0/0/3

Nature of Course : D (Theory application)

Pre requisites : Industrial Engineering and Operational Research

Course Objectives:

1. To enable the students to understand the principles, functions and practices adapted in industry for the successful management of financial accounting.
2. To make the students to explain the Techniques related to management of engineering activities
3. To illustrate engineer's transition into management and engineering managerial functions
4. To enable the students to understand the need for effective project management skills, training and the specific training needs of project managers and financial accounting.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|------|
| C004.1 | Identify the operations of an industry and account management | [R] |
| C004.2 | Understand the concepts based on the engineering activities related to the management. | [U] |
| C004.3 | Apply the concepts of management principles | [AP] |
| C004.4 | Analyse and interpret the skill of handling management projects and project accounting. | [A] |

Course Contents:

INTRODUCTION Managerial concepts - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis. **DEMAND & SUPPLY ANALYSIS** Demand - Types of demand - Determinants of demand - Demand function - Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity.

PRODUCTION AND COST ANALYSIS Production function - Returns to scale - Production optimization - Least cost input – Isoquants - Managerial uses of production function. Cost Concepts- Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost – Pricing - Determinants of Price - Pricing under different objectives and different market structures- Price discrimination - Pricing methods in practice.

FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) Balance sheet and related concepts - Profit & Loss Statement and related concepts - -Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements **CAPITAL BUDGETING (ELEMENTARY TREATMENT)** Investments - Risks and return evaluation of investment decision - Average rate of return- Payback Period - Net Present Value - Internal rate of return.

Total Hours: 45

TEXT BOOKS:

1. B. Ram, “Accounting for Managers”, New Age Publications (Academic) Edition: First, 2015.
2. C. M. Chang, “Engineering Management: Meeting the Global Challenges”, CRC Press , Second Edition, 2016.

REFERENCE BOOKS:

1. Basic Knowledge of Accounting/Finance for Project Managers and Engineers, Syed Ali Dilawer, 2nd Edition, 2011.
2. A.K. Gupta, "Engineering Management", S. Chand Publication, 2014.

Web References:

- 1 <http://bookboon.com/en/accounting-basics-ebooks>
- 2 <http://bookboon.com/en/management-organisation-ebooks>
- 3 https://www.clarkson.edu/em/handbook/EM11_12StudentHandbook2.pdf

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C004.1	Remember	Quiz		5
C004.2	Understand	Assignment Presentation		5
C004.3	Apply	Group Assignment		5
C004.4	Analyse	Term Paper		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	20	30	20	20
Understand	80	40	40	40
Apply	0	30	20	20
Analyse	0	0	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : D (Theory application)
Pre requisites : Fundamentals of Mathematics and Manufacturing

Course Objectives:

1. To enable the students to understand the basic principles, function and practice adapted in industries for efficient use of quality tools.
2. To explain the technique related to managing process control activities
3. To understand the needs for effective project management skills, Various tools introduced by quality guru's and there method of adaptation, for the development of an industries

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|------|
| C324.1 | Understand the industrial related quality planning, assurance and control systems for the ongoing process | [U] |
| C324.2 | Handle the quality related issues in the industry using management tools. | [AP] |
| C324.3 | Rectify the process related issues with the aid of control charts. | [A] |
| C324.4 | Introduce new Quality control charts for new product and development | [AP] |
| C324.5 | Introduce new process control charts for new products process control. | [AP] |

Course Contents:

Basic concepts in Quality Engineering and Management: definitions, approaches and relevance to organizational excellence. **Product quality control:** Acceptance sampling methods- single, multiple and sequential sampling plans; Recent developments in inspection methods.

Statistical Process Control: Process evaluation and control by control charts: Various control charts including CUSUM charts and multivariate charts. Process capability studies: Various indices and approaches; use of Nomographs; Discussions on capabilities of Process, Machine and Gauge; Unit yields and rolled throughput yield.

Quality management: Total Quality Management perspective, methodologies and procedures; Roadmap to TQM, ISO 9000, KAIZEN, Quality Circles, Models for organizational excellence. Quality Function Deployment, Quality cost systems and Quality Policy Deployment Process evaluation and control by designs of experiment: Various basic designs; Special methods such as EVOP and ROBUST design (Taguchi Methods). Six Sigma Management: Concepts, Steps and Tools; Benchmarking and Balanced Score Cards.

Total Hours: 45

TEXT BOOKS:

1. A.Mitra, "Fundamentals of Quality Control and Improvement", 4th Edition, Pearson Education, 2nd ed. 2016.
2. Quality Management Hardcover – by Abhiji Chatterjee (Author), V.Sharma (Author) 2013.

REFERENCE BOOKS:

1. Introduction to statistical process control, PeihuaQiu, Chapman and Hall/CRC 2013.
2. H.M.Wadsworth, K.S.Stephens and A.B.Godfrey, "Modern Methods for Quality Control and Improvement", John Wiley & Sons.2014.
3. J.M.Juran, "Quality Control by Design", The Free Press.2014.

Web References:

- 1 <http://www.ieor.iitb.ac.in/acad/courses/ie646>
- 2 <http://nptel.ac.in/courses/116102019/2>
- 3 <http://nptel.ac.in/courses/110101010>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C324.1	Understand	Quiz		5
C324.2	Apply	Technical Presentation/ Assignment		5
C324.3	Analyse	Group Assignment		5
C324.4 C324.5	Apply	Case Study		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	60	60	40	40
Apply	40	20	40	40
Analyse	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course D (Theory application)
Pre requisites Manufacturing Technology

Course Objectives:

1. To enable the students to understand the importance of forecasting.
2. To make the students to implement the concepts of production planning & scheduling in an industry.
3. To imply the functions of production planning and control related to various products in industry.
4. To make the students estimate the cost for various products after process planning.

Course Outcomes:

Upon completion of the course, students shall have ability to

C325.1	Recall the forecasting techniques for production demand.	[R]
C325.2	Understand the capacity planning for an industry	[AP]
C325.3	Discuss the concepts of production and process planning and solve the various production scheduling problems	[AP]
C325.4	Estimate the cost for foundry, machining and welding	[E]

Course Contents:

DEMAND FORECASTING: The forecasting process, Time series forecasting models – moving averages, exponential smoothing- multi-item forecasting- regression models, qualitative methods, forecasting system controls **PRODUCTION PLANNING AND PROCESS PLANNING:** Product planning - extending the original product information – value analysis - problems in lack of product planning. Process planning and routing – pre-requisite information needed for process planning - steps in process planning - quantity determination in batch production - machine capacity, balancing - analysis of process capabilities in a multi-product system.

CAPACITY PLANNING: Measures of capacity, Factors affecting capacity, Capacity planning, Systematic approach to capacity planning, Long-term and short-term capacity decisions, Tools for capacity planning. **PRODUCTION SCHEDULING:** Principles of scheduling –Inputs to scheduling- strategies - types of scheduling. Master production scheduling- Inputs and data sources for MPS – Material requirement planning-dispatching - progress reporting and expediting - manufacturing lead time - techniques for aligning completion times and due dates.

PRODUCTION COST ESTIMATION: Types of estimates – methods of estimates – data requirements and sources- collection of cost- allowances in estimation, Elements of cost. Estimation of material cost, labor cost and over heads, allocation of overheads, Estimation of machining cost for drilling, boring, planning, shaping, milling and grinding, Estimation of Foundry and Welding costs

Total Hours: 45

TEXT BOOKS:

- 1 Martand T. Telsang, “Introduction to process planning”, 2015
- 2 Karl Ulrich and Steven Eppinger, “Product Design and Development”, 5th edition, 2016

REFERENCE BOOKS:

- 1 S.N. Chary, “Production and operations management”, 5th edition, 2013
- 2 J.K Yates, “Engineering Economics” , 2016
- 3 Suveera Gill, “Cost and Management Accounting”, 2015
- 4 Gregory K. Mislick , Daniel A. Nussbaum , “Cost Estimation: Methods and Tools “, 2015

Web References:

- 1 [http:// www.custompartnet.com](http://www.custompartnet.com)
- 2 <http://www.people.clarkson.edu>
- 3 http://nptel.ac.in/courses/IIT-MADRAS/Management_Science_II/Pdf/3_5.pdf.
- 4 <http://www.treehugger.com/sustainable-product-design>

Online Resources:

- 1 <https://www.coursera.org/learn/business-planning>
- 2 <https://www.edx.org/course/product-design-delft-design-approach-delftx-dda691x-1>
- 3 <https://www.coursera.org/learn/forecasting-models-marketing-decisions>
- 4 <https://www.coursera.org/learn/business-planning>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C325.1	Remember	Quiz		3
C325.2	Apply	Technical Presentation/Assignment		3
C325.3	Apply	Poster Presentation/Assignment		4
C325.4	Evaluate	Mini Project		10
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	60	50	50	40
Understand	0	0	0	0
Apply	40	50	50	60
Analyse	0	0	0	0
Evaluate	0	10	20	20
Create	0	0	0	0

Nature of Course : E (Theory Skill based)
Pre requisites : Computational Methods and Probability Distribution

Course Objectives:

- 1 To enable the students to learn the principles of data analytics and decision making.
- 2 To enable the students to understand the concept of data exploration.
- 3 To enable the students to analyse using probability and decision making under uncertainty.
- 4 To prepare the students to apply statistical Inference.
- 5 To enable the students to evaluate the concepts of optimization and simulation modelling.

Course Outcomes:**Upon completion of the course, students shall have ability to**

- | | | |
|--------|--|------|
| C207.1 | Describe the properties of normal, binomial, Poisson, and exponential distributions and Provide examples of when they apply, and perform calculations involving them | [R] |
| C207.2 | Classify sample data in order to infer the properties of the entire population and Construct and analyse data files using Excel | [U] |
| C207.3 | Determine relationships between variables using hypothesis testing | [AP] |
| C207.4 | Identify decision problems that involve uncertainty and Apply linear programming techniques to business decisions | [A] |
| C207.5 | Perform statistical analysis and management science techniques to decision making situations. | [E] |

Course Contents:

Introduction to Data Analysis & Decision Making and Exploring Data: Introduction to Data Analysis and Decision Making, Describing the Distribution of a Single Variable, Finding Relationships among Variables, Probability and Decision Making under Uncertainty: Probability and Probability Distributions; Normal, Binomial, Poisson, and Exponential Distributions, Decision Making under Uncertainty

Statistical Inference: Sampling and Sampling Distributions, Confidence Interval Estimation, Hypothesis Testing .Regression Analysis and Time Series Forecasting: Regression Analysis: Estimating Relationships, Regression Analysis: Statistical Inference, Linear Regression, Logistic Regression Time Series Analysis and Forecasting, advanced data analysis, Data Mining

Applications: Importing Data into Excel, Analysis of Variance and Experimental Design, Statistical Process Control, Statistical Reporting. R tool Machine learning algorithm Tools used in Tesla : SAS Eminer, Tableau Public tool – Data Visualization Tool, SPASS, OTA Analytics.

Total Hours: 45

TEXT BOOKS:

- 1 Statistical Analysis for Decision Making by Hamburg, M., and P. Young. Fort Worth, TX: Dryden Press, 2006.ISBN: 9780534510374.
- 2 Data Analysis and Decision Making by S. Albright , Wayne Winston, 2011

REFERENCE BOOKS:

- 1 Data Analysis and Decision Making with Microsoft Excel (with CD-ROM, InfoTrac, and Decision Tools and Statistic Tools Suite) 3 The Decision Tools Stud. Ed Edition by S. Christian Albright , Wayne Winston , Christopher Zappe, 2011.
- 2 Aczel Amir, Sounder pandian, Jayvel - Complete Business Statistics 6th Edition - Tata McGraw Hill – 2006.

Web References:

- 1 https://en.wikipedia.org/wiki/Data_analysis
- 2 https://en.wikipedia.org/wiki/Data_based_decision_making

Online Resources:

- 1 Data driven decision making @ www.coursera.org
- 2 Business analytics for decision making @ www.coursera.org

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C207.1	Remember	Online Quiz		4
C207.2	Understand	Assignment		4
C207.3	Apply	Technical presentation		4
C207.4	Analyse	Case studies/Group Assignment		8
C207.5	Evaluate			
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	30	30	20	10
Understand	40	30	20	30
Apply	30	20	20	20
Analyse	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : L (Problem experimental)
Co requisites : Electrical Drives and Microprocessor Laboratory
 Fluid Power Laboratory + Project

Course Objectives:

- 1 To Understand and classify the basic of Sensors, PLC and Robotics.
- 2 To learn and design various industrial automation using Sensors, PLC, Robotics.
- 3 To train the students in the different aspects of Sensors, PLC programming languages and robot languages.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C208.1 | Interpret the concepts of sensors, PLC and Robotics. | [U] |
| C208.2 | Select Sensors, PLC & Robot depending upon the application. | [U] |
| C208.3 | Use Sensors, PLC and Robots to monitor and control the behaviour of a process or product | [AP] |
| C208.4 | Develop programs for PLC & Robotics for a given task | [C] |

Course Contents:

Introduction to Sensors and Transducers ,Performance and Terminology, Sensors for Displacement, Position and Proximity, Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature sensor, Light Sensors – Selection & Applications of Sensors.

Introduction to PLC, Basic structure, I/O Processing, Timers, Timers, Internal relays and counters, Shift Registers, Master and Jump Controls, Data Handling, Analog Input / Output, Programming and mnemonics, Selection of PLC & Applications. Robotics – Introduction, Anatomy of robots, Classifications of robot, parts of robot – Manipulator, End effector, Actuator, Sensors, Power supply, robot programming means, application of robot.

1. Measurement of displacement using LVDT, potentiometer & Capacitive Transducer
2. Measurement of torque using Torque Measurement device
3. Measurement of temperature using RTD & Thermistor
4. Measurement of Level using Ultrasonic transducer
5. Measurement of pressure using bourdon gauge
6. Servo motor control using PLC
7. Design and Simulation of Belt conveyor
8. Design and Simulation of Water level control
9. Design and simulation of Temperature control
10. TCP teaching to robot
11. Gripper based pick and place
12. Metal and non-metal component sorting
13. Vision inspection and sorting
14. Matrix palletizing
15. Cartoon palletizing

Total Hours: 45

REFERENCE BOOKS:

- 1 W. Bolton, "Programmable Logic Controllers" 6th Edition Newnes, ,2015
- 2 Petruzella, "Programmable Logic Controllers", TMH Hill Publication, 2016.
- 3 Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications ", McGraw Hill International Editions, 1st Edition, 2012

Web References:

- 1 www.inderscience.com/ijam
- 2 www.iitk.ac.in/robotics

Online Resources:

- 1 <http://nptel.ac.in/courses/>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	0	0
Understand	30	30
Apply	40	40
Analyse	0	0
Evaluate	0	0
Create	30	30

1. The entire semester shall be utilized by the students to do their final year project. Students could join (maximum 3) together, form a small team and execute a project in the area of Design, Analysis, Fabrication, and Thermal Engineering relevant to Mechanical Engineering field.
2. Every team shall have a guide who is the member of the faculty of the institution. Identification of faculty guide has to be completed within a week from the day of beginning of semester.
3. The students have to identify and select the problem to be addressed as his/her project work; carry out a complete literature survey and finalize a comprehensive aim and scope of his/her work to be done. They can do either in house project or industrial project.
4. The progress of the project is to be evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.
5. Team of students shall finally produce a comprehensive report covering background information, literature survey, problem statement, solution methodology, results and conclusion. This final report shall be in typewritten form as specified in the guidelines issued by the COE.
6. The project work is evaluated jointly by external and internal examiners constituted by the COE based on oral presentation and the project report.

Tentative schedule of Project Review:

Review	Month	Activity	Marks
Review 1	August	Team formation	5
Review 2	September	Identifying the area of project work	5
Review 3	November	Problem statement	10
Review 4	January	Project evaluation	10
Review 5	February	Project evaluation	15
Review 6	March	Project evaluation	15

Web References:

- 1 <http://www.electrical4u.com/digital-electronics.htm>
- 2 <http://www.technologystudent.com/elec1/dig1.htm>

Online Resources:

- 1 <https://www.edx.org/course/product-design-delft-design-approach-delftx-dda691x-1>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C401.1	Remember	Quiz		5
C401.2	Understand	Technical Presentation		5
C401.3	Apply	Assignment		5
C401.4	Analyze	Group Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	40	40	40	40
Understand	30	30	30	30
Apply	20	20	20	20
Analyse	10	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : G (Theory Analytical)
Pre requisites : Manufacturing Technology-II, Kinematics of Machinery and Industrial Metallurgy

Course Objectives:

1. To uncover the essential properties, selection and recent progress in cutting tool materials.
2. To select suitable single point cutting tool and multipoint cutting tool for machining process.
3. Design of Jigs and Fixtures for holding tool and work piece respective.
4. To communicate the different types of tool manufacturing process.

Course Outcomes:

Upon completion of the course, students shall have ability to

CO402.1	Recognise the materials properties, tool nomenclature and to categorize the cutting tools.	[U]
CO402.2	Interpret the parameters of the cutting tools for machining process	[AP]
CO402.3	Distinguish the various locating and clamping methods.	[A]
CO402.4	Design the jigs, fixtures, press tools and moulds.	[C]

Course Contents:

Introduction to cutting tools Introduction to cutting tools, Materials properties, classification, selection, tool wear and tool life. Single point tools: Nomenclature, types, styles, design. Multipoint cutters: Nomenclature, classification, selection, construction methods. Recent developments and applications. **Design of single point and multi point cutting tools:** Single point cutting tools: Manufacture of HSS and carbide insert type tools, turning, shaping, and slotting operations. Multi point cutting tools: Design and manufacture of, drills, hobs and gear shaper cutters

Design of jigs: Types of drill jigs, General considerations in the design of drill jigs, Drill bushings, Types, methods of construction. Simple designs of, Plate, Channel, Boxes, Post, Angle plate, Turnovers, Pot Jigs. **Design of fixtures:** Design principles, Types of fixtures, Fixtures for machine tools: Lathe, Milling, Boring, Broaching, grinding, Assembly fixtures, Inspection and Welding fixtures.

Design of Press tools: Design of die sets for, sheet metal components, simple, compound and progressive dies for, punching and blanking operations, Dies for drawing and bending operations, Selection of presses and tools, Basic construction of mould – Types of moulds – Mould parts – mould plates, sprue bush, locating ring, core and cavity, Guide pillar & guide bush, Bolsters, Types of Bolsters, Mould clamping methods, Mould lifting arrangements.

Total Hours: 45

TEXT BOOKS:

- 1 Donaldson C., Lecain G.H. and Goold V.C."Tool Design" McGraw Hill Education; 4 edition (20 April 2012)

REFERENCE BOOKS:

- 1 Metal Cutting Theory and Practice (Manufacturing Engineering and Materials Processing), David A. Stephenson, John S Agapiou, March 2016.
- 2 Mikell P Groover, "Fundamentals of Modern Manufacturing", John Wiley and Sons, Singapore, January 2010.

Web References:

- 1 <http://www.dimensionalacademy.com/courses/mechanical/machine-tool-drawing.html/>

Online Resources:1 <http://www.toolingu.com/ilt/915101/Design-for-TOOL-DFT/>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
CO402.1	Understand	Class Presentation/ Assignment		3
CO402.2	Apply	Group Discussion/ Assignment		3
CO402.3	Analyse	Term Paper/ Case Study		4
CO402.4	Create	Mini Project		10
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	50	50	50	50
Apply	40	50	30	20
Analyse	30	40	20	30
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : D (Theory application)

Pre requisites : Fluid Mechanics and Machinery

Course Objectives:

1. To introduce the working of the components of a fluid power system and their needs.
2. To enable the students to understand the operation of various fluid power circuits
3. To enable the students to understand the concepts like synchronising, sequencing for automation.
4. To prepare the students to design electro-pneumatic circuit, ladder diagrams and
5. To allow students to design and simulate the circuits.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C403.1 | Select the components as per the application | [R] |
| C403.2 | Select the control elements as per the need of the application. | [U] |
| C403.3 | Incorporate the accessories as per the emergency needs and for temporary usage in an existing application. | [AP] |
| C403.4 | Analyse the problems and provide solution to the problems in hydraulic and pneumatic systems. | [A] |
| C403.5 | Design simple and complex sequential circuits using fluid power. | [C] |

Course Contents:

Fluid power systems and Fundamentals: Introduction to fluid power, advantages of fluid power, application of fluid power system. Types of fluid power systems, properties of hydraulic fluids, general types of fluids, fluid power symbols. Basics of hydraulics, applications of Pascal's Law, laminar and turbulent flow, Reynold's number, Darcy's equation, losses in pipe, valves and fittings. **Hydraulic System and Components:** Sources of Hydraulic Power- Pumping theory, pump classification, gear pump, vane pump, piston pump. Construction and working of pumps, pump performance, variable displacement pumps. Fluid Power Actuators, Linear hydraulic actuators, types of hydraulic cylinders, single acting, double acting special cylinders like tandem, rodless, telescopic, cushioning mechanism. Construction of double acting cylinder, rotary actuators, fluid motors, gear, vane and piston motors.

Design of Hydraulic Circuits: Construction of Control Components, Directional control valve , 3/2 way valve , 4/2 way valve, shuttle valve, check valve, pressure control valve, pressure reducing valve, sequence valve, flow control valve, fixed and adjustable, electrical control solenoid valves, relays, ladder diagram. Accumulators and Intensifiers, Types of accumulators, accumulator's circuits, sizing of accumulators, intensifier, applications of intensifier, intensifier circuit. **Pneumatic System and Components:** Pneumatic Components, Properties of air, compressors, filter, regulator, lubricator unit, air control valves, quick exhaust valves, and pneumatic actuators. Fluid power circuit design, speed control circuits, synchronizing circuit, penumo-hydraulic circuit, sequential circuit design for simple applications using cascade method, Use of Karnaugh, Veitch map for pneumatic circuit design.

Design of Fluid Power Circuits: Servo systems, Hydro mechanical servo systems, electro hydraulic servo systems and proportional Valves, Introduction to electro hydraulic pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits, failure and troubleshooting. **Case studies:** A simple sequence, synchronise circuits using hydraulic and pneumatics components.

Total Hours:

45

TEXT BOOKS:

- 1 Anthony Esposito, "Fluid Power with Applications", Pearson Education 2013.
- 2 Manjundar S.R, "Oil Hydraulics", Tata McGraw-Hill, December 2002.

REFERENCE BOOKS:

- 1 Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 2010
- 2 Bolton W. "Pneumatic and hydraulic system", Butterworth-Heinemann 1997
- 3 Andrew Parr, "Hydraulic and Pneumatics", Jaico Publications House, 2005.

Web References:

- 1 <http://www.nfpa.com>
- 2 <http://www.fluidpowerjournal.com>
- 3 <http://14.139.160.15/courses/112102011/2>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C403.1	Remember	Quiz		6
C403.2	Understand			
C403.3	Apply	Assignment		3
C403.4	Analyse	Group Assignment		4
C403.5	Create	Simulation Exercise/ Mini Project		7
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	20	20	10	10
Understand	80	40	30	30
Apply	0	40	20	20
Analyse	0	0	20	20
Evaluate	0	0	0	0
Create	0	0	10	10

Nature of Course : D (Theory Application)

Pre requisites : Manufacturing technology

Course Objectives:

1. To enable the students to understand the general design guidelines of design for manufacture and assembly.
2. To provide the knowledge on minimising the cost/time, maximising the quality and ease of manufacture and assembly.
3. To enable the students to understand the principles and design rules for the design for assembly, machining metal forming and casting.
4. To imply the various design principles in design and development of a product.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C404.1 | Summarize the design procedure of engineering products in order to minimize the cost/time. | [U] |
| C404.2 | Design the engineering products in order to maximize the quantity. | [A] |
| C404.3 | Design the engineering products for ease of assembly and machining. | [A] |
| C404.4 | Apply the design concepts of engineering products for ease of metal forming and casting. | [AP] |
| C404.5 | Imply the design in DFMA software and analyze the Design parameters of a product. | [E] |

Course Contents:

DFMA Introduction: Engineering design – Kinds of design – Design process steps – Factors influencing design – Concurrent Engineering – Material selection process – Evaluation methods for material selection. **Tolerance analysis:** Process capability analysis – Cumulative effect of tolerances – Centrality analysis – Compound assembly – Selective and Interchangeable assembly – Grouped Datum systems.

Design for casting, welding and machining: Design for castings – Design for weldments – Design for forgings – Design for sheet metal formed parts – Design for powder metallurgy parts – Design for plastic parts. Design for machining – Design for economy – Design for clampability – Design for ease of assembly – Design for disassembly.

DFMA software: Advances in DFMA- Design for robustness – Axiomatic design – Design for environment – DFA index – Poka Yoke – Lean principles – Six sigma concepts – Computer aided DFA using software.

Total Hours: 45

TEXT BOOKS:

1. Matousek, R. "Engineering Design" Blackie and Son Limited, Glasgow, 2015.
2. Dieter, G.E. "Engineering Design: A Materials and processing Approach", McGraw Hill Co. Ltd, 5th edition, 2012.

REFERENCE BOOKS:

1. Eggert, R.J. "Engineering Design" Pearson Education, Inc. New Jersey, 2014.
2. Peck, H. "Designing for Manufacture", Pitman Publications, London, 2013.
3. Kalandar Saheb, S.D and Prabhakar, O. "Engineering Design for Manufacture", ISPE 2014.
4. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, "Product design for manufacture and assembly", Second edition, Taylor and Francis 2015.

Web References:

1. www.dfma.com
2. www.mjme.ir -International journal of advanced design and manufacturing.

Online Courses:

- 1 www.nptel.ac.in/courses/107103012

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C404.1	Understand	Class presentation		4
C404.2	Analyze	Assignment/ Case study		8
C404.3	Analyze			
C404.4	Apply	Puzzles and Games		4
C404.5	Evaluate	Group Assignment		4
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	40	40	40	35
Apply	20	30	30	35
Analyse	20	20	20	20
Evaluate	20	10	10	10
Create	0	0	0	0

Nature of Course : G (Theory analytical)

Pre requisites : Industrial Engineering and Operations Research

Course Objectives:

- 1 To enable the students to have an insight knowledge about the optimization techniques to industrial operations.
- 2 To make the students understand and apply optimization techniques to real world problems.
- 3 To make the student develop the Mathematical techniques and algorithms to practical problems.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C405.1 | Implement the basics of optimization techniques to engineering problems. | [U] |
| C405.2 | Formulate and solve non-linear programming problems. | [AP] |
| C405.3 | Solve integer programming problems. | [A] |
| C405.4 | Solve dynamic programming problems. | [A] |
| C405.5 | Apply non-traditional techniques to managerial problems. | [E] |

Course Contents:

Non Linear Optimization: Introduction to Non-linear optimum design-General principles of optimization–Problem formulation & their classifications. Single variable and multivariable optimization, Techniques of unconstrained minimization. Golden section, Random, pattern and gradient search methods. Non-linear Optimization with equality and inequality constraints. Direct methods–Indirect methods using penalty functions. Lagrange multipliers -Geometric programming.

Integer Programming Problems: Introduction- Integer Programming formulations. Branch and bound technique. Gomory's cutting plane method.

Dynamic Programming Problems: Introduction to Dynamic Programming (DP) - Bellman's principle of optimality. Application of DP-Capital budgeting, Reliability improvement. Shortest path and cutting stock problems.

Nontraditional Optimization: Introduction to non-traditional optimization, Computational Complexity – NP-Hard and NP-Complete. Taguchi method ,Working principles of Genetic Algorithm, Simulated Annealing and Particle Swarm Optimization, Fuzzy logic and neural networks - Simple applications

Total Hours: 45

TEXT BOOKS:

- 1 Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall India (Pvt) Ltd., New Delhi, 2012.
- 2 Ravindran, Phillips and Solberg, "Operations Research: Principles and practice", Wiley India 2nd edition, 2007.

REFERENCE BOOKS:

- 1 Taha H.A, "Operation Research: An Introduction", Pearson Education 9th Edition, 2013.
- 2 Paneerselvam R., Operations Research, Prentice Hall of India, Fourth Print, 2009.
- 3 David E Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Addison, Wesley Pub Co, 2000.

Web References:

- 1 <http://www.nptel.ac.in/downloads/105108127>.
- 2 <http://nptel.ac.in/courses/Webcourse-contents/iisbang/optimization/methods/pdf>.

Online Resources:

- 1 <https://www.coursera.org/learn/algorithms-npcomplete>
- 2 <https://www.coursera.org/learn/neural-networks>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C405.1	Understand	Quiz		4
C405.2	Apply	Assignment Presentation		4
C405.3	Analyse	Case Study/Test/ Assignment		8
C405.4	Analyse			
C405.5	Evaluate	Group Assignment		4
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	30	30	30	30
Apply	20	30	30	30
Analyse	30	30	30	30
Evaluate	20	10	10	10
Create	0	0	0	0

Nature of Course : C (Theory Concept)
Pre requisites Engineering Mechanics, Kinematics of Machinery

Course Objectives:

- 1 To be familiar with the industrial automation and brief history of robot and its application.
- 2 To enable the students to familiarize with the kinematics of robots.
- 3 To impart knowledge on robot end effectors, arm and their design.
- 4 To enable the students to write programs for Robot
- 5 To impart knowledge on various Sensors and their applications in robots.

Course Outcomes:**Upon completion of the course, students shall have ability to**

- | | | |
|--------|--|------|
| C406.1 | Summarize the types, principles and applications of industrial robots and sensors | [U] |
| C406.2 | Elaborate types of robot arm, manipulator, and gripper configuration based on kinematics and dynamics of robot depending upon the application. | [U] |
| C406.3 | Apply the kinematic and dynamic motions of robot based on application. | [AP] |
| C406.4 | Design the drive mechanism and power transmission method used in robot based on applications. | [C] |
| C406.5 | Develop robot by applying the concepts such as kinematics, drive, transmission and control mechanism, sensors and programming language to according to an application. | [C] |

Course Contents:

Introduction : Robot definition: Robotic systems - Its role in automated manufacturing; robot anatomy; robot classifications and specifications - Types of industrial robots - Work envelope - Flexible automation versus Robotic technology – Applications of Robots. **Robot Kinematics and dynamics:** Translations, Rotations and Transformations - Forward and reverse transformation, homogeneous transformations - Forward and inverse Kinematics Of three & four Degree of Freedom Robot Arm. Robot Arm dynamics.

Robot drives, power transmission: Robot drive mechanisms – hydraulic – pneumatic and electric, Mechanical transmission methods. Electronic and Pneumatic manipulators - Construction of Manipulators. Classification of End effectors - Drive system for grippers-Mechanical-adhesive-vacuum-magnetic-grippers. Active and passive grippers.

Robot sensors, programming and language: Robot sensors, different types of contact and non-contact sensors. Robot languages and programming techniques. **Industrial Applications of robot:** Material transfer, Machine loading, Assembly, inspection, processing operations and service robots, Robots in continuous arc welding, Robots, Robot cell.

Case studies: Robotic vision systems, image representation, object recognition and categorization, Future of robotics.

Total Hours: 45

TEXT BOOKS:

- 1 Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications ", McGraw Hill International Editions, 1st Edition, 2012
- 2 Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, 2012

REFERENCE BOOKS:

- 1 Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 2009
- 2 M.P Groover, M Weiss, R M Gnagel and N G Ordrey, "Industrial Robotics", Tata McGraw - Hill, New Delhi, 2012

Web References:

- 1 <http://www.robotics.org/>
- 2 <http://www.robotbooks.com/general-robotics-links.htm>

Online Resources:

- 1 <https://www.edx.org/course/robotics-columbiacx-csmm-103x>
- 2 <https://www.edx.org/course/robot-mechanics-control-part-i>
- 3 <https://www.edx.org/course/robot-mechanics-control-part-ii>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C406.1	Understand	Class Presentation		4
C406.2	Understand	Quiz		4
C406.3	Apply	Group Assignment		4
C406.4	Create	Case study		4
C406.5	Create	Mini Project		4
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	60	60	60	60
Apply	40	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: D (Theory)

Pre Requisites: Engineering Mechanics , Kinematics of Machinery , Dynamics of Machinery

Course Objectives:

- | | | |
|----|--|----|
| 1. | impart knowledge on vibrations and its types. | To |
| 2. | understand the experimental procedures of vibration measurement. | To |
| 3. | study the control measures of vibrations. | To |

Course Outcomes

Upon completion of the course, students shall have ability to

- | | |
|--|------|
| C407.1. To understand the different types of vibrations and the related terms. | [U] |
| C407.2. Develop schematic models for physical systems and formulate governing equations of motion for various vibrating systems. | [AP] |
| C407.3. Analyze and design supporting structures, vibration isolators and absorbers. | [A] |
| C407.4. Examine the vibration control methods | [A] |

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

INTRODUCTION & SINGLE DOF SYSTEMS Introduction-Causes and effects of vibration, Classification of vibrating system, Physical models, Schematic models and Mathematical models. SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert’s method, Energy method, Free Vibration: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation. **FORCED VIBRATIONS** Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension.

TWO DOF SYSTEMS Two degree of freedom systems: Introduction, Formulation of equation of motion , General solution to free vibration problem - damped free vibration - Forced vibration of undamped system -dynamic vibration absorbers - Technical applications. **MULTI DOF SYSTEMS** Newton’s second law to derive equation of motion, Influence co-efficient - Stiffness influence co-efficient - Flexibility influence co- efficient - Inertia influence co - efficient, Eigen values & Eigen vectors. Methods of finding Natural Frequencies for simple problems -Dunkley, Rayleigh’s, Matrix iteration - Stodolo’s methods.

EXPERIMENTAL METHODS IN VIBRATION MEASUREMENT & CONTROL Vibration Instruments, Vibration exciters and Measuring devices, Analysis, Vibration Tests, Free and Forced Vibration tests. Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber- Damped Vibration absorbers-Static and Dynamic Balancing

Total Hours : 60

TEXT BOOKS:

1. Singiresu S. Rao, Mechanical Vibrations, Prentice Hall Publish, New Delhi, 2010.
2. J. S. Rao , Vibratory Condition Monitoring of Machines, Narosa Publishing House, New Delhi, 2013.

REFERENCE BOOKS:

1. J. P. Den Hartog – Mechanical Vibrations, Caster press, 2007.
2. K.J.Bathe, Finite Element Methods, Prentice Hall, Pearson Education, Inc, 2016.

Web References:

1. NPTEL:<http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT%20Guwahati/ve/index.htm>
2. www.conditionmonitoringsystem.com/

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C407.1	Understanding	Presentation/Quiz	5	
C407.2	Apply	Presentation/Assignment	5	
C407.3	Analyse	Group Assignment	5	
C407.4	Analyse	Technical Quiz	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 8 marks	
Remember	0	0	0	0
Understand	60	40	50	50
Apply	40	20	30	30
Analyse	0	40	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: (Theory)

Pre Requisites: Fundamentals of Materials

Course Objectives:

1. Students will be able to understand the basic concepts and classifications of composite materials.
2. Students will be able to analysis micro & macro mechanical behavior of composites.
3. Students will be able to understand the basics of smart materials.

Course Outcomes

Upon completion of the course, students shall have ability to

- | | |
|--|------|
| C408.1. Define the basic concepts of composite Materials | [U] |
| C408.2. Illustrate the Applications of Smart materials | [Ap] |
| C408.3. Analysis the micro and macro mechanical properties | [A] |
| C408.4. Evaluate the Fatigue and Fracture Mechanics | [E] |

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

INTRODUCTION: Modern materials in design, types, metals, polymers, ceramics, composites, Classification of composites, advantages, applications and limitations, Matrix and reinforcement-their roles, principal types of fibre and matrix materials. **MANUFACTURE OF COMPOSITE COMPONENTS:** Lay up and curing, open and closed mould processes, bag moulding, filament winding, pultrusion, pulforming, thermoforming, injection moulding, blow moulding,an overview of metal matrix composite processing and ceramic matrix composite processing.

MICRO MECHANICAL BEHAVIOUR OF A LAMINA: Volume and mass fractions, evaluation of elastic moduli, strength of unidirectional lamina. **MACRO MECHANICAL BEHAVIOUR OF A LAMINA:** Hooke's law for different types of materials, engineering constants for orthotropic materials. Stress, strain relations for plane stress in an orthotropic materials and in a lamina of arbitrary orientation, strength of an orthotropic lamina, basic strength theories.

MACRO MECHANICAL BEHAVIOUR OF A LAMINATE: Classical lamination theory - lamina stress - strain behaviour - resultant forces and moments in a laminate - types of laminates - strength and stiffness of laminates - inter laminar stresses in laminates. **ANALYSIS OF COMPOSITE STRUCTURES:** Fatigue, Fracture mechanics-basic principles, fracture initiation, crack growth and crack growth modes, toughening mechanisms, Environmental effects, Composite joints-bonded, bolted and bonded-bolted joints.

Total Hours: 45

TEXT BOOKS:

1. Autar K Kaw, "Mechanics of Composite Materials", CRC Press, NY, 2006.
2. Srinivasan A V and Michael McFarland, "Smart Structures: Analysis and Design", Cambridge University Press, UK, 2001.

REFERENCE BOOKS:

1. Ronald F Gibson, "Principles of Composite Material Mechanics", McGraw Hill Book Co, 2007.
2. Robert M Jones, "Mechanics of Composite Materials", Taylor and Francis, 1999.

Web References:

1. <http://nptel.ac.in/courses/101104010/>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C408.1	Understand	Group Assignment		5
C408.2 & C408.3	Apply / Analyse	Poster Presentation		10
C408.4	Evaluate	Individual Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	0	0	0	0
Understand	40	40	50	40
Apply	40	40	30	30
Analyse	20	20	20	20
Evaluate	0	0	0	10
Create	0	0	0	0

Nature of Course: D (Theory)

Pre Requisites Design of Machine Elements

Course Objectives:

1. To introduce the engineering design process through selective design challenges.
2. To understand the role of computer-based modelling as an essential tool in the engineering design process.
3. To understand the design process leading to a realizable product with an appreciation of the economic, environmental concerns, manufacturability and product life cycle management.

Course Outcomes

Upon completion of the course, students shall have ability to

- C409.1: Describe an engineering design and development process. [U]
 C409.2: Conduct Investigations using design of experiments, analyse and interpret data to arrive at valid conclusions. [E]
 C409.3: Formulate, analyse and solve mechanical engineering problems [A]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

PRODUCT DESIGN PROCESS Importance of product design - design process - design considerations - morphology of design - marketing organization for design - computer aided engineering - codes and standards - Product and process cycles – Technological Forecasting - Market Identification – Competition Benchmarking. **PRODUCT PLANNING AND SPECIFICATION** Opportunities identification – evaluation Resource allocation – pre project planning Customer need identification Establishing target specification- setting the final specification

CONCEPT GENERATION, SELECTION AND TESTING Concept generation through TRIZ- Theory to Resolve Inventive Problem - Concept of ideality/ physical & Technical contradiction – 39 Contradiction matrix – 40 Inventive principles – 76 Standard solutions – ARIZ algorithm Case studies - concept testing - choice of survey population - survey formats - measurement of customer response - interpretation and analysis of results. **INDUSTRIAL DESIGN, DFM AND PROTOTYPING** Product architecture – implications – establishment - platform planning System level design, need for industrial design and its impact - industrial design process and its management - assessment of quality. Overview of design for manufacture process - steps in DFM. Basics principles of prototyping - prototyping technologies - planning for prototypes.

ROBUST DESIGN AND INTELLECTUAL PROPERTY RIGHTS Design of experiments - steps in the robust design process. Elements of economic analysis - steps in economic analysis process Overview of patents - utility patents - steps in preparing disclosure

Total Hours 45

TEXT BOOKS:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development”, Tata McGraw - Hill Education (2009).
2. George Ellwood Dieter, “Engineering Design”, McGraw-Hill Book Company, International Edition, 2012.
3. The Mechanical Design Process (McGraw-Hill Series in Mechanical Engineering) by David Ullman, 2009.

REFERENCE BOOKS:

1. Product Design: Techniques in Reverse Engineering and New Product Development by Kristin L Otto Kevin N.; Wood, 2006.
2. Engineering of Creativity: Introduction to Triz Methodology of Inventive Problem Solving by Semyon D. Savransky CRC Press, 2000.

Web References:

1. <http://www.walkinginfo.org/engineering/case-studies.cfm>.
2. <http://www.springer.com/engineering/mechanical+engineering/journal/163>
3. <http://www.triz-journal.com/>
4. <http://www.trizasia.com/>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C409.1	Understanding	Presentation/Quiz		5
C409.2	Evaluate	Assignment		5
C409.3	Analyse	Case Study		10
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	0	0	0	0
Understand	50	70	60	60
Apply	0	0	0	0
Analyse	30	20	20	20
Evaluate	20	10	20	20
Create	0	0	0	0

ELECTIVE STREAM – II THERMAL ENGINEERING

15ME410

RENEWABLE ENERGY SOURCES

3/0/0/3

Nature of Course: G (Theory, Analytical)

Pre Requisites: Thermodynamics, Fluid Mechanics, Heat and Mass Transfer

Course Objectives:

4. To understand and analyze the patterns of renewable energy resources and its environmental merits
5. To discuss technologies for utilization of renewable energy sources
6. To enable the students to understand the various economics involved in the utilization of renewable energy sources

Course Outcomes

Upon completion of the course, students shall have ability to

- | | |
|--|------|
| C410.1 List the various sources of energy | [R] |
| C410.2 Explain the various means to utilize the Renewable Energy resources | [U] |
| C410.3 Interpret the impact of renewable energy resources on the environment | [AP] |
| C410.4 Explain the scope of newer sources of energy and their application | [A] |

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

Role and potential of new and renewable source, the solar energy option– solar Cells – PV Systems, Solar Thermal Collectors – Flat Plate and Concentrating Collectors – Solar Applications – fundamentals of photo Voltaic Conversion, **Solar Radiation** – Measurements of solar Radiation and sunshine – PV Applications and state of the art applications like solar walls, solar refrigeration, etc., Environmental Impact of Solar power.

Energy available from wind, Basis of Wind energy conversion, General formula, Lift and drag, Effect of density, Angle of attack, Wind Energy generators and its performance – Wind Energy Storage – **Applications** – Hybrid systems – State of the art technology trends for offshore wind energy operation Biomass, Biogas, Source, Composition, Raw materials, Properties of bio gas, Producer gas, Transportation of bio gas, Bio gas production Aerobic and anaerobic bio-conversion process, Technology for utilization – Biomass direct combustion – Biomass gasifier – Biogas plant – Digesters – Ethanol production – Bio diesel production and economics. Photosynthesis, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production. Government Policy and Status of Bio fuel technologies in India Principle of **ocean thermal energy conversion**, Tidal energy – Data, Technology options, Offshore and Onshore wave energy conversion machines.

Power plants based on ocean energy, Problems associated with ocean thermal energy conversion systems – Open and closed OTEC Cycles – Small hydro turbines, **Geothermal energy sources**, power plant and environmental issues – potential in India. **Hydrogen**, generation, storage, transport and utilization, **Nuclear fission and fusion**, Applications: power generation, transport – *Fuel cells – technologies*, types – economics and the power generation - **Magneto-hydro-dynamic** (MHD) energy conversion. Fuel from sea – concept.

Total Hours 45

TEXT BOOKS:

1. A G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 2011.
2. S.P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2008.

REFERENCE BOOKS:

1. C. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 2012.
2. D. Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 2015.
3. E.G.N. Tiwari, Solar Energy – Fundamentals Design, Modelling& applications, Narosa Publishing House, New Delhi, 2012.

Web References:

1. www.nptel.ac.in
2. www.learnerstv.com
3. www.academia.edu

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	Bloom's Level	Assessment Component	Marks
C410.1	Remember	Quiz	5
C410.2	Understand	Group Discussion	5
C410.3	Apply	Assignment	5
C410.4	Analyze	Case Study	5

Blooms Taxonomy based Assessment Pattern:

Bloom's Category	Continuous Assessment Tests			Semester End Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	40	40	40	40
Understand	30	30	30	30
Apply	0	0	0	0
Analyse	20	20	20	20
Evaluate	10	10	10	10
Create	0	0	0	0

Nature of Course : G (Theory analytical)

Pre requisites : Engineering Thermodynamics, Thermal Engineering.

Course Objectives:

- 1 To understand Vapour compression and vapour absorption system operation
- 2 To analyse the refrigeration cycles and methods for improving Performance
- 3 To familiarize the components of refrigeration systems
- 4 To design air conditioning systems using cooling load calculations
- 5 To know the application of refrigeration and air conditioning systems

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|------|
| C411.1 | Explain the principles and applications of refrigeration and air conditioning systems. | [R] |
| C411.2 | Differentiate the various types of refrigeration and air conditioning systems. | [U] |
| C411.3 | Design and Analyse various refrigeration and air conditioning systems. | [AP] |
| C411.4 | Select methods for performance improvement of refrigeration and air conditioning systems. | [A] |

Course Contents:

Introduction to Refrigeration –Basic Definition, ASHRAE Nomenclature, **Air Refrigeration Cycles**-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits, analysis. **Vapour Compression Refrigeration system** – Carnot Vapour compression refrigeration cycle, Working and analysis, Limitations, Effects of sub cooling and super heating, Multi- Pressure or Compound Vapour Compression Refrigeration Systems.

Vapour Absorption Refrigeration Systems - Absorbent – Refrigerant combinations, Water-Ammonia Systems, Water-Lithium Bromide System, Contrast between the two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyser Assembly. **REFRIGERANTS&REFRIGERATION SYSTEM EQUIPMENT** - Classification, Selection and Nomenclature of refrigerants. Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, Testing and charging of refrigeration units.

AIR CONDITIONING SYSTEMS- Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Different Air-Conditioning Systems- Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems. Introduction to HVAC systems.

Total Hours: 45

TEXT BOOKS:

- 1 Arora.S.C and Domkundwar.S, “A course in Refrigeration and Air conditioning”, Dhanpat Rai (P) Ltd., New Delhi, 2012
- 2 Ananthanarayanan.P.N, “Basic Refrigeration and Air Conditioning”, Tata McGraw Hill, 5th edition, New Delhi, 2013.

REFERENCE BOOKS:

- 1 Arora,C.P.,”Refrigeration and Air Conditioning”,Tata McGraw Hill, New Delhi, 2010.
- 2 Manohar Prasad, “Refrigeration and Air conditioning”, New Age International (P) Ltd, New Delhi, 2010.
- 3 Roy J. Dossat, “Principles of Refrigeration”, Pearson Education Asia, 4th edition, 2008.

Web References:

- 1 <http://nptel.ac.in/courses/112105128/>
- 2 <http://www.technologystudent.com/mech1/dig1.html>

Online Resources:

- 1 [http://www.nesoac.org/mechanical engineering/ refrigeration](http://www.nesoac.org/mechanical%20engineering/refrigeration)
- 2 [http://www.slideshare.net/ refrigeration and air conditioning notes](http://www.slideshare.net/refrigeration%20and%20air%20conditioning%20notes)

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C411.1	Remember	Quiz		5
C411.2	Understand	Technical Presentation/ Assignment		5
C411.3	Apply	Group Assignment		5
C411.4	Analyze	Term paper/ Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	40	30	30	30
Understand	40	30	30	30
Apply	20	20	20	20
Analyse	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : H (Theory technology)

Pre requisites : Engineering Thermodynamics, Thermal Engineering

Course Objectives:

- 1 To be aware of the available alternate resources available
- 2 To recognize the ways of implementing the resources

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|-----|
| C412.1 | Interpret the need, availability and difficulty in alternate fuel | [U] |
| C412.2 | Know the standards followed and properties of alternate fuels | [A] |
| C412.3 | Examine the performance and emission characteristics of engines using alternate fuels | [A] |
| C412.4 | Identify the most effective alternative resource | [U] |

Course Contents:

Introduction: Need for alternate fuel Availability, Properties of alternate fuels, general use of alcohols, LPG, hydrogen, CNG, LNG **Alcohols:** Properties of engine fuel, alcohols and gasoline blends, Performance in SI and CI engine, combustion characteristics in CI engines, Emission characteristics.

Natural Gas, LPG, Hydrogen and Biogas: Availability of CNG, Properties, modifications required to use in engines, Performance and emission characteristics of CNG and LPG in SI and CI engines, Hydrogen storage and handling, performance and safety aspects. **Vegetable Oils:** Esterification, Performance in engines and emission characteristics, Bio-diesel and its characteristics

Electric, Hybrid, Fuel Cell and Solar Cars: Layout of an electric vehicle, advantage and limitations, specifications, system components, electronic control system, high energy and power density batteries, hybrid vehicle, fuel cell vehicles, solar powered vehicle

Total Hours: 45

TEXT BOOKS:

- 1 Amit Sarin, "Biodiesel- Production and Properties"-RSC Publishing- 2012- ISBN:978-1-84973-470-7, 2012
- 2 Sunggyu Lee, James G. Speight, Sudarshan K. Loyalku- "Handbook of Alternative Fuel Technologies"- CRC Press- 2015

REFERENCE BOOKS:

- 1 Ayhan Demirbas, "Biodiesel- A Realistic Fuel Alternative for Diesel Engines"- Springer- ISBN:978-1-84628-994-1, 2008.
- 2 Curtis D. Anderson and Judy Anderson, "Electric and Hybrid Cars- A History"- McFarlad & Company, Inc, Publishers- 2005

Web References:

- 1 <http://www.dailymotion.com/video/x49y62q>

Online Resources:

- 1 <http://www.bloomberg.com/features/2016-ev-oil-crisis/>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C412.1	Understand	Online Quiz		5
C412.2	Analyze	Assignment		5
C412.3	Analyze	Group Assignment		5
C412.4	Understand	Case Study/Quiz		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination (60 Marks)
	CIA1 (6 Marks)	CIA2 (6 Marks)	Term End Assessment (8 Marks)	
Remember	0	0	0	0
Understand	60	50	50	60
Apply	40	50	50	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : G (Theory analytical)

Pre requisites : Thermodynamics, Thermal Engineering

Course Objectives:

- 1 To study the concept of unified theory applicable for all turbo machines.
- 2 To learn the fundamental knowledge about the design variations of thermal turbo machines.
- 3 To understand the design for developing thermal turbo machines.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C413.1 | Understand the basics of turbo machines including dimensional analysis | [U] |
| C413.2 | Apply the concept of velocity triangle in determining the performance of the turbo machines | [Ap] |
| C413.3 | Analyse the efficiencies and losses in the performance characteristics of the turbo machines | [A] |
| C413.4 | Evaluate the power and operational characteristics of the turbo machines | [E] |

Course Contents:

Introduction- Turbines, Pumps, Compressors, Fans and Blowers, Stages of Turbo machines, Energy transfer between fluid and rotor, Stage velocity triangles Thermal Turbo machines, Classification, General energy equation, Modified to turbo machines, compression and expansion process, Velocity triangles, Work, T-S and H-S diagram, Total to Total and Total to Static efficiencies, Dimensional analysis, Non-dimensional parameters of compressible flow Turbo machines, Similarity laws, applications and limitations Definition, selection and classifications, Types of blading design-velocity triangles, Stage Parameters, Flow analysis in impeller blades, Design parameter, Volute and Diffusers, Efficiencies and Losses, Fan noises, Causes and remedial measures, Centrifugal Compressors, Constructional details, Stage velocity triangles, Stage work, Stage pressure rise, Stage efficiency, Degree of reaction, Slip factor, H-S diagram. Efficiencies, Performance characteristics Definition and classifications, Stage parameters, Types of fan stages, performance characteristics. Cascade of blades, Cascade tunnel, Blade geometry, Cascade variables, Energy transfer and loss in terms of lift and drag, Axial Flow

Compressors: definition and classifications, Constructional details, Stage velocity triangles, Stage work, Stage pressure rise, H-S diagram, Stage efficiencies and losses, Degree of reaction, Radial equilibrium, Surging and Stalling, Performance characteristics Construction details, 900 IFR turbine, Stage work, Stage Velocity triangles, Stage pressure rise, Impulse and reaction stage, Effect of degree of reaction, H-S diagram, Efficiencies and Losses, Performance characteristics Constructional details, Stage velocity triangles, H-S diagram, Stage efficiencies and losses, Performance characteristics.

Wind turbines- definition and classifications, Constructional details, Horizontal axis wind turbine, Power developed, Axial thrust and Efficiency. Turbo expander, Turbo prop, Mixed flow compressor Mini Project : Analyse any one type of turbine using a software; Self-study: Experimental analysis of a turbine model in wind tunnel.

Total Hours: 45

TEXT BOOKS:

- 1 Yahya, S M, Turbines Compressors and fans, 4th ed, Tata McGraw-Hill, 2010.
- 2 Dixon, S L, Fluid Mechanics and Thermodynamics of Turbo machinery 7th Ed, Elsevier Butterworths Heinemann, 2014.

REFERENCE BOOKS:

- 1 Prithvi Raj, D and Gopalakrishnan, G, A Tratise on Turbomachines, Scitech publication, 2003
- 2 Ganesan, V., Gas Turbines, Tata McGrawHill, 2011
- 3 Cohen H, Rogers,G F C and Saravan motto H I H, Gas Turbine Theory, John Wiely, 6th Edition 2013.

Web References:

- 1 www.nptel.ac.in
- 2 www.learnerstv.com

Online Resources:

- 1 www.academia.edu

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C413.1	Understand	Quiz		5
C413.2	Apply	Assignment		5
C413.3	Analyse	Assignment/Case Study		5
C413.4	Evaluate	Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	0	0	0	0
Understand	50	50	50	50
Apply	30	30	30	30
Analyse	20	10	10	10
Evaluate	0	10	10	10
Create	0	0	0	0

Nature of Course : G (Theory analytical)
Pre requisites : Engineering Thermodynamics, Thermal Engineering

Course Objectives:

1. To understand the basic difference between incompressible and compressible flow.
2. To understand the phenomenon of shock waves and its effect on flow.
3. To gain basic knowledge about jet propulsion.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | |
|---|------|
| C414.1. Discover the behavior of various flow regimes. | [U] |
| C414.2. Assess the properties of fluid when the fluid flow under different flow conditions. | [AP] |
| C414.3. Analysis the flow behaviour and consequent loads due to flow. | [A] |
| C414.4. Estimate propulsion efficiency and design inlets and nozzles. | [E] |

Course Contents:

Compressible flow fundamentals: Energy and momentum equations for compressible fluid flows, Various regions of flow, Reference Velocities, Stagnation state, velocity of sound, Critical states, Mach Number, (Significance and Characteristics) Critical Mach number, Types of waves, Mach cone, Mach angle, Effect of Mach Number on compressibility. **Flow through variable area ducts:** Isentropic flow through variable area ducts, T-s, h-s diagrams for nozzles & diffusers, Mach number variation, Area ratio as a function of Mach number, Mass flow rate through nozzles & diffusers, Effect of friction in flow through Nozzles.

Fanno and Rayleigh flow: Isentropic flow through variable area ducts, T-s, h-s diagrams for nozzles & diffusers, Mach number variation, Area ratio as a function of Mach number, Mass flow rate through nozzles & diffusers, Effect of friction in flow through Nozzles. **Normal shock:** Governing equations, variation of flow parameters like static pressure, static temperature density, stagnation pressure and entropy across the normal shock, Prandtl-Meyer Equation, Impossibility of shock in subsonic flows, Flow in convergent and divergent nozzles with shock, normal shock in Fanno and Rayleigh flows. Flow with oblique shock (Elementary treatment only).

Jet propulsion: Aircraft propulsion, Types of Jet Engines, Energy flow through Jet Engines, Study of turbojet engine, Performance of Turbo jet engines-thrust and thrust power, propulsive and overall efficiencies, Cryogenics, Aero elasticity.

Total Hours: 45

TEXT BOOKS:

- 1 Yahya. S.M., "Fundamental of Compressible Flow", New Age International (p) Ltd., New Delhi, 2010
- 2 Patrich.H. Oosthvizen, William E.Carscallen, "Compressible Fluid Flow", McGraw-Hill Education, 2013.

REFERENCE BOOKS:

- 1 Cohen. H., Rogers R.E.C and Sravanamutoo, "Gas Turbine Theory", Addison Wesley Ltd., 2014.
- 2 Ganesan. V., "Gas Turbines", McGraw-Hill Education, New Delhi, 2010.
- 3 Balachandran.P, "Fundamentals of Compressible Fluid Dynamics", Prentice Hall of India, New Delhi, 2013.

Web References:

- 1 <http://www.grc.nasa.gov/WWW/K-12/airplane/bgp.html>
- 2 <http://history.nasa.gov/SP-4219/Contents.html>

Online Resources:

- 1 <http://nptel.ac.in/syllabus/112102013/>
<http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-120-compressible-flow-spring-2003/>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C414.1.	Understand	Quiz		5
C414.2.	Apply	Group Assignment		5
C414.3.	Analyze	Tutorial / Case Study		5
C414.4.	Evaluate	Term paper/ Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	0	0	0	0
Understand	40	40	40	40
Apply	20	20	30	30
Analyse	20	20	20	20
Evaluate	20	20	10	10
Create	0	0	0	0

Nature of Course : D (Theory Application)
Pre requisites : Thermodynamics, Thermal Engineering

Course Objectives:

- 1 To provide a general perspective of Power Plant engineering indicating the role of mechanical Engineers in their operation and maintenance.
- 2 To understand the construction, working principles and advantages of a combined gas turbine steam turbine power plant and diesel power plant.
- 3 To create awareness about cost of electric energy, tariff calculation and economics of various power plants.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C415.1 | Recall the various techniques used for power generation | [R] |
| C415.2 | Describe the functioning of components in steam power plant. | [U] |
| C415.3 | Sketch the design layout and explain the working of hydroelectric, nuclear and renewable power plants. | [AP] |
| C415.4 | Deduce the economic feasibility and its implications on power generating units. | [A] |

Course Contents:

Layout of modern coal power **thermal power plant**, Steam Boilers– High Pressure and Super Critical Boilers– Fluidized Bed Boilers, *Water treatment methods*, Fuel and Ash Handling, Combustion Equipment for burning coal, Mechanical Stokers, Pulveriser, *De-aerators*, Electrostatic Precipitator, Draught – different types, Surface Condenser Types,

Cooling Towers Layout and Types of Diesel Plants, Components, Selection of Engine type , layout of gas turbine power plant - Applications -Fuels - Gas Turbine Material – Open and Closed Cycles – Reheating – Regeneration and Intercooling (Descriptive only)– Combined Cycle. Nuclear Energy – Fission, Fusion Reaction, Types of Reactors, Waste Disposal and safety, *evacuation and sheltering*, Hydel Power Plant – typical layout, Essential Elements,

Selection of Turbines, Governing of Turbines, Construction and working of wind, tidal, solar photo voltaic, geothermal ,biogas and ocean Thermal Energy Conversion power plants, Economics of power plant – Actual load curves, cost of electric energy-fixed and operating Costs-energy rates – Types of Tariffs, Economics of load sharing – variable load operation –Comparison of economics of various power plants.

Total Hours: 45

TEXT BOOKS:

- 1 P.K. Nag, “Power Plant Engineering”, McGraw – Hill Education, Third Edition, 2014.
- 2 Frederick T. Morse, “Power Plant Engineering”, Affiliated East-West-Press Private Ltd.,New Delhi 2011.

REFERENCE BOOKS:

- 1 G. R. Nagpal, “Power Plant Engineering”, Khanna Publishers, New Delhi, 2015.
- 2 Arora S C and Domkundwar, S., “Power Plant Engineering”, DhanpatRai& Sons,2007
- 3 Wakil, M.M., “Power Plant Technology”, McGraw-Hill Education, 2014

Web References:

- 1 www.nptel.ac.in
- 2 www.learnerstv.com

Online Resources:1 www.academia.edu

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C415.1	Remember	Quiz		5
C415.2	Understand	Group Discussion/ Assignment		5
C415.3	Apply	Group Assignment		5
C415.4	Analyze	Case study		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	40	40	40	40
Understand	30	30	30	30
Apply	20	20	20	20
Analyse	10	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: D (Theory Application)

Pre Requisites: Nil.

Course Objectives:

1. To familiarize the student with Concepts of Solar and Wind energy conversion
2. To give knowledge about the various systems involved in Solar and wind energy

Course Outcomes

Upon completion of the course, students shall have ability to

- C416.1 : Define the basic concepts of generation and selection of solar panel [R]
 C416.2 : Explore the various aspects of solar thermal systems and PV cell [Ap]
 C416.3 : Compare the characteristics of various wind turbine and wind energy conversation system [A]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

SOLAR RADIATION: Availability, Measurement and Estimation, Isotropic and an isotropic models, Introduction to solar collectors flat, plate collectors, Air heater and Concentrating collectors and Thermal storage, Steady state transient analysis, Solar Pond Solar Refrigeration..

MODELLING OF SOLAR THERMAL SYSTEMS AND SIMULATIONS IN PROCESS DESIGN Design of active systems by f-chart and utilizability methods, water heating systems, Active and passive, Passive heating and cooling of buildings, Solar distillation, Solar Drying.

PHOTOVOLTAIC SOLAR CELL: P-N Junction, Metal, Schottky junction, Electrolyte, Semiconductor Junction, Types of solar cell, their Applications, Experimental Techniques to determine the characteristics of Solar cells Photovoltaic Hybrid Systems Photovoltaic Thermal Systems, Storage Battery, Solar Array Characteristics, Evaluation, Solar Chargeable Battery.

WIND TURBINE: Structure, Statistics, Measurements and Data Presentation, Wind Turbine Aerodynamics, Momentum Theories, Basics Aerodynamics, Airfoils Characteristics, HAWT, Blade Element Theory, Prandtl's Lifting Line Theory (prescribed wake analysis), VAWT Aerodynamic Loads in Steady Operation, Wind Turbulence, Yawed Operation and Tower Shadow.

WIND ENERGY CONVERSION SYSTEM (WECS): Siting, Rotor Selection, Annual Energy Output, Horizontal Axis Wind Turbine (HAWT) Vertical Axis Wind Turbine, Rotor Design Considerations, Number of Blades, Blade Profile, 2/3 Blades and Teetering, Coning, Upwind/ Downwind, Power Regulation, Yaw system, Tower, Synchronous and Asynchronous Generators and Loads, Integration of Wind Energy Converters to Electrical Networks, Inverters, Testing of WECS, WECS Control System Requirements and Strategies, Miscellaneous Topics, Noise, Other Applications.

Total Hours 45

TEXT BOOKS:

1. L.L.Freis, Wind Energy Conversion Systems, Prentice Hall, 2000.
2. D.A.Spera, Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press.
3. S.P.Sukhatme-Solar Energy:Principles of Thermal Collection and Storage, Tata McGraw-Hill (2016).

REFERENCE BOOKS:

1. F.A.Duffie and W.A.Beckman-Solar Engineering of Thermal Processes-John Wiley 2015.
2. J.F.Krider and F.Kreith-Solar Energy Handbook McGraw-Hill 2016.

Web References:

1. <http://www.ises.ors>
2. <http://www.windpower-monthly.com>
3. <http://www.solarpv.com>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C416.1	Remember	Presentation/ Assignment		5
C416.2	Apply	Presentation/ Assignment		5
C416.3	Analyze	Presentation / Case Study		10
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	50	50	50	50
Understand	0	0	0	0
Apply	30	30	30	30
Analyse	20	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: D (Theory Application)

Pre Requisites: Engineering Thermodynamics, Thermal Engineering

Course Objectives:

1. To understand the underlying principles of operation of different IC Engines and components.
2. To provide knowledge on pollutant formation, control, alternate fuel etc.

Course Outcomes

- C417.1: Recall the concepts of combustion in IC engines [R]
 C417.2: Elaborate the working principles of spark ignition and compression ignition engines [U]
 C417.3: Explore the formation of exhaust gas components [Ap]
 C417.4 : Compare the characteristics of various emission control methods [A]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

SPARK IGNITION ENGINES: Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers- Air fuel ratio- Design of carburetor- Derivation of fuel jet size and venture size- Thermodynamic analysis of SI engine combustion process.
COMPRESSION IGNITION ENGINES: Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behavior – Spray structure and spray penetration – Air motion - Introduction to Turbo charging- Thermodynamic analysis of CI engine combustion process.

POLLUTANT FORMATION AND CONTROL: Pollutant – Sources – Formation of Carbon Monoxide, Un burnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles.

RECENT TRENDS: Air assisted Combustion, Homogeneous charge compression ignition engines – Lean burn engine, Stratified charge engine, Surface ignition engine, Four valve and overhead cam engines, Electronic engine management systems- Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles – NO_x Adsorbers - Onboard Diagnostics.

Total Hours 45

TEXT BOOKS:

1. Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications, 2002.
2. Ganesan, "Internal Combustion Engines", II Edition, TMH, 2002.

REFERENCE BOOKS:

1. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines"., Dhanpat Rai & Sons 2007.
2. James E. Duffy, Howard Bud Smith, "Auto Fuel and Emission Control Systems Technology", Goodheart-Willcox, 2011.
3. William B. Ribbens, Norman P. Mansour, "Understanding Automotive Electronics", Newnes (an imprint of Butterworth-Heinemann Ltd); 6th Revised edition edition, 2003.

Web References:

1. [http://nptel.ac.in/courses/112103019/Cryogenic engineering.](http://nptel.ac.in/courses/112103019/Cryogenic%20engineering)
2. <http://pioneer.netserv.chula.ac.th/~kjrapon/self-practice.html>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C417.1	Remember	Presentation/ Quiz		5
C417.2	Understand	Assignment		5
C417.3	Apply	Group Assignment		5
C417.4	Analyze	Presentation / Case Study		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	40	40	40	40
Understand	50	50	40	40
Apply	0	0	10	10
Analyse	10	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: D (Theory Application)

Pre Requisites: Engineering Thermodynamics, Thermal Engineering

Course Objectives:

1. To make the students understand the properties of Cryogenic fluids, various liquefaction cycles, liquefaction systems and components in liquefaction system.
2. To understand the effect of rectification, absorption systems for purification, Binary Mixtures and T-C and H-C diagrams
3. To make the students understand the types of cryogenic refrigerators, various methods of handling cryogenes and its applications.

Course Outcomes

Upon completion of the course, students shall have ability to

- | | |
|--|------|
| C418.1: Define the basic concepts of cryogenic and liquefaction cycles. | [R] |
| C418.2: Elaborate the working principles of rectification, purification and liquefaction | [U] |
| C418.3: Explore the various types of cryogenic refrigerator and understand its working procedure | [Ap] |
| C418.4 : Compare the characteristics of various cryogenes and explain their applications | [A] |

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

INTRODUCTION : Insight on Cryogenics, Methods of producing cold - thermodynamic basis, first and second law analyses, Vapour compression systems, Properties of Cryogenic fluids, and Material properties at Cryogenic temperatures. **LIQUEFACTION CYCLES:** Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles, Inversion Curve-JouleThomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle, Dual Cycle, Helium Regefrigerated Hydrogen Liquefaction Systems. Critical components in Liquefaction Systems.

SEPARATION OF CRYOGENIC GASES: Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis – McCabe Thiele Method. Adsorption Systems for purification. **CRYOGENIC REFRIGERATORS:** J.T.Cryocoolers, Stiriling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators.

HANDLING OF CRYOGENS AND APPLICATIONS: Cryogenic Dewar Construction and Design, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Different Types of Vacuum Pumps, Instrumentation to measure Flow, Level and Temperature. Applications of Cryogenics in Space Programmes, Superconductivity, Cryo Metallurgy, Medical applications

Total Hours 45

TEXT BOOKS:

1. Thomas M.Flynn, Cryogenic Engineering, Marcel Dekker, New York, 2005.
2. Klaus D.Timmerhaus and Thomas M.Flynn, “Cryogenic Process Engineering”, Springer US, 2013.

Reference book

1. Randall F.Barron, Cryogenic Systems, McGraw Hill, 2002.
2. Mukhopadhyay, Mamata, “ Fundamentals of Cryogenic Engineering”, Prentice Hall India Learning Private Limited, 2010.
3. Robert W. Vance, Cryogenic Technology, Johnwiley & Sons, Inc.2002, New York, London
4. G.Venkatathnam, Cryogenic Mixed Refrigerant Processes, Springer Publication, 2010.

Web References:

1. http://www.wiley-vch.de/contents/ullmann/ull_10211.html.
2. <http://www.onecro.com>
3. <http://www.caddet-ee.org/search/produce.cfm?ID=R072>
4. <http://www.sumkasons.20m.com/In2.html>
5. <http://www.thtcryogenics.freeserve.co.uk/crogenics.html>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C418.1	Remember	Presentation/Quiz		5
C418.2	Understand	Assignment		5
C418.3	Apply	Group Assignment		5
C418.4	Analyze	Presentation / Case Study		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	40	40	40	40
Understand	40	40	40	40
Apply	10	10	10	10
Analyse	10	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

ELECTIVE STREAM –III MANUFACTURING/INDUSTRIAL ENGINEERING

15ME419 COMPOSITE MATERIALS, PROCESSING AND APPLICATIONS 3/0/0/3

Nature of Course : D (Theory Application)

Pre requisites : Industrial Metallurgy

Course Objectives:

- 1 Introduce students to the concepts of modern composite materials and equip them with knowledge on how to fabricate and carry out standard mechanical test on composites.
- 2 To understand the different types of composite materials, their properties and applications.
- 3 Describe fundamental fabrication processes for polymer matrix, metal matrix and ceramic matrix composites.
- 4 Ability to do research and present on an advanced material topic.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C419.1 | Recall the types of composite materials and their characteristic features | [R] |
| C419.2 | Identify the advances in composite materials and their applications | [U] |
| C419.3 | Choose the suitable technique for manufacturing different types of composite materials | [AP] |
| C419.4 | Categorize a suitable composite material for automotive, aerospace and industrial applications | [AP] |

Course Contents:

Polymer matrix composites: Understand the concepts of Polymer matrix resins-thermosetting, thermoplastic-various types of reinforcements used in PMC, merits, demerits and applications of PMC. **PMC manufacturing processes:** Hand layup processes, Spray up processes. Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding. Pultrusion, Filament winding, Injection moulding.

Metal matrix composites: Understand the concepts of MMC, Types of Metal matrix composites, Types of reinforcements used in MMC, Volume fraction, Rule of mixtures, merits, demerits and applications of MMC. **Processing of MMC** – Powder metallurgy process - diffusion bonding, stir casting – squeeze casting.

Ceramic matrix composites: Understand the concepts of Engineering ceramic materials, Ceramic matrix composites, and various types of Ceramic Matrix composites, merits, demerits and applications of CMC. **Processing of CMC:** Sintering - Hot pressing, Cold isostatic pressing (CIP), Hot isostatic pressing. **Advances in Composites:** Understand the concepts of Carbon-carbon composites, merits, demerits and applications of CCC. **Processing of Carbon composites:** chemical vapour deposition, Sol-gel technique.

Total Hours: 45

TEXT BOOKS:

- 1 Ronald, F. Gibson, “Principles of Composite Material Mechanics”, Fourth Edition, 2016
- 2 Daniel Gay “Composite Materials: Design and Applications”, Third Edition, 2014
- 3 P.K Mallick “Fiber reinforced composites: Materials, Manufacturing and Design” Third Edition, 2008.

REFERENCE BOOKS:

- 1 Deborah D.L. Chung, "Composite Materials", Second Edition, 2014.
- 2 Nikhilesh Chawla, Krishan K. Chawla, "Metal Matrix Composites", Second Edition, 2013.
- 3 Chawla K.K., "Composite Materials", Springer – Verlag, 2012.

Web References:

- 1 <https://www.youtube.com/watch?v=VMH6qbED7pg>
- 2 <https://www.youtube.com/watch?v=LHHAPJbakEc>

Online Resources:

- 1 <http://nptel.ac.in/courses/112104168/Composite materials>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C419.1	Remember	Quiz		5
C419.2	Understand	Technical Presentation		5
C419.3	Apply	Assignment		5
C419.4	Apply	Group Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	50	50	40	40
Understand	30	30	30	30
Apply	20	20	30	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course :D (Theory application)
Pre requisites :Engineering management and Financial accounting,
Manufacturing Technology II

Course Objectives:

- 1 To acquire knowledge about industrial layout.
- 2 To imply the ideas of safety culture and its importance in industry.
- 3 To enable the students to identify the causes of accidents and the impact of accident costs.
- 4 To impart knowledge on OSHAS (Occupational Safety and Health Assessment Series) in jobsite safety.
- 5 To make students to identify hazard and risk assessment techniques.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C420.1 | Identify factors for location decision and site selection. | [R] |
| C420.2 | Illustrate plant layout knowledge for betterment of plant. | [U] |
| C420.3 | Summarise the OSHA's general reporting and recordkeeping rules and guidelines. | [U] |
| C420.4 | Classify the worker's rights and responsibilities in general industry. | [U] |
| C420.5 | Demonstrate the ability to avoid, prevent and control workplace hazards. | [AP] |

Course Contents:

Plant Layout: Nature of Location Decision, Importance of Plant Location, Dynamic Nature of Plant Location, Choice of site for selection, Comparison of location, Principles of Plant layout and Types, factors affecting layout, methods, factors governing flow pattern, travel chart, analytical tools of plant layout, layout of manufacturing shop floor, repair shop, services sectors and process plant. Quantitative methods of Plant layout: CRAFT and CORELAP, Relationship diagrams.

Hazards: Electrical hazards, detection and prevention of electrical hazards, Chemical hazardous materials, material safety Material Safety Data Sheet (MSDS Fire hazard and life safety Mechanical hazards and machine safe guarding common mechanical hazards, safeguarding and OSHA's requirement for safeguarding Industrial safety awareness Safety health and the environment Hazards of the environment Hazardous waste reduction Cost of accident and accident preventions Workman's compensation issues. Hazard analysis, prevention and safety management, Tactile and non-tactile methods

Ergonomics: Ergonomic considerations including repetitive motion, Stress and safety Osha's voluntary Ergonomics guidelines Economics of Ergonomics considerations in workplace lightings, Ergonomics considerations in workstation design, Ergonomics considerations in welfare facilities Ergonomics considerations in plant layout, Ergonomic considerations in machine design. **Safety and Health** : safety and health training Occupational Safety and Health Administration OSHA Worker's Rights, Employer Responsibilities Occupational safety and work place violence.

Total Hours: 45

TEXT BOOKS:

- 1 Theresa Stack, Lee T. Ostrom, Cheryl A. Wilhelmsen "Occupational Ergonomics: A Practical Approach", 2016.
- 2 Mark A. Friend, James P. Kohn "Fundamentals of Occupational Safety and Health", 2014.

REFERENCE BOOKS:

- 1 Charles D. Reese “Occupational Health and Safety Management: A Practical Approach”, 2015.
- 2 Chandrashekar Hiregoudar “Facility Planning And Layout Design”, 2007.
- 3 Khan, Khan M. I., M I “Industrial Ergonomics”, 2010.
- 4 Gavriel Salvendy Handbook of Human Factors and Ergonomics, 2012.

Web References:

- 1 <http://nptel.ac.in/courses/107103004/31>
- 2 <http://ergonomics.org/>

Online Resources:

- 1 <https://alison.com/courses/Workstation-Ergonomics>
- 2 <http://www.online.colostate.edu/certificates/ergonomics/>
- 3 <http://dce.mst.edu/credit/certificates/safetyengineering/>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C420.1	Remember	Quiz		4
C420.2	Understand	Technical Presentation/ Assignment/ Group Discussion		12
C420.3	Understand			
C420.4	Understand			
C420.5	Apply	Poster presentation/ Assignment		4
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	40	40	40	40
Understand	40	40	40	40
Apply	20	20	20	20
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : D (Theory Application)

Pre requisites : Manufacturing Technology

Course Objectives:

1. To develop skills, ideas and knowledge about rapid prototyping process and its tooling.
2. To demonstrate about liquid, solid and powder based rapid prototyping process.
3. To impart knowledge about rapid prototyping data formats and its applications.
4. To impart knowledge about modern manufacturing techniques

Course Outcomes:

Upon completion of the course, students shall have ability to

C421.1	Understand the basics of rapid prototyping and reverse engineering process	[U]
C421.2	Apply the various types of rapid prototyping and tooling techniques	[AP]
C421.3	Analyse the rapid prototyping data formats	[A]
C421.4	Understand the processing of modern manufacturing techniques	[U]

Course Contents:

Introduction: Rapid Prototyping - Fundamentals of Prototyping and Rapid Prototyping, Classification of RP process, Rapid Prototyping Process Chain, Fundamental Automated Processes. Reverse Engineering – Basic concepts, Digitization Techniques – Model Reconstruction, Data Processing for Rapid Prototyping.

Liquid Based, Solid Based and Powder Based Rapid Prototyping Systems: Liquid-based: Stereo lithography Apparatus and Solid Ground Curing specifications, working principle, Process, Applications, Advantages and Disadvantages, Case studies. Solid Based: Laminated Object Manufacturing and Fused Deposition Modeling specifications, working principle, Process, Applications, Advantages and Disadvantages, Case studies. Powder-based: Selective laser sintering and 3-Dimensional Printing specifications, working principle, Process, Applications, Advantages and Disadvantages, Case studies **Rapid Tooling and Prototyping Data Formats:** Rapid Tooling, Classification: Indirect Rapid Tooling Methods, Direct Rapid Tooling. Rapid Prototyping Data Formats: Data formats-data interfacing- Part orientation and support generation- Support structure design- Model Slicing and contour data organization- direct and adaptive slicing- Tool path generation, Rapid Prototyping Software's.

Advanced Manufacturing Methods: Introduction, Need, classification, overview of all techniques. Mechanical energy based process: Water jet machining and Abrasive jet machining - principles, process, merits, demerits and applications. Chemical energy based process: Electro chemical machining - principles, process, merits, demerits and applications. Electrical energy based process Electric discharge machining – Principle, process, merits, demerits and applications.

Total Hours: 45

TEXT BOOKS:

1. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific publications, Third Edition, 2010..

REFERENCE BOOKS:

1. Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer , 2011.
2. Whalers Report 2000 – Terry Wohlers, Wohlers Associates, 2000 RapidPrototyping & Manufacturing – Paul F.Jacobs, ASME Press, 1996.

Web References:

1. <http://nptel.ac.in/courses/112107077/382>.
2. <http://nptel.ac.in/courses/112107078/37>
3. <http://nptel.ac.in/courses/112102103/16>
4. <https://www.youtube.com/watch?v=NkC8TNts4B4>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C421.1	Understand	Class presentation/ Assignment		4
C421.2	Apply	Quiz		4
C421.3	Analyse	Case study		8
C421.4	Understand	Poster Presentation/ Assignment		4
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	50	50	50	50
Apply	30	30	30	30
Analyse	20	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : D (Theory Application)
Pre requisites : MANUFACTURING TECHNOLOGY-I

Course Objectives:

1. To enable the students to understand the general guidelines for the implementation of six sigma
2. To make the students implement six sigma tools in order to minimize the cost/time and maximize the quality.
3. To imply the terminologies relating to six sigma operations in both service and manufacturing organizations.
4. To enable the students to understand various terms related to agile manufacturing.

Course Outcomes:

Upon completion of the course, students shall have ability to

C422.1	Examine the various applications of agile manufacturing tools in industries.	[R]
C422.2	Understand the implementation of six sigma concepts in the industries.	[U]
C422.3	Apply the various principles of agile manufacturing.	[AP]
C422.4	Reduce the cycle time and improve the efficiency of the process using various tools of six sigma	[A]
C422.5	Evaluate the various industrial projects and improve the performance.	[E]

Course Contents:

Six sigma defined – six sigma compared to total quality management – transactional vs. Manufacturing six sigma – common terms. **PREPARATION PHASE:** Organizational success factors - six sigma training plan, project selection, assessing organizational readiness, and pitfalls. Work as a process – vertical functions and horizontal processes. Voice of customer – importance, collect voc data, critical to quality customer requirements. **DEFINE & MEASURE PHASES:** Project charter – voice of the customer – high level process map –project team – case study. Overview – types of measures – introduction to statistical methods – sampling plan – data collection – choosing statistical software – measure tools – process maps, pareto charts, cause and effect diagrams, histograms, control charts – six sigma measurements – cost of poor quality – measurement system analysis – process capability calculations. Quality Function Deployment (QFD).

ANALYSE PHASE: Analyze – overview – process analysis – hypothesis testing – statistical tests and tables – tools for analyzing relationships among variables – survival analysis. Failure Modes and Effects Analysis (FMEA). Design of Experiments (DOE). **IMPROVE AND CONTROL PHASES:** Overview – process redesign – generating improvement alternatives – design of experiments – pilot experiments – cost/benefit analysis – implementation plan. Control phase – overview – control plan – process scorecard - SPC charts, final project report and documentation.

THE AGILE PRODUCTION SYSTEM: The task aligned organisation - agile manufacturing production system - production, production support, production planning and control, quality assurance, purchasing, maintenance, overview of production support, business operations, engineering, marketing, human resource, finance and accounting. Agile practice for product development - Manufacturing agile practices - understanding the value of investing in people, removing inappropriate fear from the shop floor - not sacrificing agility for perfectionism.

Total Hours: 45

TEXT BOOKS:

1. Betsiharris Ehrlich, "Transactional Six Sigma and Lean Servicing", St. Lucia Press, 2015.
2. Devadasan S R, Mohan Sivakumar V, Murugesh R and Shalij P R, "Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities", Prentice Hall of India (PHI) Private Limited, New Delhi, India, 2012.

REFERENCE BOOKS:

1. Jay Arthur, "Lean Six Sigma – Demystified", Tata McGraw Hill Companies Inc, 2014.
2. Michael L George, David T Rowlands, and Bill Kastle, "What is Lean Six Sigma", McGraw Hill, New York, 2014.
3. Gunasekaran A, "Agile Manufacturing, 21st Strategy Competitiveness Strategy", Elsevier Publications, 2015.

Web References:

1. <http://nptel.ac.in/courses/110105039/>
2. https://www.tutorialspoint.com/six_sigma/six_sigma_introduction.htm

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C422.1	Remember	Quiz		4
C422.2	Understand	Technical presentation/ Assignment		4
C422.3	Apply	Assignment		4
C422.4, C422.5	Analyze, Evaluate	Case study		8
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	30	30	30	30
Understand	40	40	20	30
Apply	20	20	30	20
Analyse	10	10	10	10
Evaluate	0	0	10	10
Create	0	0	0	0

Nature of Course D (Theory application)
Pre requisites Manufacturing Technology

Course Objectives:

1. To familiarize the student with tool nomenclature and cutting forces.
2. To give knowledge about heat distribution and thermal aspects of machining.
3. To impart knowledge on tool materials, tool life and tool wear.
4. To educate students on failure analysis of cutting tools.

Course Outcomes:

Upon completion of the course, students shall have ability to

C423.1	Analyze cutting forces in turning, drilling and milling	[Ap]
C423.2	Adjust varies parameters and reduce temperature developed during machining	[Ap]
C423.3	Reduce the cost of machinery	[Ap]
C423.4	Prevent failures of cutting tool.	[A]

Course Contents:

Introduction: Basic mechanism of chip formation - types of chips-Chip breaker - Orthogonal Vs Oblique cutting - force and velocity relationship and expression for shear plane angle in orthogonal cutting - Modern theories in Mechanics of cutting - Review of Merchant and Lee Shaffer Theories.

Tool Nomenclature and Cutting Forces: Nomenclature of single point tool - Systems of tool Nomenclature - Nomenclature of multi point tools like drills, milling cutters and broaches. Forces in turning, drilling and milling - specific cutting pressure- measurement of cutting forces.

Thermal Aspects of Machining: Thermodynamics of chip formation - Heat distributions in machining - Effects of various parameters on temperature - Method of temperature measurement in machining - Hot machining - cutting fluids.

Tool Materials, Tool Life and Tool Wear: Essential requirements of tool materials - Developments in tool materials-ISO specifications for inserts and tool holders -Tool life - Conventional and accelerated tool life tests - Concepts of machinability and machinability index - Economics of machining. **Wear Mechanisms and Chatter in Machining:** Reasons for failure of cutting tools and forms of wear - mechanisms of wear - chatter in machining - Factors effecting chatter in machining - types of chatters - Mechanism of chatter based on Force Vs Speed graph.

Total Hours: 45

TEXT BOOKS:

- 1 Shaw .M.C., "Metal cutting Principles ", Oxford clarendon Press, 2nd edition, 2005.
- 2 Juneja. B. L and Sekhon.G.S, "Fundamentals of metal cutting and machine tools", New Age International (p) Ltd., 2003.

REFERENCE BOOKS:

- 1 Geoffrey Boothroyd and Knight. W.A "Fundamentals of Machining and Machine tools", Crc Press, New York, 2006.
- 2 Bhattacharya. - "Metal Cutting Theory and Practice ", New central Book Agency pvt. Ltd., Calcutta, 2000.

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C423.1	Apply	Multiple Objective Quiz/ Assignment		10
C423.2	Apply			
C423.3	Apply			
C423.4	Analyze	Technical Presentation/ Assignment		10
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	0	0	0	0
Apply	60	60	60	60
Analyse	40	40	40	40
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course : E (Theory Skill based)

Pre requisites : Engineering Management and Financial Accounting

Course Objectives:

- 1 To make the students to understand the scope of entrepreneurship, key areas of development.
- 2 To enable the students to identify the financial assistance by the institutions, methods of taxation and tax benefits, etc.
- 3 To enable the students to understand the government policies for establishing small scale sectors.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|---|------|
| C424.1 | Define the foundational concepts of entrepreneurship, skills needed for entrepreneurial management. | [R] |
| C424.2 | Identify the motivational factors, techniques for evaluating business opportunities | [U] |
| C424.3 | Demonstrate the opportunities for launching start-ups and expansion | [AP] |
| C424.4 | Applying Accounting and financing skills to overcome risks and make sound business decisions | [AP] |
| C424.5 | Analyze the performance of a new venture | [A] |

Course Contents:

Entrepreneurship: Entrepreneur, Types of Entrepreneurs, Difference between Entrepreneur and Intrapreneur, Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth, Knowledge and Skills of Entrepreneur. **Motivation:** Major Motives Influencing an Entrepreneur, Achievement Motivation Training, Self-Rating, Stress management, Entrepreneurship Development Programs, Need, Objectives.

Business: Small Enterprises, Definition, Classification, Characteristics, Ownership Structures, Project Formulation, Steps involved in setting up a Business, Identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment, Preparation of Preliminary Project Reports, Project Appraisal, Sources of Information, Classification of Needs and Agencies. Business plan preparation.

Financing And Accounting: Need, Sources of Finance, Term Loans, Capital Structure, Financial Institution, management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT/CPM, Taxation, Income Tax, Excise Duty, Sales Tax. **Support To Entrepreneurs:** Sickness in small Business, Concept, Magnitude, causes and consequences, Corrective Measures, Government Policy for Small Scale Enterprises, Growth Strategies in small industry, Expansion, Diversification, Joint Venture, Merger and Sub Contracting, Entrepreneurship Development Support, Central and State Government Industrial Policies, Government clearance and liberalization.

Total Hours: 45

TEXT BOOKS:

- 1 S.S.Khanka "Entrepreneurial Development" S.Chand & Co. Ltd. 4th Edition 2012
- 2 Hisrich R D and Peters M P, "Entrepreneurship" 10th Edition Mc Graw-Hill, 2016

REFERENCE BOOKS:

- 1 Nuzhath Khatoon, "Entrepreneurial Development", Himalaya Publishing House Pvt. Ltd, 2012
- 2 B.S. Bhatia, G.S. Batra, "Entrepreneurship and Small Business Management", Regal Publications, 2007

- 3 Marc H. Meyer, Frederick G. Crane, "Entrepreneurship", Sage Publications,2010
- 4 David Oates, "A Guide to Entrepreneurship", Jaico Publishing House,2009

Web References:

- 1 <http://nptel.ac.in/courses/118105009/50>

Online Resources:

- 1 <https://www.edx.org/course/becoming-entrepreneur-mitx-launch-x0?gclid=CN64suCMitACFdeGaAodIX4MMw>
- 2 <https://www.coursera.org/specializations/wharton-entrepreneurship>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C424.1	Remember	Quiz		4
C424.2	Understand	Class Presentation/ Assignment		4
C424.3,4	Apply	Group Assignment		4
C424.5	Analyze	Case Study		8
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	30	40	30	30
Understand	70	40	30	30
Apply	0	20	20	20
Analyse	0	0	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: D (Theory)

Pre Requisites: Manufacturing technology I

Course Objectives:

1. To acquire the general knowledge to deliver consistently high quality and value added products and services to the customer in a lean environment.
2. To understand the terminology relating to lean operations in both service and manufacturing

Course Outcomes

Upon completion of the course, students shall have ability to

C425.1. Familiarize with fundamentals of lean manufacturing and thus acquire the capability to apply them. [Ap]

C425.2. Analyze the concept of lean manufacturing in the industries. [A]

C425.3 Relate lean manufacturing in other concepts. [A]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

INTRODUCTION TO LEAN MANUFACTURING & BASIC CONCEPTS: Objectives of lean manufacturing-key principles and implications of lean manufacturing- traditional Vs lean manufacturing. Value creation and waste elimination- main kinds of waste- pull production different models of pull production-continuous flow- worker involvement -cellular layout-administrative lean.

LEAN MANUFACTURING TOOLS AND METHODOLOGIES: Standard work -communication of standard work to employees -standard work and flexibility -visual controls-quality at the source- 5S principles -total quality management-total productive maintenance -Single minute exchange of Dies - **VALUE STREAM MAPPING** - The current state diagram - the future state map - application to the factory simulation scenario - line balancing - poke yoke - Kanban - overall equipment effectiveness.

JUST IN TIME MANUFACTURING & ONE-PIECE FLOW - Introduction - elements of JIT - uniform production rate - pull versus push method- Kanban system - small lot size. Continuous improvement/Kaizen - cells for assembly line - case studies. **IMPLEMENTING LEAN & RECONCILING LEAN WITH OTHER SYSTEMS** - Road map-senior management Involvement-best practices. Toyota production system-lean six sigma - lean and ERP-lean with ISO9001:2000.

Total Hours 45

TEXT BOOKS:

1. Askin R G and Goldberg J B, "Design and Analysis of Lean Production Systems", John Wiley and Sons Inc., 2012.
2. Michael L George, David T Rowlands, Bill Kastle, "What is Lean Six Sigma", McGraw Hill, New York, 2008.

REFERENCE BOOKS:

1. Micheal Wader, "Lean Tools: A Pocket Guide to Implementing Lean Practices", Productivity and Quality Publishing Pvt Ltd, 2012.
2. Kenichi Sekine, "One-Piece Flow", Productivity Press, Portland, Oregon, 2013.
3. Alan Robinson "Continuous Improvement in Operations", Productivity Press, Portland, Oregon, 2015.

Web References:

1. www.lean.org
2. www.continental-design.com

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C425.1	Apply	Online Quiz		4
C425.2	Analyze	Presentation/ Assignment		8
C425.3	Analyze	Mini Project/ Case Study		8
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 8 marks	
Remember	0	0	0	0
Understand	0	0	0	0
Apply	60	60	60	60
Analyse	40	40	40	40
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: D (Theory)

Pre Requisites: Manufacturing technology

Course Objectives:

1. To understand the principles of plastic chemistry
2. To study the different types of special processes in manufacturing mould
3. To understand fundamentals of plastic materials.
4. To understand fundamentals of processing technology.
5. To study different mould and die design.

Course Outcomes

Upon completion of the course, students shall have ability to

C426.1.Understand the basics of polymer	[U]
C426.2.Impart the knowledge on plastic process	[AP]
C426.3.Selection of plastic materials for different application in design	[U]
C426.4. Apply the process techniques for different types of components.	[AP]
C426.5 Apply the basic design concepts for mould design.	[AP]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

POLYMER CHEMISTRY-Basic concepts of macromolecules - Monomers- Functionality - Classification and nomenclature of polymers. Types of polymers-Addition polymerization Mechanism and kinetics of free radical-Copolymerization-Molecular weight-Chemical reactions of polymers **MOULD MANUFACTURING ENGINEERING**-Mold Making-Copy milling, Pantograph, Profile grinding, Electrical discharge machining-Electroforming for mold manufacturing-Polishing technology in mold making-Metrology and inspection.

POLYMERIC MATERIALS-Properties and applications of polyethylene-Properties and applications of poly(vinyl chloride)-properties and applications of Acrylates-Properties and applications of Fluoro polymers-properties and applications of High performance Thermoplastic materials.

PROCESSING TECHNOLOGY-Introduction to polymer processing-Types Injection unit & Elements of plasticising process-Non Conventional Injection Moulding-Blow moulding-Thermoforming-Extrusion-Compression moulding-Rotational moulding-Calendering. **MOULD AND DIE DESIGN**-Classification of Injection Moulds-Classification of Compression Moulds-Blow Mould Design-Extrusion die design.

Total Hours 45

TEXT BOOKS:

1. F.W. Billmeyer, "Textbook of Polymer Science", Wiley international publishers, 2000.
2. Plastics Mould design , CIPET Publications , 2007
1. Feldman.D and Barbalata.A, "Synthetic Polymers", Chapman Hall, 2006
- D.V. Rosato Kluwer, "Injection Moulding Handbook", Academic Publishers Boston 2nd Edition 2015
4. P.S.CRACKNELL and R.W DYSON, "Hand Book of Thermoplastics - Injection Mould Design", Chapman & Hall, 2013.

REFERENCE BOOKS:

1. M.G. Cowie, "Polymers: Chemistry and Physics of Modern Materials", Blackie, and London, 2011.
2. George Menges & Paul Mohren, How To Make Injection Molds, Hanser Publishers.
3. Olagoke Olabisi, "Hand Book of Thermoplastics", Marcel Decker, inc., 2015
4. N.P. Chareminoff & P.N. Chere, "Handbook of Applied Polymer Processing Tech", Marcel Dekker, Inc, NY 2016.
5. R.G.W.PYE, Injection Mould Design, SPE Publication.

Web References:

1. www.nptel.ac.in

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C426.1	Understand	Presentation/ Quiz		5
C426.2	Apply	Presentation/ Assignment		5
C426.3	Understand	Presentation/ Quiz		5
C426.4	Apply	Case study/ Assignment		5
C426.5				
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 8 marks	
Remember	0	0	0	0
Understand	60	60	60	60
Apply	40	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: D (Theory)

Pre Requisites: Manufacturing technology I & Environmental Science

Course Objectives:

1. To understand the principles of casting design
2. To study the different types of special casting processes
3. To understand fundamentals of welding process.
4. To validate the welded structure.
5. To explore the special welding techniques and defects in welding.

Course Outcomes

Upon completion of the course, students shall have ability to

C427.1. Understand the casting metallurgy	[U]
C427.2. Impart the knowledge on designing parameters of casting and welding process	[AP]
C427.3. Understand the advancement in casting processes and welding processes	[U]
C427.4. Apply the heat treatment processes to modify the properties.	[AP]
C427.5 Understand the basic principles of automation of welding techniques.	[U]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

CASTING METALLURGY AND DESIGN Heat transfer between metal and mould-Solidification of pure metal and alloys-Shrinkage in cast metals -progressive and directional solidification. Principles of gating and riser-Degasification of the melt-Design considerations in casting-Designing for directional solidification and minimum stresses-casting defects. **SPECIAL CASTING PROCESSES** Shell moulding, Precision investment casting, CO₂ moulding, centrifugal casting, Die casting, squeeze casting and Continuous casting.

RECENT ADVANCES IN CASTING Layout of mechanised foundry-sand reclamation-Material handling in foundry - pollution control in Foundry - Recent trends in casting-Computer Aided design of Castings. **WELDING Metallurgy and DESIGN** Significance, Heat affected Zone and its characteristics, Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment.

RECENT TRENDS IN WELDING Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding –Plasma welding- Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

Total Hours 45

TEXT BOOKS:

1. Jain, "Principles of Foundry Technology ", Tata McGraw Hill, 3rd Edition, 2000.
2. Richard L Little, "Welding and Welding Technology" Tata McGraw Hill, 2004.

REFERENCE BOOKS:

1. John Campbell, "Casting Practice" Elsevier Science Publishing CO.,2004
2. Larry Jeffus, "Welding Principles and Applications" Delmar Publishers, 2004.
3. Howard B Cary, " Modern Welding Technology" Prentice Hall, 2002
4. "ASM Hand Book Volume15: Casting", ASM International 2008.

Web References:

1. www.nptel.ac.in

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C427.1,3,5	Understand	Presentation/ Quiz		10
C427.2,4	Apply	Presentation/ Assignment		10
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 8 marks	
Remember	0	0	0	0
Understand	60	60	60	60
Apply	40	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

OPEN ELECTIVES

15ME501

INDUSTRIAL SAFETY

3/0/0/3

Nature of Course: G (Theory)

Pre Requisites: General Engineering

Course Objectives:

1. Define and understand basic Productivity Measurement approaches of the organizations and safety management.
2. Perform Work design and facility planning.
3. To understand the principles of performance management.
4. To understand the methods of safety education and training.

Course Outcomes

Upon completion of the course, students shall have ability to

- | | |
|--|------|
| C501.1. Identify factors for location decision and site selection. | [R] |
| C501.2. Illustrate plant layout knowledge for betterment of plant | [U] |
| C501.3. Classify the worker's rights and responsibilities in general industry. | [U] |
| C501.4. Demonstrate the ability to avoid, prevent and control workplace hazards. | [AP] |

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

BASICS OF SAFETY ENGINEERING & ACTS : Evolution of modern safety concept – safety audit – concept of an accident investigation and reporting – safety performance monitoring; Acts – factories act – 1948 – statutory authorities – inspecting staff – Tamilnadu factories Rules 1950 under safety and health – environment act – 1986 – air act 1981, water act 1974 – other acts; safety in industries – general safety concepts, machine guarding, hazards in metal removing process, welding process, cold and hot working process. **SAFETY MANAGEMENT:** History of Safety movement –Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity -productivity, quality and safety-line and staff functions for safety-budgeting for safety-safety policy. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.

ACCIDENT INVESTIGATION AND REPORTING: Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee – Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports - Class exercise with case study. **SAFETY PERFORMANCE MONITORING:** Reactive and proactive monitoring techniques - Permanent total disabilities, permanent partial disabilities, temporary total disabilities -Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate – problems.

SAFETY EDUCATION AND TRAINING: Importance of training - identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

Total Hours 45

TEXT BOOKS:

1. Krishnan N.V., “Safety Management in Industry”, Jaico Publishing House, Bombay 2015.
2. Heinrich H.W. “Industrial Accident Prevention” McGraw-Hill Company, New York, 1980.

REFERENCE BOOKS:

1. "The Factories Act 1948", Madras Book Agency, Chennai, 2000.
2. Relevant India Acts and Rules, Government of India.
3. Relevant Indian Standards and Specifications, BIS, New Delhi.
4. "Industrial safety management", L M Deshmukh, TATA McGraw Hill, 2010.

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C501.1	Remember	Quiz		5
C501.2	Understand	Assignment		5
C501.3	Understand	Technical Seminar		5
C501.4	Apply	Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 8 marks	
Remember	30	30	30	20
Understand	30	30	30	30
Apply	40	40	40	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: D (Theory)

Pre Requisites: Basics of Physics and chemistry

Course Objectives:

1. To make the students learn various techniques available to make micro shapes and design in various Materials.
2. To make students understand requirements and methodologies to be followed in micro fabrication and forming pat.

Course Outcomes

Upon completion of the course, students shall have ability to

- C502.1: Understand the physical concepts and underlying various engineering and technologies applications. [U]
 C502.2: Elaborate fabrication techniques and various micro machining processes [Ap]
 C502.3: Explore various materials for micro fabrication and MEMS devices [Ap]
 C502.4 : Compare the characteristics of MEMS and NEMS devices [A]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

INTRODUCTION TO MEMS : Introduction - Evolution of Microsensors and MEMs Mechanical, Inertial, Biological, Chemical, Acoustic, Microsystems Technology, Integrated Smart Sensors and MEMS, Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Conclusions & Future Trends. **LITHOGRAPHY:** Introduction -Lithography's Origins, Photolithography- Overview Critical Dimension -Overall Resolution- Line-Width - Lithographic Sensitivity and Intrinsic Resist Sensitivity Resist Profiles- Contrast and Experimental Determination of Lithographic Sensitivity Resolution in Photolithography - Photolithography Resolution - Enhancement Technology Beyond Moore's Law Next Generation - Lithographies Emerging Lithography Technologies

ADDITIVE TECHNOLOGY: Introduction -Silicon Growth -Doping of Si - Oxidation of Silicon-Physical Vapor Deposition - Chemical Vapor Deposition- Silk-Screening or Screen-Printing - Sol-Gel Deposition Technique . Plasma Spraying - Deposition and Arraying Methods of Organic Layers in BIOMEMS - Thin versus Thick Film Deposition - Selection Criteria for Deposition Method.

MINIATURIZATION TECHNIQUES Introduction - Absolute and Relative Tolerance in Manufacturing - Historical Note: Human Manufacturing - Top-Down Manufacturing Methods, Bottom-Up Approaches - modelling, brains, packaging, sample preparation and new MEMS materials Introduction- Modelling, Brains In Miniaturization- Packaging, Substrate Choice.

MINIATURIZATION APPLICATIONS: Introduction - Scaling, Actuators, Fluidics- Scaling In Analytical Separation Equipment- Other Actuators - Integrated Power miniaturization applications- Introduction - Definitions and Classification Method.

Identified Industries for visits:

1. Introduction to MEMS – MEMS and NEMS industry group
2. Lithography- Solid State Technology
3. Additive Technology – Sony Semi conductor Pvt.Ltd
4. Miniaturization Techniques – Lingsen precision industries
5. Miniaturization Applications - Dy Tran Instruments

Total Hours 45

TEXT BOOKS

1. Marc J. Madou, 'Fundamentals of Micro fabrication: The Science of Miniaturization', Second Edition, CRC Press, 2002.

REFERENCE BOOKS:

1. Process engineering analysis in semiconductor device fabrication by Stanley Middleman and Arthur k.kochberg, McGraw Hill 1993
2. Itching in Micro system technology by Michael Kohler,1999

Web References:

1. www.nptel.ac.in
2. www.sme.org
3. <https://www.coursera.org/learn/MEMS/NEMS>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C502.1	Understand	Presentation/ Quiz		5
C502.2	Understand	Presentation/ Assignment		5
C502.3	Apply	Presentation/ Assignment		5
C502.4	Analyze	Presentation / Case Study		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 8 marks	
Remember	0	0	0	0
Understand	50	50	40	40
Apply	40	40	40	40
Analyse	10	10	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course: D (Theory Application)

Pre Requisites: Nil

Course Objectives:

1. To understand the Engineering and Management aspects of Planning, Designing, Controlling and Improving Quality in Manufactured products.

Course Outcomes

Upon completion of the course, students shall have ability to

- C503.1: Define the basic concepts and understand the fundamentals of quality [R]
 C503.2: Elaborate the role of TQM tools and techniques in elimination of wastages and reduction of defects [U]
 C503.3: Explore the development in quality as a passion and habit [Ap]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

QUALITY GURUS AND TQM KITEMARKS: Evolution of TQM, Quality Guru's - Edward Deming, Joseph Juran, Philip Crosby, Genichi Taguchi, Walter Shewart, Criteria for Deming's Prize.

PRODUCT DESIGN AND ANALYSIS: Basic Design Concepts and TQM, Design Assurance, Design Validation, Failure Mode Effect Analysis, Fault Tree Analysis, Design for Robustness, Value Analysis.

PROCESS IMPROVEMENT AND MODERN PRODUCTION MANAGEMENT TOOLS: Six Sigma Approach, Total Productive Maintenance, Just-In-Time, Lean Manufacturing, Paradigms

QUALITY IMPROVEMENT TOOLS AND CONTINUOUS IMPROVEMENT: Q-7 Tools, New Q-7 Tools, Quality Function Deployment, Kaizen, 5S, Poka- Yoke, SMED.

QUALITY MANAGEMENT SYSTEMS: Quality Management Systems, Introduction to ISO9000, TS16949:2002 and EMS14001 certifications.

Total Hours 45

TEXT BOOKS:

1. Total Engineering Quality Management, Sunil Sharma, 4th Edition, MacMillan India Limited, 2014.
2. Total Quality Management, Poornima M. Charantimath, 3rd Edition, Pearson Education, 2015.

Reference book

1. "Quality and Performance Excellence", James R Evans, Edition, 7th Edition, Cengage Learning.
2. "Quality Management", Howard S Gitlow, Alan J Oppenheim, Rosa Oppenheim, David M Levine, 3rd Edition, Tata McGraw Hill Limited.
3. "Fundamentals of Quality Control & Improvement", Amitava Mitra, 3rd Edition, Wiley Publications, 2012.

Web References:

1. http://www.wiley-vch.de/contents/ullmann/ull_10211.html.
2. <http://www.onecro.com>
3. <http://www.caddet-ee.org/search/produce.cfm?ID=R072>
4. <http://www.sumkasans.20m.com/ln2.html>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C503.1	Remember	Presentation/ Assignment		5
C503.2	Understand	Presentation/ Assignment		5
C503.3	Apply	Presentation/ Case Study		10
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 6 marks	CIA2 6 marks	Term End Assessment 8 marks	
Remember	40	40	40	40
Understand	50	50	40	40
Apply	10	10	20	20
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

15ME504

PRODUCT DEVELOPMENT

3/0/0/3

Nature of Course: D (Theory application)

Pre Requisites: Basics of Manufacturing Process

Course Objectives:

1. To understand the new product process and to learn how to integrate the customer and end-consumer into this process.
2. To learn and apply the concepts and tools necessary through case examples and assignments.
3. To actually use the new product development process by conceiving your own new product or service and an introductory launch plan.

Course Outcomes

Upon completion of the course, students shall have ability to

- C504.1: Recall the concepts of discovery - opportunity identification [R]
C504.2: Elaborate the concept and product design, development and evaluation [U]
C504.3: Explore the process of delivery and its innovative approaches to product launch and introduction. [Ap]
C504.4: Awareness of the role of multiple functions in creating a new product [A]

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

INTRODUCTION: New product development process, Product development Methodologies And Organization - Team Assignments Logistics - Identifying Market Opportunities Product Planning - Understanding Customer and User Needs- Strategic Planning and Opportunity Identification for new products

DESIGN THINKING TECHNIQUES: Product Specifications - Product Architecture - Industrial Design - User Interface Design – Concept and Idea generation - Concept development Product and positioning - Prototyping - Program Management for Product - Development - Product Development Economics. **DESIGN FOR MANUFACTURING:** Design for Manufacturing - Product Testing and Reliability - Simulation and Design Tools - Product Launch.

DESIGN FOR THE ENVIRONMENT : Design for the Environment - Product Lifecycle Management - Portfolio Management and the - Program Management Office **NEW PRODUCT LAUNCH AND MARKET ENTRY:** Preparing a Launch Plan - Market Testing - Pricing, Packaging - Integrated Marketing - Innovation Marketing.

Total Hours 45

TEXT BOOKS:

1. Ulrich, Karl, and Steven Eppinger. Product Design and Development. 3rd ed. New York, Y: McGraw-Hill, 2003.
2. 4. Product Design Techniques in Reverse Engineering and New Product Development, KEVINOTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.

REFERENCE BOOKS:

Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development “, 4th Edition, , Tata McGraw-Hill Education, ISBN-10-007-14679-9 - 2009.
George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th Edition, ISBN 978-007-127189-9- 2009.
Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint, Pearson Education, ISBN 9788177588217 – 2004.

Web References:

1. www.nptel.ac.in

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C504.1	Remember	Presentation/ Quiz		5
C504.2	Understand	Presentation/ Assignment		5
C504.3	Apply	Presentation/ Assignment		5
C504.4	Analyze	Presentation / Case Study		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination 60 marks
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	
Remember	40	40	40	40
Understand	40	50	40	40
Apply	20	10	10	10
Analyse	0	0	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

Nature of Course D (Theory application)
Pre requisites Engineering Physics, Engineering Chemistry

Course Objectives:

1. To familiarize the students with the basics of Mechanical Engineering.

Course Outcomes:

Upon completion of the course, students shall have ability to

- | | | |
|--------|--|------|
| C505.1 | Understand the basic machine elements | [U] |
| C505.2 | Discuss the concepts of Power Generation and Sources of Energy | [AP] |
| C505.3 | To apply the concepts of various manufacturing processes | [AP] |

Course Contents:

MACHINE ELEMENTS: Springs: Helical and leaf springs – Springs in series and parallel. Cams: Types of cams and followers – Cam profile. **POWER TRANSMISSION:** Gears (terminology, spur, helical and bevel gears, gear trains). Belt drives (types). Chain drives. Simple Problems.

ENERGY: Sources - Renewable and non-renewable (various types, characteristics, advantages/disadvantages). Power Generation: External and internal combustion engines – Hydro, thermal and nuclear power plants (layouts, element/component description, advantages, disadvantages, applications). Simple Problems.

MANUFACTURING PROCESSES: Sheet Metal Work: Introduction – Equipments – Tools and accessories – Various processes (applications, advantages / disadvantages). Welding: Types – Equipments – Tools and accessories – Techniques employed -applications, advantages / disadvantages – Gas cutting – Brazing and soldering. Lathe Practice: Types - Description of main components – Cutting tools – Work holding devices – Basic operations. Simple Problems. Drilling Practice: Introduction – Types – Description – Tools. Simple Problems.

Total Hours: 45

TEXT BOOKS:

- 1 Kumar, T., Leenus Jesu Martin and Murali, G., Basic Mechanical Engineering, Suma Publications, Chennai, 2012.
- 2 Prabhu, T. J., Jai Ganesh, V. and Jebaraj, S., Basic Mechanical Engineering, Scitech Publications, Chennai, 2013.

REFERENCE BOOKS:

- 1 Hajra Choudhary, S.K. and HajraChoudhary, A. K., Elements of Workshop Technology Vols. I & II, Indian Book Distributing Company Calcutta, 2015.
- 2 Nag, P.K., Power Plant Engineering, Tata McGraw-Hill, New Delhi, 2012.
- 3 Rattan, S.S., Theory of Machines, Tata McGraw-Hill, New Delhi, 2014.

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C505.1	Understand	Multiple Objective Quiz		5
C505.2	Apply	Poster Presentation/Assignment		10
C505.3	Apply	Technical Presentation/Assignment		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	0	0	0	0
Understand	70	70	70	70
Apply	30	30	30	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

MANDATORY COURSES

15MC702

ENVIRONMENTAL SCIENCES

2/0/0/1

Nature of Course: G (Theory)

Pre Requisites: Basics of environmental sciences

Course Objectives:

5. To study the integrated themes on various natural resources.
6. To acquire knowledge about the various aspects of ecosystem and biodiversity.
7. To gain knowledge on the type of pollution and its control methods.
8. To understand the current environmental issues and the impacts of human population on environment.

Course Outcomes

Upon successful completion of the course, students shall have ability to

C7ZZ.1: Understand the importance of Natural resources. [U]

C7ZZ.2: Analyse the various types of ecosystem and biodiversity. [A]

C7ZZ.3: Execute the gained knowledge to prevent pollution. [E]

C7ZZ.4: Apply the knowledge gained about the interrelation between human and Environment in various environmental issues and sustainable development. [Ap]

Course Contents

Natural Resources

Introduction-Forest resources: Use and abuse.-**Ecosystems and Biodiversity**- Concept of an ecosystem – structure and function of an ecosystem–producers, consumers and decomposers - Carbon cycle and Nitrogen cycle.

Environmental Pollution- Definition – causes, effects and control measures of: a. Air pollution- Acid rain-Greenhouse effect-Global warming- Ozone layer depletion – Water pollution- Soil pollution - Solid waste management: causes, effects and control measures of municipal solid wastes-Noise pollution- Thermal pollution-Nuclear hazards.

Social Issues and Green Approaches- Sustainable development-water conservation, rain water harvesting.

Human Population and Environment- Population growth, variation among nations – population explosion – family welfare programme – environment and human health- Human rights– value education – HIV / AIDS- Woman and child welfare.

Total Hours 15

Text Books:

1. Anubha Kaushik and C P Kaushik ‘Perspectives in Environmental Studies’4thEdition, New Age International (P) Limited, Publisher Reprint 2014. New Delhi.
2. Benny Joseph, ‘Environmental Science and Engineering’, Tata McGraw-Hill, New Delhi, 2008.

Reference Books:

1. Gilbert M. Masters, ‘Introduction to Environmental Engineering and Science’, Third Edition, Pearson Education, 2009.
2. Tyler Miller, Jr., ‘Environmental Science, Brooks/Cole a part of Cengage Learning, 2014.
3. Rajagopalan, R, ‘Environmental Studies-From Crisis to Cure’, Oxford University Press 2015.

Web References:

6. <http://nptel.ac.in/courses/104103020/20>
7. <http://nptel.ac.in/courses/120108002>
8. <http://nptel.ac.in/courses/122106030>
9. <http://nptel.ac.in/courses/120108004/>
10. <http://nptel.ac.in/courses/122102006/20>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)**Summative assessment based on Continuous and End Semester Examination**

Bloom's Level	Term End Examination [100 marks]
Remember	30
Understand	50
Apply	20
Analyse	0
Evaluate	0
Create	0

Nature of Course : C (Theory concept)

Pre requisites : Nil

Course Objectives:

- 1 To create an awareness on professional ethics amongst the engineering students.
- 2 To instill Moral values, Social Values and Loyalty amongst the students.
- 3 To impart knowledge about human relations
- 4 To impart the habit of respecting the rights of others.

Course Outcomes:

Upon completion of the course,

- | | | |
|--------|---|------|
| C7ZZ.1 | Describe the significance and relevance of values in management. | [U] |
| C7ZZ.2 | Discover the roles, rights and responsibilities as an engineer. | [R] |
| C7ZZ.3 | Use the professional ethics and values to the organization to reach the goals | [Ap] |

Course Contents:

Human Values: Meaning and significance of values - Formation of values and human values - Relevance of values in management - Personal values and organizational commitment - Need for values in global change - Personal Values Influence Ethical Choices - Learn to distinguish right and wrong - Positive steps toward preventing corporate crime - Develop support for whistle blowing. **Engineering Ethics:** Ethics – various disciplines – Engineering ethics - Senses of Engineering Ethics - variety of moral issues - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory –ethical theories and their uses. **Engineering As Social Experimentation:** Engineering as experimentation - engineers as responsible experimenters - codes of ethics - Safety and risk- Assessment - Collegiality and loyalty - respect for authority - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights. Case studies - challenger case study - The three mile island - Chernobyl case studies. **Human relations and Forces influencing behaviour at work:** The Nature, Purpose of Human Relations - Importance of Human Relations - Human relations defined – Forces influencing Behaviour at work – Captain Singh case study. **Major themes in Human Relations:** Communication Process -Functions - filters and barriers –self-awareness – self acceptance - motivation – process – trust - self disclosure - Conflict management and resolution.

Total Hours: 15

Text Books:

- 1 R. Nandagopal and AjithSankar R. N., Indian Ethos and Values in Management, Tata McGraw-Hill Publications, 2010.
- 2 Barry L. Reece and Rhonda Brandt, Effective Human Relations 9th Edition, Cengage Publications, 2010
- 3 V.Jayakumar, Professional Ethics and Human Values, Lakshmi Publications, 8th edition, 2008.

Reference Books:

- 1 Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint)
- 2 A.N Tripathi, Human Values, 2nd Edition New Age International Publication 2010.
- 3 Human Values Dr. Rajan Misra, Laxmi Publications, 2009.

Web References:

1 <http://nptel.ac.in/courses/109104068/30>

Online Resources:

1 <http://nptel.ac.in/courses/109104068/30>

Tentative Assessment Methods & Levels (based on Blooms' Taxonomy)	
Summative assessment based on Continuous and End Semester Examination	
Bloom's Level	Term End Examination [100 marks]
Remember	30
Understand	50
Apply	20
Analyse	0
Evaluate	0
Create	0



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DEPARTMENT OF MECHANICAL ENGINEERING

AUTONOMOUS SYLLABUS

Service Subjects

Web References:

1. <http://www.allaboutcircuits.com/education/>
2. <http://www.nptel.ac.in/courses/112107090/>
3. [nptel.ac.in/courses/112101005/14](http://www.nptel.ac.in/courses/112101005/14)

Online Resources:

1. <http://www.electrical4u.com/>
2. <http://vlab.co.in/>

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	0	0
Understand	0	0
Apply	30	30
Analyse	30	20
Evaluate	20	10
Create	20	30

15UA354 ENGINEERING GRAPHICS LABORATORY

2/0/2/2

Nature of Course: M (Practical application)**Co Requisites:** Basic drawing and Computer Knowledge**Course Objectives:**

1. To know the method to construct the conic curves used in Engineering Applications.
2. To develop an understanding of Isometric to Orthographic Views and vice versa.
3. To learn the basic projection of straight lines and plane surfaces.
4. To develop the imagination of solids inclined to one reference planes.
5. To know the sectioning of solids and development of surfaces used in various fields.

Course Outcomes

- C354.1: Understand the basic drawing concepts. [R]
 C354.2: Student will be able to visual all in the form of technical views of drawing.. [R]
 C354.3: Student will be familiar with the software drawings. [U]
 C354.4: Student will be familiarizing with new design of Engineering Products [Ap]

Course Contents**UNIT I - CURVES USED IN ENGINEERING GRAPHICS****12**

Introduction of Basic Concepts and Conventions, Conic Section – Ellipse, Parabola, Hyperbola, Cycloids, Involute, Introduction to 2D Software – Sketching, Mirroring, Scaling, Copying and Dimensioning

UNIT II - ISOMETRIC TO ORTHOGRAPHIC AND ORTHOGRAPHIC TO ISOMETRIC VIEWS [FREE HAND SKETCHING AND 2D SOFTWARE] **12**

General principles of orthographic projection – Need for importance of multiple views and their placement – First angle projection – Free hand sketching of multiple views from pictorial views of 3D objects, Orthographic Projection - 2D Software, Isometric View - Manual (Free Hand Sketching), Isometric View Using 2D Software

UNIT III - PROJECTION OF LINES AND PLANE SURFACES [2D SOFTWARE]**12**

Projection of straight lines located in the first quadrant – Determination of true lengths and true inclinations of lines, Inclined to Both Planes.

Projection of Polygonal Surface and circular lamina inclined to any one reference plane - Inclined to HP, Inclined to VP.

UNIT IV - PROJECTION OF SOLIDS [2D SOFTWARE]**12**

Projection of Solids when the axis is inclined to one reference plane by change of position method – Prisms, Pyramids, Cylinder and Cone.

UNIT V – SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES [2D SOFTWARE]**12**

Sectioning of solids in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other – Prisms, Pyramids, Cylinder and Cone.

Development of lateral surfaces - Development of lateral surfaces - Prism and Pyramid.

Total Hours 60

Reference Books:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2014.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2011.
3. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2013.

Web References:

1. <http://nptel.ac.in/courses/112102101/>
2. www.solidworks.com

Blooms Taxonomy based Assessment Pattern:

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment[60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	30	30
Understand	30	30
Apply	20	20
Analyze	20	20
Evaluate	0	0
Create	0	0