Gurugram University Gurugram

Curriculum for UG Degree Course

in

Mechanical Engineering

Gurugram University Gurugram

GENERAL COURSE STRUCTURE and CREDIT DISTRIBUTION

STRUCTURE OF UNDERGRADUATE ENGINEERING PROGRAM

S.No.	Category	Breakup of Credits (Total 158)
1	Humanities and Social Sciences including Management courses	11
2	Basic Science courses	20
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	34
4	Professional core courses	61
5	Professional Elective courses relevant to chosen specialization/branch	12
6	Open subjects – Electives from other technical and /or emerging subjects	12
7	Project work, seminar and internship in industry or elsewhere	16
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Economics for Engineers]	Non-credit
9	**Total**	**166**

SEMESTER WISE SUMMARY OF THE PROGRAM

S.No.	Semester	No. of Contact Hours	Marks	Credits
1.	I	24	900	19.5
2.	II	27	800	22.5
3.	III	32	900	21
4.	IV	34	1000	22
5.	V	28	1000	22
6.	VI	33	1000	24
7.	VII	25	900	21
8.	VIII	5	500	14
	Total	**208**	**7000**	**166**

COURSE CODE AND DEFINITIONS

Course Code	Definitions
L	Lecture
T	Tutorial
P	Practical
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
OEC	Open Elective courses
LC	Laboratory course

MC	Mandatory courses
PROJ	Project

CREDIT DISTRIBUTION IN THE FIRST YEAR OF UNDERGRADUATE ENGINEERING PROGRAM

Bachelor of Technology Semester-1

Subject	Lecture (L)	Tutorial (T)	Laboratory/ Practical (P)	Total credits (C)
Communication Skills in English	2	0	0	2
Mathematics-I	3	1	0	4
Chemistry OR Basic of Electrical and Electronics Engineering	3 3	0 0	0 0	3 OR 3
Programing for problem solving using C	3	0	0	3
Basics of Environmental Science	2	0	0	2
Communication Skills in English(P).	0	0	2	1
Chemistry (P) OR Basic of Electrical and Electronics Engineering(P)	0	0	2	1
Programing for problem solving using C	0	0	2	1
Engineering Graphics (Web Design) OR Workshop Practices(P)	1 1	0 0	3 3	2.5 0R 2.5
Sports (Audit Course) Compulsory	0	0	2	0

ENGINEERING PROGRAM

Bachelor of Technology Semester-II

Subject	Lecture (L)	Tutorial (T)	Laboratory/ Practical (P)	Total credits (C)
Mathematics-II	3	1	0	4
Human Value and Soft Skills	2	0	2	3
Basic of Electrical and Electronics Engineering OR Chemistry OR Material Science	3 3	0 0	0 0	3 OR 3
Physics	3	1	0	4
Engineering Mechanics	3	1	0	4
Basic of Electrical and Electronics Engineering(P) OR Chemistry (P).	0	0	2	1
Physics (P)	0	0	2	1
Workshop Practices (P) OR Engineering Drawing	1 1	0 0	3 3	2.5 OR 2.5

HUMANITIES and SOCIAL SCIENCES INCLUDING MANAGEMENT

S. No.	Code No.	Course Title	Hours Per week			Total Credits	Semester
			L	T	P		
1		Communication Skills in English	2	0	2	3	I
2		Basics of Environmental Science	2	0	0	2	I
3		Human Value and Soft Skills	2	0	2	3	II
4		Entrepreneurship Development	3	0	0	3	VI
					Total Credits	**11**	

BASIC SCIENCE COURSES (BSC)

S. No.	Code No.	Course	Hours Per Week			Total Credits	Semester
			L	T	P		
1.		Mathematics-I	3	1	0	4	I
2.		Physics	3	1	2	5	II
3.		Chemistry	3	0	2	4	II
4.		Mathematics-II	3	1	0	4	II
5.		Mathematics-III	3	0	0	3	III
					Total Credits	**20**	

ENGINEERING SCIENCE COURSE (ESC)

S. No.	Code No.	Course Title	Hours Per Week			Total Credits	Semester
			L	T	P		
1.		Engineering Drawing	1	0	3	2.5	I
2.		Programing for problem solving using C	3	0	2	4	I
3.		Basic of Electrical and Electronics Engineering	3	0	2	4	I
4.		Engineering Mechanics	3	1	0	4	II
5.		Workshop Practices(P)	1	0	3	2.5	II
6.		Thermodynamics	3	0	2	4	III
7.		Instrumentation and Control	3	0	2	4	IV
8.		Applied Thermodynamics	3	0	0	3	IV
9.		MOOCI (Essential)	3	-	-	3	VIII
10.		MOOCII (Essential)	3	-	-	3	VIII
					Total Credits	**34**	

PROFESSIONAL CORE COURSES (PCC)

S. No.	Code No.	Course Title	Hours Per Week			Total Credits	Semester
			L	T	P		
1.		Strength of materials	3	0	2	4	III
2.		Production Process-I	3	0	0	3	III
3.		Computer Aided Design and Manufacturing	3	0	2	4	IV
4.		Production Process-II	3	0	2	4	IV
5.		Kinematics of Machine	3	0	2	4	IV
6.		Machine Tools and Machining	3	0	0	3	IV
7.		Fluid Mechanics	3	0	2	4	III
8.		Design of machine element-I	3	0	0	3	V
9.		Internal Combustion Engines and Gas Turbines	3	0	2	4	V
10.		Fluid Machines	3	0	2	4	V
11.		Dynamics of Machines	3	0	2	4	V
12.		Design of machine element-II	3	0	0	3	VI
13.		Industrial Automation	3	0	0	3	III
14.		Operation Research	3	0	0	3	VI
15.		Heat Transfer	3	0	2	4	V
16.		Non-Conventional Energy Resources	3	0	0	3	VII
17.		Refrigeration And Air Conditioning	3	0	2	4	VII
					Total Credits	**61**	

PROFESSIONAL ELECTIVE COURSES (PEC)

S. No.	Code No.	Course Title	Hours Per Week			Total Credits	Semester
			L	T	P		
1	Elective I	Elective I	3	0	0	3	V
2	Elective II	Elective II	3	0	0	3	VI
3	Elective III	Elective III	3	0	0	3	VI
4	Elective IV	Elective IV	3	0	0	3	VII
					Total Credits	**12**	

PROFESSIONAL ELECTIVE COURSES (PEC)

S. No.	Code No.	Course Title	Hours Per Week			Total Credits	Semester
1.			L	T	P		
1.		Strength of Material-II	3	0	0	3	V
2.		Welding Technology	3	0	0	3	V
3.		Tribology	3	0	0	3	V
4.		Robotics Engineering	3	0	0	3	V
5.		Power Plant Engineering	3	0	0	3	VI
6.		Solar Energy Engineering	3	0	0	3	VI
7.		Artificial and Machine Learning	3	0	0	3	VI
8.		Machine Tool Design	3	0	0	3	VI
9.		Additive Manufacturing	3	0	0	3	VI
10.		Finite Element Method	3	0	0	3	VI
11.		System Modelling And Simulation	3	0	0	3	VI
12.		Noise and Vibrations	3	0	0	3	VI
13.		Hydraulics ans Pneumatics	3	0	0	3	VI
14.		Composite Materials	3	0	0	3	VII
15.		Gas Dynamics and Turbo machine	3	0	0	3	VII
16.		Non-Destructive Evaluation and Testing	3	0	0	3	VII
17.		Computational Fluid Dynamics	3	0	0	3	VII
					Total Credits	**54**	

PROJECT WORK, SEMINAR AND INTERNSHIP IN INDUSTRY OR ELSEWHERE

Sl. No	Course Code	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1		Project-I	VI	0	0	4	2
2		Practical Training -I	V	0	0	2	1
3		Project-II	VII	0	0	8	4
4		Practical Training-II	VII	0	0	2	1
5		Industrial Project/Project-III	VIII	0	0	16	8
						Total Credits	**16**

Semester wise Structure and Curriculum for

UG Course in

Mechanical Engineering (Engineering and Technology)

Gurugram University Scheme of Studies and Examination

Bachelor of Technology (SCHEME A3) Semester-1

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit
			L	T	P		
1.	HSE-101	Communication Skills in English	2	0	0	2	2
2.	BSM-103	Mathematics-I	3	1	0	4	4
3.	BSC-101 OR EEE-101	Chemistry OR Basic of Electrical and Electronics Engineering	3 3	0 0	0 0	3	3
4.	CSE-101	Programing for problem solving using C	3	0	0	3	3
5.	ENV-101	Basics of Environmental Science	2	0	0	2	2
6.	HSE-101P	Communication Skills in English (P).	0	0	2	2	1
7.	BSC-101P OR EEE-101P	Chemistry (P) OR Basics of Electrical and Electronics Engineering (P)	0	0	2	2	1
8.	CSE-101P	Programing for Problem solving using C (P)	0	0	2	2	1
9.	MEE-104P OR MEE-102P	Engineering Drawing OR Workshop Practices (P)	1 1	0 0	3 3	4	2.5

10.	AUS-101	Sports (Audit Course) Compulsory	0	0	2	2*	0
Total						**24+2***	**19.5**

Course code	HSE-101				
Category	Humanities and Social Sciences				
Course title	Communication Skills in English				
Scheme and Credits	L	T	P	Credits	
	2	0	0	2	
Class work/ Practical	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Objectives of the course:

- **a.** The course will focus on the four integral skills of language, improving the proficiency levels in all of them and to learn to use language as a tool for effective communication.
- **b.** This course will widen the understanding of the learners in all genres of literature (short stories, poetry, autobiographies.) with the help of expository pieces .
- **c.** The course will strive to equip the learner with the ability to express oneself and be understood by others with clarity and precision, in both written and spoken forms.
- **d.** This course will encourage creative use of language through translation, paraphrasing and paragraph writing.
- **e.** Along with the above, the course will also build confidence and encourage the students to use a standard spoken form of English in order to prepare them to face job interviews, workplace and in higher studies.

Unit:1

Remedial English : Parts of speech, Gerunds, Participles and infinitives; Clauses; Sentence constructions (unity; avoidance of choppy and rambling sentences, logic and consistency, conciseness, sequencing of ideas); Sentence errors-agreement between verb and subject, pronoun and antecedents, sequence of tenses, problems involving modifiers (dangling and misplaced modifiers); Shifts in point of view consistency of number and person, tense, mood, voice and subject; Parallelism; Omissions and mixed constructions.

Unit: 2

Vocabulary : Methods of building vocabulary-etmological roots, prefixes and suffixes; Commonly used foreign words and phrases; spelling; words often confused synonyms and homonyms; one word substitutes; verbal idioms.

Unit: 3

Punctuation and Mechanics: End Punctuation; internal Punctuation; Word Punctuation. Comprehension: Abstracting; Summarizing; Observation, Findings and Conclusions; Illustration and Inductive Logic; Deduction and Analogy.

Unit: 4

Presentation: Oral presentation- Extempore, discussion on topics of contemporary relevance, Interviews.

Written Comprehension: The ability to write after listening to and reading select speeches, news bulletins, presentations and answering questions based on what has been heard. Reading the given texts to skim, scan, infer and answer comprehension questions. Reading texts like case studies and project reports for critical assessment and book Review.

Suggested Books:

1. Nitin Bhatnagar and Mamta Bhatnagar, Communicative English for Engineers and Professionals. Pearson Education.
2. Bhatnagar, k. Manmohan.Ed. The Spectrum of Life: An Anthology of Modern Prose. Delhi: Macmillan India Ltd., 2006.
3 C. Murlikrishnaand Sunita Mishra, Communication Skills for Engineers, Pearson Ed.
4 Sinha, R.P.Current English Grammar and Usage. OUP.
1. Rizvi, M. Ashraf.Effective Technical Communication. McGraw Hill Education (India) Pvt. Ltd., 2014.
2. Eastwood, John.Oxford Guide to English Grammar.OUP, 2010.
7.Kumar, Sanjay and PushpLata. Communication Skills. OUP, 2011.
8. Raman, Meenakshi and Sangeeta Sharma.CommunicationSkills.NewDelhi:OUP,2011.
9.Hill, L.A.A Guide to Correct English.London:OUP,1965.
10.Oxford Dictionary of English Idioms. New Delhi: OUP, 2009
11*http://yousigma.com/religionandphilosophy/swamivivekananda/thescecretofwork.pdf

Course code	BSM-103				
Category	Basic Science Course				
Course title	Mathematics-I				
Scheme and Credits	L	T	P	Credits	
	3	1	0	4	
Class work	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Objectives of the course

1. To develop logical understanding of the subject
2. To develop mathematical skill so that students are able to apply mathematical methods and principals in solving problem from Engineering fields.
3. To make aware students about the importance and symbiosis between Mathematics and Engineering.

Unit-I

Matrices and Its Application:

Elementary Matrices, Elementary Transformations, Inverse using elementary transformations, Rank of a matrix, Normal form of a matrix, Linear dependence and independence of vectors, Consistency of linear system of equations, Linear and Orthogonal Transformations, Eigenvalues and Eigenvectors, Properties of eigenvalues, Cayley-Hamilton Theorem, Diagonalization of Matrices.

Unit-II

Sequences and Series:

Convergence of sequence and series, Tests for convergence, Power series: Taylor's series, series for exponential, trigonometric and logarithm functions, Fourier series: Half range sine and cosine series, Parseval's theorem.

Unit-III

Differential Calculus: Limit, Continuity and Differentiability of function of single variable, Successive Differentiation, Leibnitz Theorem, Taylor's and Maclaurin's Series for Single Variable function, Partial derivatives, Homogeneous functions, Euler's Theorem, Jacobian, Maxima-Minima of function of two variables, Lagrange's Method of undetermined multipliers.

Unit-IV

Integral Calculus: Basic concepts of integration and properties of definite integrals, Applications of single integration to find volume of solids and surface area of solids of revolution, Double integral, Change of order of integration, Double integral in Polar Co- ordinates, Applications of double integral to find area enclosed by plane curves, Triple integral, Beta and Gamma functions.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, Pearson Education.

2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons.

3. D. Poole, Linear Algebra: A Modern Introduction, Brooks Cole.

4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited.

5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications.

6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

7. V. Krishnamurthy, V.P. Mainra and J. L. Arora, An introduction to Linear Algebra, Affiliated East– West Press Private limited

Course code	BSC-101				
Category	BASIC SCIENCE COURSES				
Course title	Chemistry				
Scheme and Credits	L	T	P	Credits	
	3	0	0	3	
Class work	30Marks				
Theory Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objective:

1. To analyse microscopic chemistry
2. Understand the concept of hardness of water and phenomenon of corrosion
3. Rationalise periodic properties
4. Distinguish the ranges of the electromagnetic spectrum

UNIT-I

Atomic and molecular structure: Schrodinger equation (Introduction and concept only). Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations (derivation excluded). Molecular orbital energy level diagrams of diatomic molecules. Pi-molecular orbitals of butadiene and benzene. Crystal field theory and the energy level diagrams for transition metal ions.

UNIT-III

Periodic properties: Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes,ionization energies, electron affinity and electronegativity, polarizability, oxidation states.

UNIT-III

Stereochemistry: Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations, symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

Organic reactions: Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization (mechanism excluded).

UNIT-IV

Intermolecular forces: Ionic, dipolar and Van der Waals interactions.

Water Chemistry: Hardness of water- Introduction, Types, Measurement of hardness by EDTA method, Methods of water softening (Lime soda process, Zeolite Process, Demineralisation process).

Text Books:

(i) University Chemistry, Bruce M. Mahan, Pearson Education.

(ii) Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane

(iii) Essentials of Analytical Chemistry, Shobha Ramakrishnan and Banani Mukhopadhyay, Pearson Education.

(iv) Fundamentals of Molecular Spectroscopy, by C. N. Banwell

(v) Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan

(vi) Physical Chemistry, by P. W. Atkins

(vii) Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition.

Course Outcomes:

The course will enable the student to:

- Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
- Understand the concept of hardness of water and phenomenon of corrosion.
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.
- Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electron affinity.

Course code	EEE-101				
Category	**Engineering Science Course**				
Course title	**Basics of Electrical and Electronics Engineering**				
Scheme and Credits	L	T	P	Credits	
	3	**0**	**0**	3	
Class work	**30 Marks**				
Exam	**70 Marks**				
Total	**100 Marks**				
Duration of Exam	**03 Hours**				

Objectives of the course

To provide basic knowledge of different elements of electrical and electronics engineering field.
To familiarize the students with the concepts of electrical circuits and network Analysis.

To understand the basics of AC and DC circuits.

To familiarize students to the analysis and design of analog electronic circuits which form the basic building blocks of almost any electronic system.

To introduce p-n junction theory, operation of the semiconductor devices and their use in basic electronic circuits.

Unit: 1
DC Circuits

Role and importance of circuits in Engineering, Concept of fields, charge, current, voltage, energy and their interrelationships. Electrical circuit elements (R, L and C), voltage and current sources(ideal and Controlled),series and parallel circuits, Network reduction: voltage and current division Kirchhoff current and voltage laws with their applications (Nodal and Mesh Analysis), Source transformation - star delta conversion. Superposition theorem, Thevenin and Norton Theorems, Millman,Substitution and Reciprocity theorem.

Unit: 2
AC Circuits

Representation of sinusoidal waveforms, average, peak and rms values, complex representation of impedance, phasor representation, complex power, real power, reactive power, apparent power, power factor and Energy, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel),Resonance; Introduction to three- phase circuits

Unit: 3

Introduction to p-n junction diode and its applications. Half wave and full wave rectifiers. clipping and clamping circuits, Varactor, Varistor, Voltage Regulator

Bipolar junction transistors and its biasing BJT operation, BJT voltages and currents, CE, CB and CC characteristics, DC load line and bias point, base bias, emitter feedback bias, collector feedback bias, voltage divider bias, Thermal stability, biasing BJT switching circuits, transistor power dissipation and switching time, Testing of bipolar junction transistor with multi-meter, Reading datasheet of BJT.

Unit: 4

Field Effect Devices: JFET : basic Operation and characteristics, drain and transfer characteristics, pinch off voltage, parameters of JFET: Transconductance (gm), ac drain resistance (rd), amplification factor(μ) ,Small Signal Model and Frequency Limitations. MOSFET: basic operation, depletion and enhancement type, pinch-off voltage, Shockley equation and Small Signal Model of MOSFET, MOS capacitor.

Suggested books:

1. E. Huges, "Electrical Technology", ELBS.
2. J. Millman and C. Halkias, Integrated Electronics, McGraw Hill, 2nd Edition, 2009.
3. M.M. Mano: Digital Logic Design, Phi.

Suggested reference books

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. V. Del Toro, "Principles of Electrical engineering", PHI.
3. A. Sedra and C. Smith, Microelectronic Circuits: Theory and Applications, Oxford University Press, 6th Edition, 2013.
4. Boylestad and Nashelsky, "Electronic Devices and Circuit Theory" Pearson publishers, 10th Edition
5. R.P. Jain: Modern Digital Electronics, Tmh.
6. Malvino and Leach, " Digital Principles and Applications", TMH publishers, 8th Edition
7. Tyagi M.S., "Introduction to Semiconductor Materials and Devices", John Wiley and Sons, 1993.
8. Basic Electrical Engineering, A.E. Fitzgerald , David Higginbotham 2009 , Arvin Grabel, Tata McGraw-Hill Publishing Company; 5th Edition.

Course code	CSE-101				
Category	Professional Core Course				
Course title	Programming for Problem Solving Using C				
Scheme and Credits	L	T	P	Credits	
	3	0	0	3	
Class work	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Unit 1

Introduction to Programming: Idea of Algorithm: Steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. C Programming: Keywords, Variables and Data Types: basic, derived and user defined, Type Conversions, Header Files, Basic Input and Output Functions and Statements, Compilation, Syntax and Logical Errors in compilation, Object and Executable Code, Storage Classes, Arithmetic Expressions and Precedence.

Unit 2

Preprocessors, Conditional and Branching Statements, Loops/ Iterative Statements, Writing and evaluation of conditionals and consequent branching.

Unit 3

Arrays (1-D, 2-D), Character Arrays and Strings, Arrays with Pointers, Functions (including using built in libraries), Parameter passing in functions, Call by Value, Call by Reference, Passing arrays to functions, Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc.

Unit 4

Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, Introduction to Dynamic Memory Allocation and its Methods, Structures, Union, Defining Structures and Array of Structures, File Handling.

Suggested Text Books:

Ajay Mittal, Programming in C, 'A Practical Approach', Pearson Education.
Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
Yashavant Kanetkar, Let Us C, BPB Publication.

Suggested Reference Books

Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Course code	ENV-101				
Category	Humanities and Social Sciences				
Course title	Basics of Environmental Science				
Scheme and Credits	L	T	P	Credits	
	2	0	0	2	
Class work/Practical	50Marks				
Exam	50Marks				
Total	100Marks				
Duration of Exam	03 Hours				

Course Objective:

To impart the knowledge and awareness for the environmental protection for real-time contribution during an execution of engineering practices in the society.

Unit 1

Environmental studies and Natural Resources:

Definition, scope and importance of environmental studies.

Natural Resources: Renewable and non-renewable resources, and associated problems

(a) Forest resources: Use and over-exploitation, deforestation, Timber extraction, mining, dams and their effects on forests and tribal people.

(b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems.

(c) Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources.

(d) Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers-pesticides problems, water logging, salinity.

(e) Energy Resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources.

Unit 2

Eco Systems:

Concept of an eco-system, Structure and function of an eco-system, Producers, consumers, decomposers, Energy flow in the ecosystems, Ecological succession, Food chains, food webs and ecological pyramids.

Introduction, types, characteristic features, structure and function of the following ecosystems:

(a) Forest ecosystem

(b) Grass land ecosystem
(c) Desert ecosystem
(d) Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3

Environmental Pollution:
Definition, Causes, effects and control measures of;
(a) Air pollution
(b) Soil pollution
(c) Marine pollution
(d) Noise pollution
(e) Nuclear hazards
Disaster management: Floods, earth quake, cyclone and landslides.

Unit 4

Social issues and the Environment:
From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management.
Environmental ethics: issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment protection Act, Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife protection Act, Forest conservation Act, Issues involved in enforcement of environmental legislations.

Recommended Books:

1. Textbook of Environmental studies, Erach Bharucha, UGC.
2. Fundamental concepts in Environmental Studies, D. D. Mishra, S Chand and Co Ltd. Course Outcomes :
1. To understand the basic concepts of environmental studies and natural resources.
2. To learn about the various eco-systems of nature.
3. To gain knowledge about different types of environmental pollutions and their control measures.
4. To acquire the knowledge about the various social aspects related to the environment.

Course code	HSE-101P				
Category	Humanities and Social Sciences				
Course title	Communication Skills in English (P)				
Scheme and Credits	L	T	P	Credits	
	0	0	2	1	
Class work/ Practical	50 Marks				
Exam	50 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Communication Skills in English (P)

Lab Activity: The students will acquire basic proficiency in English with special emphasis on listening, comprehension and speaking skills both at social and professional platforms.

(i) Listening comprehension
(ii) Recognition of phonemes in International Phonetic Alphabet
(iii) Self introduction and introduction of another person
(iv) Conversation and dialogues in common everyday situations
(v) Communication at work place (Standard phrases and sentences in various situations)
(vi) Telephonic communication
(vii) Speeches for special occasions (Welcome speeches, Introduction speeches, Felicitation speeches and Farewell speeches)
(viii) Tag Questions
(ix) Formal Presentations on literary texts prescribed in theory paper, Question Formation and Mock Press Conference

Course code	BSC-101P				
Category	BASIC SCIENCE COURSES				
Course title	Chemistry (P)				
Scheme and Credits	L	T	P	Credits	
	0	0	2	1	
External Practical	50 Marks				
Internal Practical	50 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objective:

The chemistry Laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.

LIST OF EXPERIMENTS: -

1. Determination of surface tension of given liquid by drop number method.
2. Determine the viscosity of given liquid by using Ostwald's viscometer / Redwood viscometer.
3. Calculate the Rf value of given sample using Thin layer chromatography / Paper chromatography.
4. Removal of Ca^{2+} and Mg^{2+} hardness from given water sample using ion exchange column.
5. Determination of chloride content in given water sample.
6. Calculate the strength of strong acid by titrating it with strong base using conductometer.
7. Calculate the emf value of given cell.
8. To prepare the of urea formaldehyde and phenol formaldehyde resin.
9. To determine the rate constant of a reaction.
10. To Prepare iodoform.
11. Calculate the saponification value / acid value of given oil sample.
12. Chemical analysis of two anions and two cations in given sample of salt.
13. Determination of the partition coefficient of a substance between two immiscible liquids.
14. To determine the total hardness of given water sample by EDTA method.

Note: At least 08 experiments are to be performed by the students.

Suggested Books:

1. A Text book on Experiments and Calculation –Engineering Chemistry by S.S.Dara, S.Chand and Company Ltd.
2. Essentials of Analytical Chemisty, Shobha Ramakrishnan, Pearson Education.
3. Essential of Experimental Engineering chemistry, Shashi Chawla, Dhanpat Rai Publishing Co.
4. Theory and Practice Applied Chemistry – O.P.Virmani, A.K. Narula (New Age).
5. Engineering Chemistry, K.Sesha Maheswaramma and Mridula Chugh, Pearson Education.

Course code	EEE-101P				
Category	Engineering Science Course				
Course title	**Basics of Electrical and Electronics Engineering (P)**				
Scheme and Credits	L	T	P	Credits	
	0	0	2	1	
Class work	50 Marks				
Exam	**50 Marks**				
Total	**100 Marks**				
Duration of Exam	03 Hours				

Note: At least 8 experiments are to be performed by the students.

List of Subject related Experiments:

1. Verify that resistance of conductor is directly proportional to resistivity and length and inversely proportional to cross- sectional area of the conductor.

2. Verification of Ohm's Law, Kirchhoff current and voltage laws

3. Verification of temperature co-efficient of resistance: (i) Positive for Tungsten and Nichrome and (ii) Negative for carbon.

4. To measure DC voltage and current, AC voltage and current with multi-meter

5. To observe waveforms on oscilloscope, measure basic parameters amplitude and frequency of sine wave and square wave.

6. Obtain VI characteristics of semiconductor rectifier diode, LED, Photo-diode

7. To observe waveform at the output of half wave rectifier with and without filter capacitor.

8. To observe waveform at the output of full wave rectifier with and without filter capacitor.

9. To experimentally plot the input and output characteristics of a given BJT transistor in CE configuration and calculate its various parameters.

10. To experimentally plot the input and output characteristics of a given BJT transistor in CB configuration and calculate its various parameters.

11. To study the transfer and drain characteristics of JFET and calculate its various parameters.

12. To study the transfer and drain characteristics of MOSFET and calculate its various parameters.

Course code	CSE-101P				
Category	Professional Core Course				
Course title	Programming for Problem Solving Using C (P)				
Scheme and Credits	L	T	P	Credits	
	0	0	2	1	
Class work	50 Marks				
Exam	50 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: At least 6 experiments are to be performed by the students.

List of Subject related Experiments:

Laboratory Outcomes

- To formulate the algorithms for simple problems
- To translate given algorithms to a working and correct program
- To be able to correct syntax errors as reported by the compilers
- To be able to identify and correct logical errors encountered at run time
- To be able to write iterative as well as recursive programs
- To be able to represent data in arrays, strings and structures and manipulate them through a program

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
Tutorial 5: 1D Arrays
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Course code	MEE - 104P				
Category	Engineering Science Course				
Course title	Engineering Drawing (P)				
Scheme and Credits	L	T	P	Credits	
	1	0	3	2.5	
Class work	50 Marks				
Exam	50 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes:

On completion of this course, the students will be able to:

- Introduction to engineering design and its place in society
- Exposure to the visual aspects of engineering design
- Exposure to engineering graphics standards
- Exposure to solid modeling

UNIT-I

Module 1: Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module2: Orthographic Projections

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes –Auxiliary Planes;

UNIT-II

Module3: Projections of Regular Solids

Those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioningand scale.Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Module4: Sections and Sectional Views of Right Angular Solids

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of RightRegular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings(foundation to sLab only)

Module5: Isometric Projections

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions;Isometric Views of lines, Planes, Simple and compound Solids; Conversion of IsometricViewsto OrthographicViews andVice-versa,Conventions;

UNIT- III

Module6: Overview of Computer Graphics

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area(Back ground, Crosshairs, Coordinate System),Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line(where applicable),The Status Bar, Different methods of zoom as used in CAD, Select and eraseobjects.; IsometricViews of lines,Planes,Simple andcompound Solids]

UNIT-IV

Module7: Annotations, layering and other functions

Applying dimensions to objects, applying an notations to drawings; layers to create drawings, orthographic projection techniques; Drawing sectional views of composite right regular geometric solidsand project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies.

Drawing of Engineering objects like coupling, crank shaft, pulley.

Module8: Demonstration of a simple team design project that illustrates

Geometry and topology of engineered components, Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

SuggestedText/ReferenceBooks:

(i) Shah, M.B. and Rana B.C., Engineering Drawing, Pearson Education
(ii) Bhatt N.D., Panchal V.M. and Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
(iii) A grawal B. and Agrawal C. M.(2012), Engineering Graphics, TMH Publication
(iv) Narayana, K.L. and P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
(v) CAD Software Theory and User Manuals

Course code	MEE-102P				
Category	Engineering Science Course				
Course title	Workshop Practices (P)				
Scheme and Credits	L	T	P	Credits	
	1	0	3	2.5	
Class work	50 Marks				
Exam	50 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Objectives of the course

1. To impart fundamental Knowledge of engineering practices such as fitting, wood working, foundry, machining, welding, etc. for manufacturing a product.
2. To prepare the students to understand the various tools and equipment's used in these processes and their working principle
3. To impart fundamental Knowledge of Lathe machine
4. To able to understand the basic knowledge of various welding processes

Class Work

Introduction:

Introduction to Manufacturing Processes and their Classification, Introduction to additive manufacturing, Industrial Safety.

Machining Shop

Lathe, description of lathe: headstock, tailstock, gearbox, carriage, apron, cutting speed, feed and depth of cut, cutting tools, Chucks: 3 jaw, 4 jaw.

Fitting shop:

Introduction, classification of metals: ferrous and nonferrous, fitting tools: measuring and marking tools, marking schemes for a fitting jobs, cutting tools.

Carpentry shop:

Introduction of carpentry, types of woods, carpentry tolls: measuring tools, marking tolls, cutting tools: saws, chisels, planning tools, drilling tools, striking tools, drilling tools, wood working joints, wood working lathe.

Foundry Shop

Introduction, foundry hand tools, measuring boxes, ladle, moulding, furnaces,Pattern: Types of Pattern and Allowances

Welding Shop

Introduction to welding, Classification of Welding Processes,Arc welding and Gas welding equipment's.

Reference Books:

1. S K Hajra Choudhury, Nirjhar Roy, A K Hajra Choudhury, Elements of workshop Technology (vol. 1and2), Media Promoters.
2. B S Raghuwanshi, A Course in Workshop Technology (manufacturing Process vol. 1and 2) Dhanpat Rai and CO.
3. O.P. Khanna, Workshop Technology. Dhanpat Rai Publication.
4. W A J Chapman, Workshop technology in SI unit (part – 1 and2), Mc Graw Hill Education.
5. M.P. GROOVER, Principles of Modern Manufacturing, Wiley.
6. Kalpakjian, Manufacturing Process for Engineering Materials, Pearson Education India.

Lab Work

List of Experiments

1. To study different types of measuring tools used in metrology and determine least counts of vernier callipers, micrometres and vernier height gauges.

2. To study different types of machine tools (lathe, shaper, planer, milling, drilling machines)

3. To prepare a job on a lathe involving like facing, outside turning, taper turning, step turning, radius making and parting-off.

4. To study different types of fitting tools and marking tools used in fitting practice.

5. To prepare a job made out of MS Flats, making saw – cut filling V-cut taper at the corners.

6. To prepare lay out on a metal sheet by making and prepare rectangular tray pipe shaped components e.g. funnel.

7. To prepare joints for welding suitable for butt welding and lap welding.

8. To study various types of carpentry tools and prepare simple types of at least two wooden joints.

9. To prepare simple engineering components/shapes by forging.

10. To prepare mold and core assembly.

11. To prepare horizontal surface/vertical surface/curved surface/slats or V-grooves on a shaper/planner.

12. To prepare a job involving side and face milling on a milling

13. To prepare a job on CNC Machine/Additive Manufacturing.

Note : At least eight experiments/jobs are to be performed/prepared by the students in the semester.

Gurugram University Scheme of Studies and Examination

Bachelor of Technology (SCHEME A3) Semester-2

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit
			L	T	P		
1.	BSM-104	Mathematics-II	3	1	0	4	4
2.	HSV-102	Human Value and Soft Skills	2	0	2	4	3
3.	EEE-101 OR BSC-101	Basics of Electrical and Electronics Engineering OR Chemistry	3	0	0	3	3
4.	BSP-103	Physics	3	1	0	4	4
5.	MEE-106	Engineering Mechanics	3	1	0	4	4
6.	EEE-101P OR BSC-101P	Basics of Electrical and Electronics Engineering (P) OR Chemistry (P).	0	0	2	2	1
7.	BSP-103P	Physics (P)	0	0	2	2	1
8.	MEE-102P OR MEE-104P	Workshop Practices (P) OR Engineering Drawing	1	0	3	4	2.5
Total						**27**	**22.5**

Course code	BSM-104				
Category	Basic Science Course				
Course title	Mathematics-II				
Scheme and Credits	L	T	P	Credits	
	3	1	0	4	
Class work	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Objectives of the course

4. Demonstrate their understanding of mathematical ideas from multiple perspectives.
5. To develop logical understanding of the subject
6. To develop mathematical skill so that students are able to apply mathematical methods and principals in solving problem from Engineering fields.
7. To make aware students about the importance and symbiosis between Mathematics and Engineering.

Unit-I

Ordinary Differential Equations: Exact differential equations, Equations reducible to exact differential equations, Applications of differential equations of first order and first degree to simple electric circuits, Newton's law of cooling, Heat flow and Orthogonal trajectories, Linear Differential equations of second and higher order, Complete solution, Complementary function and Particular integral, Method of variation of parameters to find particular integral, Cauchy's and Legendre's linear equations.

Unit-II

Laplace Transforms and its Applications: Laplace transforms of elementary functions, Properties of Laplace transforms, Existence conditions, Transforms of derivatives, Transforms of integrals, Multiplication by tn , Division by t, Evaluation of integrals by Laplace transforms, Laplace transform of unit step function, Unit impulse function and Periodic function, Inverse transforms.

Unit-III

Partial Differential Equations: Formation of partial differential equations, Lagrange' linear partial differential equation, First order non-linear partial differential equation, Charpit's method, Method of separation of variables

Unit-IV

Basic Statistics: Measures of Central tendency: Mean, Median, Mode, Measures of Dispersion, Moments, Skewness and Kurtosis, Moments, Variance of a sum, Correlation coefficient, Correlation and regression – Rank correlation; Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves.

Reference Books:

1) G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, Pearson Education.
2) Erwin kreyszig, Advanced Engineering Mathematics, John Wiley and Sons.
3) Ramana B.V., Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited.
4) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
5) N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications.
6) P. Sivaramakrishna Das and C. Vijyakumari, Engineering Mathematics, Pearson Education.
7) W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiley India.
8) S. L. Ross, Differential Equations, Wiley India.
9) R. K, Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publication House Private Limited

Course code	HSV-102				
Category	Humanities and Social Sciences				
Course title	Human Values and Soft Skills				
Scheme and Credits	L	T	P	Credits	
	2	0	2	3	
Class work/Practical	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Objectives of the course

a. The course aims at developing the desired English language skills of students of Engineering and Technology so that they become proficient in communication to excel in their professional lives. The course has been designed as to enhance their linguistic and communicative competence.
b. Understanding (Clarity) of Human Relationships and Family.
c. Exposure to Issues in Society and nature (larger manmade systems and Nature).

Unit: 1

Motivation and Objectives of Human Values Course, Purpose of Education, Complimentarily of skills and values, how the current education system falls short, Peers Pressure, Social Pressure In various dimensions of life, Concept of Competition and Time Management.

Unit: 2

Concept of Preconditioning, Concept of Natural Acceptance in Human Being, Understanding Relationships, Dealing with anger, Nine universal values in human relationships. Concept of prosperity, idea of Society, Idea of decentralization of politics, economics, education, justice etc., Its comparison with centralized systems, Balance in nature.

Unit: 3

Techniques of Good Writing , Writing self assessment tasks, Precis writing and note making. Paragraph and Essay writing, Article writing and summarizing

Unit: 4

Business Communication: Formal and Informal Letter writing, Statement of Purpose, Job application and CV (summary statement of academic and professional profiles) and Power point presentations through relevant slides.

English Lab Activity: Blog Writing/Creating a Newsletter, Script writing and enacting for a street play. Develop negotiating skills by using appropriate language of courtesy, Recording individual efforts and holding paired interactions and Group Discussions, Preparing and practising for Interviews.

Suggested reference books

Recommended Readings:

1. Bhatnagar, Nitin andMamtaBhatnagar.Communicative English for Engineers and Professionals.Pearson Education, 2013.
2. Swan, Michael.Practical English Usage. OUP, 1995.
3. Gangal, J.K. Practical Course in Spoken English. New Delhi: PHI Learning, 2015.
4. Konar,Nira. Communication Skills for Professionals. New Delhi: PHI Learning Pvt. Ltd., 2009.
5. Bansal, R.K. and J.B. Harrison. Spoken English. Orient Longman, 1983.
6. Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. Delhi: PHI Learning Pvt. Ltd., 20
7. Annie Leonard, `` The Story of Stuff,'' Free Press
8. Mohandas Karamchand Gandhi,`` The Story of My Experiments with Truth," Beacon Press
9. J Krishnamurthy,`` On Education," Official repository
10. Hermann Hesse ,`` Siddhartha," Bantam Books
11. ThichNhatHanh,`` Old Path White Clouds," Parallex Press
12. On Education - The Mother Aurobindo Ashram Publication

Course code	EEE-101				
Category	**Engineering Science Course**				
Course title	**Basics of Electrical and Electronics Engineering**				
Scheme and Credits	L	T	P	Credits	
	3	**0**	**0**	3	
Class work	**30 Marks**				
Exam	**70 Marks**				
Total	**100 Marks**				
Duration of Exam	**03 Hours**				

Objectives of the course

To provide basic knowledge of different elements of electrical and electronics engineering field.
To familiarize the students with the concepts of electrical circuits and network Analysis.

To understand the basics of AC and DC circuits.

To familiarize students to the analysis and design of analog electronic circuits which form the basic building blocks of almost any electronic system.

To introduce p-n junction theory, operation of the semiconductor devices and their use in basic electronic circuits.

Unit: 1
DC Circuits

Role and importance of circuits in Engineering, Concept of fields, charge, current, voltage, energy and their interrelationships. Electrical circuit elements (R, L and C), voltage and current sources(ideal and Controlled),series and parallel circuits, Network reduction: voltage and current division Kirchhoff current and voltage laws with their applications (Nodal and Mesh Analysis), Source transformation - star delta conversion. Superposition theorem, Thevenin and Norton Theorems, Millman,Substitution and Reciprocity theorem.

Unit: 2
AC Circuits

Representation of sinusoidal waveforms, average, peak and rms values, complex representation of impedance, phasor representation, complex power, real power, reactive power, apparent power, power factor and Energy, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel),Resonance; Introduction to three- phase circuits

Unit: 3

Introduction to p-n junction diode and its pplications. Half wave and full wave rectifiers. clipping and clamping circuits, Varactor, Varistor, Voltage Regulator

Bipolar junction transistors and its biasing BJT operation, BJT voltages and currents, CE, CB and CC characteristics, DC load line and bias point, base bias, emitter feedback bias, collector feedback bias, voltage divider bias, Thermal stability, biasing BJT switching circuits, transistor power dissipation and switching time, Testing of bipolar junction transistor with multi-meter, Reading datasheet of BJT.

Unit: 4

Field Effect Devices: JFET : basic Operation and characteristics, drain and transfer characteristics, pinch off voltage, parameters of JFET: Transconductance (gm), ac drain resistance (rd), amplification factor(μ) ,Small Signal Model and Frequency Limitations. MOSFET: basic operation, depletion and enhancement type, pinch-off voltage, Shockley equation and Small Signal Model of MOSFET, MOS capacitor.

Suggested books:

1. E. Huges, "Electrical Technology", ELBS.
2. J. Millman and C. Halkias, Integrated Electronics, McGraw Hill, 2nd Edition, 2009.
3. M.M. Mano: Digital Logic Design, Phi.

Suggested reference books

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. V. Del Toro, "Principles of Electrical engineering", PHI.
3. A. Sedra and C. Smith, Microelectronic Circuits: Theory and Applications, Oxford University Press, 6th Edition, 2013.
4. Boylestad and Nashelsky, "Electronic Devices and Circuit Theory" Pearson publishers, 10th Edition
5. R.P. Jain: Modern Digital Electronics, Tmh.
6. Malvino and Leach, " Digital Principles and Applications", TMH publishers, 8th Edition
7. Tyagi M.S., "Introduction to Semiconductor Materials and Devices", John Wiley and Sons, 1993.
8. Basic Electrical Engineering, A.E. Fitzgerald , David Higginbotham 2009 , Arvin Grabel, Tata McGraw-Hill Publishing Company; 5th Edition.

Course code	BSC-101				
Category	BASIC SCIENCE COURSES				
Course title	Chemistry				
Scheme and Credits	L	T	P	Credits	
	3	0	0	3	
Class work	30Marks				
Theory Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objective:

1. To analyse microscopic chemistry
2. Understand the concept of hardness of water and phenomenon of corrosion
3. Rationalise periodic properties
4. Distinguish the ranges of the electromagnetic spectrum

UNIT-I

Atomic and molecular structure: Schrodinger equation (Introduction and concept only). Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations (derivation excluded). Molecular orbital energy level diagrams of diatomic molecules. Pi-molecular orbitals of butadiene and benzene. Crystal field theory and the energy level diagrams for transition metal ions.

UNIT-II

Periodic properties: Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes,ionization energies, electron affinity and electronegativity, polarizability, oxidation states.

UNIT-III

Stereochemistry: Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations, symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

Organic reactions: Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization (mechanism excluded).

UNIT-IV

Intermolecular forces: Ionic, dipolar and Van der Waals interactions.

Water Chemistry: Hardness of water- Introduction, Types, Measurement of hardness by EDTA method, Methods of water softening (Lime soda process, Zeolite Process, Demineralisation process).

Suggested Text Books:

(i) University Chemistry, Bruce M. Mahan, Pearson Education.
(ii) Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
(iii) Essentials of Analytical Chemistry, Shobha Ramakrishnan and Banani Mukhopadhyay, Pearson Education.
(iv) Fundamentals of Molecular Spectroscopy, by C. N. Banwell
(v) Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
(vi) Physical Chemistry, by P. W. Atkins
(vii) Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition.

Course Outcomes:

The course will enable the student to:

- Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
- Understand the concept of hardness of water and phenomenon of corrosion.
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.
- Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electron affinity.

Course code	BSP-103				
Category	**Basic Science Course**				
Course title	**Physics**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	3	**1**	**0**	**4**	
Class work	**30 Marks**				
Exam	**70 Marks**				
Total	**100 Marks**				
Duration of Exam	**03 Hours**				

Objectives of the course

1. To impart knowledge of basic concepts in applied physics
2. To enhance the analytical capability of the engineering students.
3. To givea balance account of the fundamentals of Physics as well as some of recent developments in this area best suited to the Engineering applications in different branches and to provide the knowledge and methodology necessary for solving problems in the field of engineering.

UNIT – I

Electrostatics in vacuum and linear dielectric medium

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential Boundary conditions of electric field and electrostatic potential; energy of a charge distribution and its expression in terms of electric field. Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement.

UNIT – II

Electromagnetism and Magnetic Properties of Materials

Laws of electrostatics, electric current and the continuity equation, laws of magnetism. Ampere's Faraday's laws. Maxwell's equations. Polarisation, permeability and dielectric constant, polar and non-polar dielectrics, applications of dielectric Magnetisation, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

UNIT – III

Wave Optics and Lasers

Wave Optics: Huygens' principle, superposition of waves and interference of light by wave-front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer. Fraunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power.

Lasers: Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity.

UNIT – IV

Introduction to Solids and Semiconductors

Free electron theory of metals, Fermi level, density of statesin1, 2 and 3 dimensions, Bloch's theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands. Types of electronic materials: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p - n junction.

Suggested reference books

1. E. Hecht, "Optics", Pearson Education
2. D. J. Griffiths, "Quantum mechanics", Pearson Education
3. B.G. Streetman, "Solid State Electronic Devices", Pearson Education
4. G. Main, "Vibrations and waves in physics", Cambridge University Press
5. H. J. Pain, "The physics of vibrations and waves", Wiley
6. A. Ghatak, "Optics", McGraw Hill Education,
7. O. Svelto, "Principles of Lasers", Springer Science and Business Media,
8. R. Robinett, "Quantum Mechanics", OUP Oxford
9. D. McQuarrie, "Quantum Chemistry", University Science Books
10. D. A. Neamen, "Semiconductor Physics and Devices", Times Mirror High Education Group, Chicago
11. E.S. Yang, "Microelectronic Devices", McGraw Hill, Singapore

Course code	MEE-106				
Category	Program Core Course				
Course title	Engineering Mechanics				
Scheme and Credits	L	T	P	Credits	
	3	1	0	4	
Class work	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes (COs):

At the end of the course, the student shall be able to:

1. Understand the basic force system.
2. Apply principles of particle kinematics.
3. Grasp the concepts of particle dynamics.
4. Learn energy methods and momentum methods.

UNIT-I

Introduction: Force system, dimensions and units in mechanics, laws of mechanics, vector algebra, addition and subtraction of forces, cross and dot products of vectors, moment of a force about a point and axis, couple and couple moment, transfer of a force to a parallel position, resultant of a force system using vector method, Problems involving vector application

Equilibrium: Static and dynamic equilibrium, static in determinacy, general equations of equilibrium, Varingnon's theorem, Lami's theorem, equilibrium of bodies under a force system, Problems.

UNIT-II

Truss and Frames: Truss, classification of truss, assumptions in truss analysis, perfect truss, analysis of perfect plane truss using method of joints and method of sections, Problems.Centroid , Centre of mass and Centre of gravity, Determination of centroid, centre of mass and centre of gravity by integration method of regular and composite figures and solid objects, Problems.

UNIT-III

Moment of Inertia: Area moment of inertia, mass moment of inertia, parallel axis andperpendicular axis theorems, radius of gyration, polar moment of inertia, product of inertia, principle axis, problem based on composite figures and solid objects.

Kinematics: Concept of rigid body, velocity and acceleration, relative velocity, translation and rotation of rigid bodies, equations of motion for translation and rotation, problems.

UNIT-IV

Particle Dynamics: Energy methods and momentum methods, Newton's laws, work energy Equation for a system of particles, linear and angular momentum equations, projectile motion, problem. Shear Force and Bending Moment Diagram for statically determinant beams classification Of beams, types of loads, shear force and bending moment calculation and their graphical presentation, point of inflection, problem.

RecommendedBooks:-

- Engineering Mechanics– Irving H. Shames, PHI Publication
- Engineering Mechanics–U.C. Jindal, Galgotia Publication
- Engineering Mechanics–A.K.Tayal, Umesh Publication

Course code	EEE-101P				
Category	Engineering Science Course				
Course title	**Basics of Electrical and Electronics Engineering (P)**				
Scheme and Credits	L	T	P	Credits	
	0	0	2	1	
Class work	50 Marks				
Exam	**50 Marks**				
Total	**100 Marks**				
Duration of Exam	03 Hours				

Note: At least 8 experiments are to be performed by the students.

List of Subject related Experiments:

1. Verify that resistance of conductor is directly proportional to resistivity and length and inversely proportional to cross- sectional area of the conductor.

2. Verification of Ohm's Law, Kirchhoff current and voltage laws

3. Verification of temperature co-efficient of resistance: (i) Positive for Tungsten and Nichrome and (ii) Negative for carbon.

4. To measure DC voltage and current, AC voltage and current with multi-meter

5. To observe waveforms on oscilloscope, measure basic parameters amplitude and frequency of sine wave and square wave.

6. Obtain VI characteristics of semiconductor rectifier diode, LED, Photo-diode

7. To observe waveform at the output of half wave rectifier with and without filter capacitor.

8. To observe waveform at the output of full wave rectifier with and without filter capacitor.

9. To experimentally plot the input and output characteristics of a given BJT transistor in CE configuration and calculate its various parameters.
10. To experimentally plot the input and output characteristics of a given BJT transistor in CB configuration and calculate its various parameters.
11. To study the transfer and drain characteristics of JFET and calculate its various parameters.
12. To study the transfer and drain characteristics of MOSFET and calculate its various parameters.

Course code	BSC-101P				
Category	BASIC SCIENCE COURSES				
Course title	Chemistry (P)				
Scheme and Credits	L	T	P	Credits	
	0	0	2	1	
External Practical	50 Marks				
Internal Practical	50 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objective:

The chemistry Laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.

LIST OF EXPERIMENTS: -

1. Determination of surface tension of given liquid by drop number method.
2. Determine the viscosity of given liquid by using Ostwald's viscometer / Redwood viscometer.
3. Calculate the Rf value of given sample using Thin layer chromatography / Paper chromatography.
4. Removal of Ca^{2+} and Mg^{2+} hardness from given water sample using ion exchange column.
5. Determination of chloride content in given water sample.
6. Calculate the strength of strong acid by titrating it with strong base using conductometer.
7. Calculate the emf value of given cell.
8. To prepare the of urea formaldehyde and phenol formaldehyde resin.
9. To determine the rate constant of a reaction.
10. To Prepare iodoform.
11. Calculate the saponification value / acid value of given oil sample.
12. Chemical analysis of two anions and two cations in given sample of salt.
13. Determination of the partition coefficient of a substance between two immiscible liquids.
14. To determine the total hardness of given water sample by EDTA method.

Note: At least 08 experiments are to be performed by the students.

Suggested Books:

1. A Text book on Experiments and Calculation –Engineering Chemistry by S.S.Dara, S.Chand and Company Ltd.
2. Essentials of Analytical Chemisty, Shobha Ramakrishnan, Pearson Education.
3. Essential of Experimental Engineering chemistry, Shashi Chawla, Dhanpat Rai Publishing Co.
4. Theory and Practice Applied Chemistry – O.P.Virmani, A.K. Narula (New Age).
5. Engineering Chemistry, K.Sesha Maheswaramma and Mridula Chugh, Pearson Education.

PHYSICS Lab

Course code	BSP-103P				
Category	**Basic Science Course**				
Course title	**Physics (P)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	
	0	**0**	**2**	**1**	
Class work	**50 Marks**				
Exam	**50 Marks**				
Total	**100 Marks**				
Duration of Exam	**03 Hours**				

Note: At least 8 experiments are to be performed by the students.

List of Subject related Experiments:

1. To find out wavelength of monochromatic light using Newton's ring experiment.
2. To find out wavelength of monochromatic light using Diffraction grating.
3. To find out wavelength of monochromatic light using Freshnel's bi-prism
4. To study interference phenomena using Michelson's Interferometer and to find out wavelength of monochromatic light.
5. To study Hall effect in semiconductors and measure the Hall coefficient.
6. To find frequency of AC mains using sonometer.
7. To study the magnetic properties of materials using B-H curve.
8. To study the Curies temperature of materials using Dielectric set up.
9. To verify the inverse square law with the help of a photovoltaic cell.
10. To determine Planks constant using photocell.
11. To study the characteristics of Solar cell and find out the fill factor.
12. To find temperature co-efficient of platinum using Callender Griffith bridge.
13. To study the forward and reverse characteristics of P-N junction diode.

Course code	MEE-102P				
Category	Engineering Science Course				
Course title	Workshop Practices (P)				
Scheme and Credits	L	T	P	Credits	
	1	0	3	2.5	
Class work	50 Marks				
Exam	50 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Objectives of the course

5. To impart fundamental Knowledge of engineering practices such as fitting, wood working, foundry, machining, welding, etc. for manufacturing a product.
6. To prepare the students to understand the various tools and equipment's used in these processes and their working principle
7. To impart fundamental Knowledge of Lathe machine
8. To able to understand the basic knowledge of various welding processes

Class Work

Introduction:

Introduction to Manufacturing Processes and their Classification, Introduction to additive manufacturing, Industrial Safety.

Machining Shop

Lathe, description of lathe: headstock, tailstock, gearbox, carriage, apron, cutting speed, feed and depth of cut, cutting tools, Chucks: 3 jaw, 4 jaw.

Fitting shop:

Introduction, classification of metals: ferrous and nonferrous, fitting tools: measuring and marking tools, marking schemes for a fitting jobs, cutting tools.

Carpentry shop:

Introduction of carpentry, types of woods, carpentry tolls: measuring tools, marking tolls, cutting tools: saws, chisels, planning tools, drilling tools, striking tools, drilling tools, wood working joints, wood working lathe.

Foundry Shop

Introduction, foundry hand tools, measuring boxes, ladle, moulding, furnaces,Pattern: Types of Pattern and Allowances

Welding Shop

Introduction to welding, Classification of Welding Processes,Arc welding and Gas welding equipment's.

Reference Books:

7. S K Hajra Choudhury, Nirjhar Roy, A K Hajra Choudhury, Elements of workshop Technology (vol. 1and2), Media Promoters.
8. B S Raghuwanshi, A Course in Workshop Technology (manufacturing Process vol. 1and 2) Dhanpat Rai and CO.
9. O.P. Khanna, Workshop Technology. Dhanpat Rai Publication.
10. W A J Chapman, Workshop technology in SI unit (part – 1 and2), Mc Graw Hill Education.
11. M.P. GROOVER, Principles of Modern Manufacturing, Wiley.
12. Kalpakjian, Manufacturing Process for Engineering Materials, Pearson Education India.

Lab Work

List of Experiments

1. To study different types of measuring tools used in metrology and determine least counts of vernier callipers, micrometres and vernier height gauges.

2. To study different types of machine tools (lathe, shaper, planer, milling, drilling machines)

3. To prepare a job on a lathe involving like facing, outside turning, taper turning, step turning, radius making and parting-off.

4. To study different types of fitting tools and marking tools used in fitting practice.

5. To prepare a job made out of MS Flats, making saw – cut filling V-cut taper at the corners.

6. To prepare lay out on a metal sheet by making and prepare rectangular tray pipe shaped components e.g. funnel.

7. To prepare joints for welding suitable for butt welding and lap welding.

8. To study various types of carpentry tools and prepare simple types of at least two wooden joints.

9. To prepare simple engineering components/shapes by forging.

10. To prepare mold and core assembly.

11. To prepare horizontal surface/vertical surface/curved surface/slats or V-grooves on a shaper/planner.

12. To prepare a job involving side and face milling on a milling

13. To prepare a job on CNC Machine/Additive Manufacturing.

Note : At least eight experiments/jobs are to be performed/prepared by the students in the semester.

Course code	MEE - 104P				
Category	Engineering Science Course				
Course title	Engineering Drawing (P)				
Scheme and Credits	L	T	P	Credits	
	1	0	3	2.5	
Class work	50 Marks				
Exam	50 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes:

On completion of this course, the students will be able to:

- Introduction to engineering design and its place in society
- Exposure to the visual aspects of engineering design
- Exposure to engineering graphics standards
- Exposure to solid modeling

UNIT-I

Module 1: Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module2: Orthographic Projections

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes –Auxiliary Planes;

UNIT-II

Module3: Projections of Regular Solids

Those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Module4: Sections and Sectional Views of Right Angular Solids

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings(foundation to sLab only)

Module5: Isometric Projections

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

UNIT- III

Module6: Overview of Computer Graphics

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area(Back ground, Crosshairs, Coordinate System),Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line(where applicable),The Status Bar, Different methods of zoom as used in CAD, Select and eraseobjects.; IsometricViews of lines,Planes,Simple andcompound Solids]

UNIT-IV

Module7: Annotations, layering and other functions

Applying dimensions to objects, applying an notations to drawings; layers to create drawings, orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies.

Drawing of Engineering objects like coupling, crank shaft, pulley.

Module8: Demonstration of a simple team design project that illustrates

Geometry and topology of engineered components, Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Suggested Text/Reference Books:

(vi) Shah, M.B. and Rana B.C., Engineering Drawing, Pearson Education

(vii) Bhatt N.D., Panchal V.M. and Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House

(viii) A grawal B. and Agrawal C. M.(2012), Engineering Graphics, TMH Publication

(ix) Narayana, K.L. and P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

(x) CAD Software Theory and User Manuals

Semester 3

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	BSC		Mathematics-III	3	0	0	3	**30**	**70**	**100**
2	PCC		Fluid Mechanics	3	0	0	3	**30**	**70**	**100**
3	HSMC		Thermodynamics	3	0	0	3	**30**	**70**	**100**
4	PCC		Industrial Automation	3	0	0	3	**30**	**70**	**100**
5	PCC		Production Process-I	3	0	0	3	**30**	**70**	**100**
6	PCC		Strength of Materials	3	0	0	3	**30**	**70**	**100**
7	LC		Fluid Mechanics_Lab	0	0	2	1	**50**	**50**	**100**
8	LC		Thermodynamics__Lab	0	0	2	1	**50**	**50**	**100**
9	LC		Strength of Materials _Lab	0	0	2	1	**50**	**50**	**100**
10	MC		**Constitution of India***	0	0	2	0	**30**	**70**	**100***
	Total						**21**			**900**

***Constitution of India : Non-credit mandatory course, students have to attain pass marks (40%)**

NOTE: The examination of the regular students will be conducted by the concerned college/Institute internally. Each student will be required to score a minimum of 40% marks to qualify in the paper. The marks will not be included in determining the percentage of marks obtained for the award of a degree. However, these marks will be shown in the detailed marks certificate of the students.

Semester 4

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	HSMC		Applied Thermodynamics	3	1	0	**3**	**30**	**70**	**100**
2	PCC		Machine Tools and Machining	3	1	0	**3**	**30**	**70**	**100**
3	PCC		Kinematics of Machine	3	1	0	**3**	**30**	**70**	**100**
4	PCC		Instrumentation and Control	3	1	0	**3**	**30**	**70**	**100**
5	PCC		Production Process-II	3	1	0	**3**	**30**	**70**	**100**
6	PCC		Computer Aided Design and Manufacturing	3	1	0	**3**	**30**	**70**	**100**
7	LC		Instrumentation and Control_ Lab	0	0	2	**1**	**50**	**50**	**100**
9	LC		Kinematics of Machine _Lab	0	0	2	**1**	**50**	**50**	**100**
10	LC		Computer Aided Design and Manufacturing _Lab	0	0	2	**1**	**50**	**50**	**100**
11	MC		Scientific and Technical writing Skills	0	0	2	**0**	**30**	**70**	**100***
			Total				**21**			**1000**

NOTE: **Scientific and Technical writing Skills**: The examination of the regular students will be conducted by the concerned college/Institute internally. Each student will be required to score a minimum of 40% marks to qualify in the paper. The marks will not be included in determining the percentage of marks obtained for the award of a degree. At the end of 4th semester each student has to undergo Practical Training of 4/6 weeks in an Industry/Institute/ Professional Organization/Research Laboratory/ training centre etc. and submit typed report along with a certificate from the organization and its evaluation shall be carried out in the 5th Semester.

Semester 5

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	PCC		Dynamics of Machines	**3**	**1**	**0**	**3**	**30**	**70**	**100**
2	PCC		Internal Combustion Engines and Gas Turbines	**3**	**1**	**0**	**3**	**30**	**70**	**100**
3	PCC		Design of Machine element-I	**3**	**1**	**0**	**3**	**30**	**70**	**100**
4	PCC		Heat Transfer	3	1	0	3	**30**	**70**	**100**
5	OEC		Open Elective -I	3	0	0	3	**30**	**70**	**100**
6	PEC		Professional Elective-I	3	0	0	3	**30**	**70**	**100**
7	LC		Dynamics of Machines _Lab	**0**	**0**	**2**	**1**	**50**	**50**	**100**
8	LC		Internal Combustion Engines and Gas Turbines _Lab	**0**	**0**	**2**	**1**	**50**	**50**	**100**
9	LC		Heat Transfer_Lab	**0**	**0**	2	1	**50**	**50**	**100**
10	PT		Practical Training I	**0**	**0**	**2**	**1**	**50**	**50**	**100**
		Total					**22**			**1000**

NOTE:
1. Choose any one from Professional Elective Course-I
2. Choose any one from Open Elective Course-I

Professional Elective-I

Sr. No.	Code	Subject	Credit
1		Strength of Material-II	3
2		Welding Technology	3
3		Tribology	3
4		Robotics Engineering	3

Semester 6

S. No.	Course Code	Category	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	HSC		Entrepreneurship Development	**3**	**0**	**0**	**3**	**30**	**70**	**100**
2	PCC		Fluid Machines	**3**	**0**	**0**	**3**	**30**	**70**	**100**
3	PCC		Design of machine Element-II	**3**	**0**	**0**	**3**	**30**	**70**	**100**
4	PCC		Operation Research	**3**	**0**	**0**	**0**	**30**	**70**	**100**
5	OEC		Open Elective-II	**3**	**0**	**0**	**3**	**30**	**70**	**100**
6	PEC		Elective-I	**3**	**0**	**0**	**3**	**30**	**70**	**100**
7	PEC		Elective-II	**3**	**0**	**0**	**3**	**30**	**70**	**100**
8	PCC		Fluid Machines _Lab	**0**	**0**	**2**	**1**	**50**	**50**	**100**
9	HSMC		Economics for Engineers	**2**	**0**	**0**	**0**	**30**	**50**	**100**
10	PROJ-1		Project-I	**0**	**0**	**4**	**2**	**50**	**50**	**100**
			Total				**24**			**1000**

NOTE

1. The examination of the regular students will be conducted by the concerned college/Institute internally. Each student will be required to score a minimum of 40% marks to qualify in the paper. The marks will not be included in determining the percentage of marks obtained for the award of a degree.
2. Choose any one from each of the Professional Elective Course-II and III .
3. Choose any one from Open Elective Course-II

Professional Elective-II

Sr. No.	Code	Subject	Credit
1		Power Plant Engineering	3
2		Solar Energy Engineering	3
3		Artificial Intelligence and Robotics	3
4		Machine Tool Design	3

Professional Elective-III

Sr. No.	Code	Subject	Credit
1		Additive Manufacturing	3
2		Finite Element Method	3
3		System Modelling And Simulation	3
4		Noise and Vibrations	3

Semester 7

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	PCC		Non-Conventional Energy Resources	3	1	0	3	30	70	100
2	PCC		Refrigeration And Air Conditioning	3	0	0	3	30	70	100
3	OEC		Open Elective-III	3	0	0	3	30	70	100
4	OEC		Open Elective-IV	3	0	0	3	30	70	100
5	PEC		Professional Elective-IV	3	1	0	3	30	70	100
6	LC		Refrigeration And Air Conditioning Lab	0	0	2	1	50	50	100
7	PT		Practical Training II	0	0	2	1	50	50	100
8	PROJ-II		Project-II	0	0	8	4	100	100	200
		Total					**21**			**900**

NOTE:
1. Choose any one from Professional Elective Course-IV
2. Choose any one from each of the Open Elective Course-III and IV

Professional Elective IV

Sr. No.	Code	Subject	Credit
1		Composite Materials	3
2		Gas Dynamics and Turbo machine	3
3		Non-Destructive Evaluation and Testing	3
4		Computational Fluid Dynamics	3

Semester 8

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	Elective		MOOC1	3	0	0	3	25	75	100
2	Elective		MOOC2	3	0	0	3	25	75	100
3	PROJECT		Industrial Project/ Project III	0	0	16	8	150	150	300
Total							**14**			**500**

Semester wise Structure and Curriculum for

UG Course in

Mechanical Engineering (Engineering and Technology)

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	BSC		Mathematics-III	3	0	0	3	**30**	**70**	**100**
2	PCC		Fluid Mechanics	3	0	0	3	**30**	**70**	**100**
3	PCC		Thermodynamics	3	0	0	3	**30**	**70**	**100**
4	PCC		Industrial Automation	3	0	0	3	**30**	**70**	**100**
5	PCC		Production Process-I	3	0	0	3	**30**	**70**	**100**
6	PCC		Strength of Materials	3	0	0	3	**30**	**70**	**100**
7	LC		Fluid Mechanics_Lab	0	0	2	1	**50**	**50**	**100**
8	LC		Thermodynamics _LAB	0	0	2	1	**50**	**50**	**100**
9	LC		Strength of materials _LAB	0	0	2	1	**50**	**50**	**100**
10	MC		**Constitution of India**	0	0	2	0	**30**	**70**	**100***
	Total						**21**			**900**

Constitution of India: Non-credit mandatory course, students have to attain pass marks (40%)

NOTE: The examination of the regular students will be conducted by the concerned college/Institute internally. Each student will be required to score a minimum of 40% marks to qualify in the paper. The marks will not be included in determining the percentage of marks obtained for the award of a degree. However, these marks will be shown in the detailed marks certificate of the students.

Course code					
Course title	**Mathematics III**				
Category	**Basic Science Course**				
Semester and Credits	L	T	P	**Credits**	Semeter
	3	0	0	3	III
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

(1) To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering

(2) To provide an overview of probability and statistics to engineers

UNIT-I

Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method. Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation.

UNIT-II

Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variables.

UNIT-III

Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random variables and their properties, distribution functions and densities, normal, exponential, and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

UNIT-IV

Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second-degree parabolas and more general curves. Test of significance: Large

sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances – Chi-square test for goodness of fit and independence of attributes.

Course Outcomes:

Upon completion of this course, students will be able to

1. Solve field problems in engineering involving PDEs.
2. Formulate and solve problems involving random variables
3. Apply statistical methods for analysing experimental data.
4. Acquire a solid understanding of linear algebra and its applications in engineering
5. Enhance mathematical reasoning and critical thinking
6. Gain knowledge of Probability and its types

Textbooks/References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley and Sons, 2006.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
3. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
4. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

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Course code					
Course title	**Fluid Mechanics**				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	III
Marks for Sessional	30 Marks				
Marks for End Term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1 To learn about the application of mass and momentum conservation laws for fluid flows
2 To understand the importance of dimensional analysis
3 To obtain the velocity and pressure variations in various types of simple flows

UNIT-I

Fluid Properties and Fluid Statics: Concept of fluid and flow, ideal and real fluids, continuum concept, and properties of fluids, Newtonian and non-Newtonian fluids. Pascal's law, hydrostatic equation, hydrostatic forces on plane and curved surfaces, stability of floating and submerged bodies, relative equilibrium, Problems.

Fluid Kinematics: Eulerian and Lagrangian description of fluid flow; stream, streak and path lines; types of flows, flow rate and continuity equation, differential equation of continuity in cylindrical and polar coordinates, rotation, vorticity and circulation, stream and potential functions, flow net, Problems.

UNIT-II

Fluid Dynamics: Concept of system and control volume, Euler's equation, Bernoulli's equation, venturimeter, orifices, orificemeter, mouthpieces, kinetic and momentum correction factors, Impulse momentum relationship and its applications, Problems. Compressible

Fluid Flow: Introduction, continuity momentum and energy equation, sonic velocity, propagation of elastic waves due to compression of fluid, propagation of elastic waves due to disturbance in fluid, stagnation properties, isentropic flow, effect of area variation on flow properties, isentropic flow through nozzles,diffusers,injectors,Problems..

UNIT-III

Viscous Flow: Flow regimes and Reynolds's number, Relationship between shear stress and pressure gradient, uni-directional flow between stationary and moving parallel plates, movement of piston in a dashpot, power absorbed in bearings. Problems.

Flow Through Pipes: Major and minor losses in pipes, Hagen-Poiseuilli law, hydraulic gradient and total energy lines, series and parallel connection of pipes, branched pipes; equivalent pipe, power transmission through pipes, Problems.

UNIT-IV

Boundary Layer Flow: Boundary layer concept, displacement, momentum and energy thickness, von-karman momentum integral equation, laminar and turbulent boundary layer flows, drag on a flat plate, boundary layer separation and control. Streamlined and bluff bodies lift and drag on a cylinder and an airfoil, Problems.

Turbulent Flow: Shear stress in turbulent flow, Prandtl mixing length hypothesis, hydraulically smooth and rough pipes, velocity distribution in pipes, friction coefficients for smooth and rough pipes, Problems.

Course Outcomes: At the end of the course, the student shall be able to:
CO1. Expedite the properties of fluid along with pressure measurement techniques and concept of stability.
CO2. Understand the characteristics of fluid and application of continuity and Bernoulli's equation.
CO3. Conceptualisation of boundary layer, laminar and turbulent flow.
CO4. Analyse flows through pipes and open channels.
CO5. Apply the principles of conservation of mass, momentum, and energy to analyze fluid flow problems
CO6. Comprehend the concept of boundary layers and be able to analyze flow phenomena near solid surfaces

TEXT BOOKS:

1. Fluid Mechanics – Streeter V L and Wylie E B, Mc Graw Hill
2. Mechanics of Fluids – I H Shames, Mc Graw Hill

REFERENCES BOOKS:

1. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som and G. Biswas, TMH
2. Fluid Mechanics and Fluid Power Engineering – D.S. Kumar, S.K. Kataria and Sons
3. Fluid Mechanics and Machinery – S.K. Agarwal, TMH, New Delhi

Course code					
Course title	**Thermodynamics**				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	III
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1 To learn about work and heat interactions, and balance of energy between system and its surroundings
2 To learn about application of I law to various energy conversion devices
3 To evaluate the changes in properties of substances in various processes
4 To understand the difference between high grade and low grade energies and II law limitations on energy conversion

UNIT-I

Fundamentals - System and Control volume; Property, State and Process; Exact and Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.
Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic and Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.

UNIT-II

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states and determination of properties, Mollier's chart.

UNIT-III

First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume. Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.

UNIT-IV

Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in Ts coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles-Irreversibility and AvaiLability, AvaiLability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis. Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.

Course Outcomes:

After completing this course, the students will be able to
CO1. Apply energy balance to systems and control volumes, in situations involving heat and work interactions
CO2. Evaluate changes in thermodynamic properties of substances
CO3. Evaluate the performance of energy conversion devices
CO4. Differentiate between high grade and low grade energies.
CO5. Comprehend thermodynamic principles to analyze and solve problems related to energy transfer and conversion in engineering systems
CO6. Analyze and evaluate the behavior of thermodynamic systems, such as ideal gases, mixtures, and pure substances

Text Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.

Course code	
Course title	**Industrial Automation**
Category	**Professional Core Course**

Semester and Credits	L	T	P	Credits	Semester
	3	1	0	3	III
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To help students gain essential and basic knowledge of automated systems.
2. To familiarize the students with the design of hydraulic and pneumatic circuits for various automated applications.
3. To make students understand the Programmable Logic Controller to control the systems at industrial premises
4. To enable the students to apply the knowledge of information technology in the field of automation for better enhancement.

Unit:1

Introduction, automation principles and strategies, basic elements of advanced functions, levels modeling of manufacturing systems, Introduction to CNC programming.

Automated material handling systems , AGV, Transfer mechanism , Buffer storage , Analysis of transfer lines, Robots in material handling, Automated storage and Retrieval Systems (AS/RS) - carousel storage, Automatic data capture, bar code technology, Automated assembly systems

Unit:2

Group Technology, Part family, Sensor technologies, Automated inspection and testing, Coordinate measuring machines, Machine vision, Rapid prototyping

PLC Architecture, Modes of operation, Programming methods, Instructions, Instruction addressing, latches, timers and counters

Unit:3

SCADA, DCS, Integration of PLC, SCADA and DCS with manufacturing systems, Man-machine interfaces, Introduction to PLM, Case studies.

Industry 4.0- Standard, Real-time production monitoring techniques with smart sensors, Configuration of smart shop floor, traceability and call back of defective products

Unit 4

Artificial Intelligence based systems, Virtual Business, e-Commerce Technologies, Global Manufacturing Networks, Digital enterprise technologies, IOT in manufacturing

Course Outcome:

Upon successful completion of the course the students will be able to

1. Apply automation principles and strategies and model manufacturing systems
2. Design automated storage and retrieval systems and employ robots in material handling
3. Implement concepts of automation in inspection and testing
4. Apply PLC timers and counters for the control of industrial processes
5. Design of Hydraulic Circuit and pneumatic circuit for manufacturing application
6. Monitor production using smart sensors based on Industry 4.0 techniques
7. Implement artificial intelligence based systems and IOT in manufacturing

Text Book(s)

1. Mikell P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, 2016, Fourth edision, Pearson Education, New Delhi

Reference book:

1. P. Radhakrishnan, S. Subramanyan, V. Raju, CAD/CAM/CIM, New age International, New Delhi.
2. Yusuf Altintas, Manufacturing Autmation, 2012, Cambridge University Press, USA.
3. David Bedworth, Computer Integrated Design and Manufacturing, TMH, New Delhi.
4. Gupta A. K., Arora S. K., Industrial Automation and robotics, 2013, Third Edision, University Science Press, New delhi.
5. Rajesh Mehra, Vikrant Vij, PLSc and SCADA Thory and Practice, 2011, First Edision, University Science Press, New delhi.

Course code					
Course title	**Strength of Materials**				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	III
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1 To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads

2 To calculate the elastic deformation occurring in various simple geometries for different types of loading

UNIT-I

Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.

UNIT-II

Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

UNIT-III

Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems. Columns and Struts: Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Euler's formulae for the elastic buckling load, Eulers, Rankine, Gordom's formulae Johnson's empirical formula for axial loading columns and their applications, eccentric compression of a short strut of rectangular and circular sections, Numerical.

UNIT-IV

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs. Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure. Slope and Deflection: Relationship between bending moment, slope and deflection, Mohr's theorem, moment area method, method of integration, Macaulay's method, calculations for slope and deflection of (i) cantilevers and (ii) simply supported beams with or without
overhang under concentrated load, Uniformly distributed loads or combination of concentrated and uniformly distributed loads, Numerical.

Course Outcomes:

After completing this course, the students should be able to

CO1. Recognise various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components

CO2. Evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading

CO3. Analyze stress and strain in various structural components, including axial stress and strain, shear stress and strain, and bending stress and strain

CO4. Determine important material properties, such as modulus of elasticity, yield strength, ultimate strength, and toughness

CO5. Analyze the behavior of structural components subjected to axial and torsional loading

CO6. Familiar with energy methods, such as strain energy and virtual work principles.

Text Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.

2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.

3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd., New Delhi 2005.

Course code					
Course title	**Production Process-I**				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	III
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods.

UNIT-I

Metal Casting Process: Introduction, Foundry: Introduction to Casting Processes, Basic Steps in Casting Processes. Pattern: Types of Pattern and Allowances. Sand Casting: Sand Properties, Constituents and Preparation. Mould and Core making with assembly and its Types. Gating System. Melting of Metal, Furnaces and Cupola, Metal Pouring, Fettling. Casting Treatment, Inspection and Quality Control, Sand Casting Defects and Remedies.

Machine tools: Introduction, constructional features, specialization, operations and devices of basic machine tools such as lathe, shaper, planner, drilling machining, and milling machine, indexing in milling operation, working principles of capstan and turret lathes.

UNIT-II

Welding: Introduction to Welding, Classification of Welding Processes, Gas Welding: Oxy-Acetylene Welding, Resistance Welding; Spot and Seam Welding, Arc Welding: Metal Arc, TIG and MIG Welding, Submerged arc welding (SAW), resistance welding principles, electrode types and selection, thermit welding, electro slag welding, electron beam welding, laser beam welding, forge welding, friction welding, Welding Defects and remedies, brazing and soldering.

Forming Processes: Basic Principle of Hot and Cold Working, Hot and Cold Working Processes, Rolling, Extrusion, Forging, Drawing, Wire Drawing and Spinning. Sheet Metal Operations: Measuring, Layout marking, Shearing, Punching, Blanking, Piercing, Forming, Bending and Joining.

UNIT-III

Metal forming Jigs and Fixtures: Introduction, Metal blow condition, theories of plasticity, conditions of plane strains, friction, conditions in metal working, wire drawing, theory of forging, rolling theory, no slip angle, and foreword slip, types of tools, principles of locations, locating and clamping devices, jigs bushes, drilling jigs, milling fixtures, turning fixtures, boring and broaching fixtures, welding fixtures, different materials, for jigs and fixtures, economics of jigs and

fixtures.

UNIT-IV

Machine Tools and Machining Processes: Grinding Machines and selection of grinding wheel (Dressing and Truing), Broaching machines, Lapping/Honing machines (Super Finishing Operations) and planning Machines. Gear Manufacturing Gear milling, standard cutters and limitations,
Polymer Processing: Polymer Moulding Techniques for thermoplastic and thermosetting plastics. Applications of Plastics in engineering field.
Powder Metallurgy: Introduction to PM, Powder making processes, Steps in PM. Compaction and Sintering processes. Secondary and finishing operations in PM

Course Outcome (COs): At the end of the course, the student shall be able to:
CO1 Demonstrate the knowledge about different sand moulding and metal casting processes.
CO2 Understand the plastic deformation of metals under rolling, extrusion, forging and sheet metal working. CO3 Acquire knowledge about basic welding processes and their selection for fabrication of different components.
CO 4 Learn about different gear manufacturing and gear finishing operations.
CO 5 Acquire the basics of powder metallurgy.
CO6 Understand the different measuring instrument for surface finish

Text Book:
1. Manufacturing Engineering Technology, K. Jain, Pearson Education
2. Manufacturing Technology: Foundry, Forming and Welding by P.N.Rao, TMH.
3. Principles of Manufacturing Materials and Processes, James S.Campbell, TMH.
4. Welding Metallurgy by G.E.Linnert, AWS.
5. Production Engineering Sciences by P.C.Pandey and C.K.Singh, Standard Publishers Ltd.
6. Manufacturing Science by A.Ghosh and A.K.Mallick, Wiley Eastern

Reference Book:

1. Welding technology by O P Khanna
2. Foundry technology by O P Khanna
3. Elements of workshop technology. Vol. 1 and II by S K Hajra Choudhury
4. Manufacturing Science by Ghosh and Malik
5. Production Technology by WAJ Chapman Vol I, II, III
6. Production Technology by P C Sharma.
7. Production Technology by Raghuvanshi.

Course code					
Course title	**Fluid Mechanics _Lab**				
Category	**Laboratory Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	0	0	2	1	III
Marks for Sessional	50 Marks				
Marks for End term Examination	50 Marks				
Total	100 Marks				

Course Objectives:

1. Understand the techniques and concept of stability.
2. Learning continuity and Bernoulli's equation.
3. Learn discharge measuring devices and hydraulic coefficients.
4. Knowledge of different types of pipe losses and determine the velocity profile in a pipe.

List of Experiments:

1. To determine the coefficient of impact for vanes.
2. To determine coefficient of discharge of an orificemeter.
3. To determine the coefficient of discharge of Notch (V and Rectangular types).
4. To determine the friction factor for the pipes.
5. To determine the coefficient of discharge of venturimeter.
6. To determine the coefficient of discharge, contraction and velocity of an orifice.
7. To verify the Bernoullis Theorem.
8. To find critical Reynolds number for a pipe flow.
9. To determine the meta-centric height of a floating body.
10. To determine the minor losses due to sudden enlargement, sudden contraction and bends.
11. To show the velocity and pressure variation with radius in a forced vertex flow.
12. To verify the momentum equation.

Course Outcomes:

Students will be able to understand:

CO1. Understand the techniques and concept of stability.

CO2. Learning continuity and Bernoulli's equation.

CO3. Analyse discharge measuring devices and hydraulic coefficients.

CO4. Knowledge of different types of pipe losses and determine the velocity profile in a pipe.

Note:

1. At least Ten experiments are to be performed in the semester.

Course code					
Course title	**Strength of Materials_Lab**				
Category	**Laboratory Course**				
Semester and Credits	L	T	P	**Credits**	Semester III
	0	0	2	1	
Marks for Sessional	50 Marks				
Marks for End term Examination	50 Marks				
Total	100 Marks				

Course Objectives

1. To learn the principles of mechanics of solid and various properties of materials.
2. Able to understand the concepts of stress, strain of materials and ability to interpret the data from the experiments.

List of Experiments:

1. To study the Brinell hardness testing machine and perform the Brinell hardness test.
2. To study the Rockwell hardness testing machine and perform the Rockwell hardness test.
3. To study the Vickers hardness testing machine and perform the Vickers hardness test.
4. To study the Erichsen sheet metal testing machine and perform the Erichsensheet metal test.
5. To study the Impact testing machine and perform the Impact tests (Izod andCharpy).
6. To study the Universal testing machine and perform the tensile test.
7. To perform compression and bending tests on UTM.
8. To perform the sheer test on UTM.
9. To study the torsion testing machine and perform the torsion test.

Course Outcomes:

The students will be able to understand

CO1. Learn the principles of mechanics of solids and engineering.

CO2. Preparation of formal Laboratory reports describing the results of experiments.

CO3. Acquire to operate basic instruments in the mechanics of materials Lab.

CO4. Able to understand the concepts of stress, strain of materials and ability to interpret the data from the experiments.

Note: 1. At least eight experiments are to be performed in the semester.

Course code					
Course title	**Thermodynamics_Lab**				
Category	**Laboratory Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	0	0	2	1	III
Marks for Sessional	50 Marks				
Marks for End term Examination	50 Marks				
Total	100 Marks				

Course Objectives:

1. To understand Vapour power cycles.
2. To understand steam boilers, their types and components.
3. To learn fundamentals of flow of steam through a nozzle.
4. To understand Steam turbines ,condensers and compressors.

List of Experiments:

1.To study low pressure boilers and their accessories and mountings.
2. To study high pressure boilers and their accessories and mountings.
3. To prepare heat balance sheet for given boiler.
4. To study the working of impulse and reaction steam turbines.
5. To find dryness fraction of steam by separating and throttling calorimeter.
6. To find power out putand efficiency of a steam turbine.
7. To find the condenser efficiencies.
8. To study and find volumetric efficiency of a reciprocating air compressor.
9. To study cooling tower and find its efficiency.
10. To find calorific value of a sample of fuel using Bomb calorimeter.
11. Calibration of Thermometers and pressure gauges.

Course Outcome:

The Students will be able to understand the practical exposure of:
CO1. Vapour power cycles and find and compare different cycles based on their performance parameters and efficiencies.
CO2. Steam boilers, their types and components.
CO3. Fundamentals of flow of steam through a nozzle.
CO4. Steam turbines and can calculate their work done and efficiencies.
CO5. Types and working of condensers and compressors and define their different types of efficiencies

Note:

1. At least eight experiments should be performed from the above list.

Course code					
Course title	**Constitution of India**				
Category	**Mandatory Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	0	0	2	0	III
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

UNIT-I

Introduction to Constitution: Meaning and importance of the Constitution, salient features of Indian Constitution. The preamble of the Constitution**.** Fundamental rights- meaning and limitations. Directive principles of state policy and Fundamental duties -their enforcement and their relevance.

UNIT-II

Union Government: Union Executive- President, Vice-president, Prime Minister, Council of Ministers. Union Legislature- Parliament and Parliamentary proceedings. Union Judiciary-Supreme Court of India – composition and powers and functions.

UNIT-III

State and Local Governments: State Executive- Governor, Chief Minister, Council of Ministers. State Legislature-State Legislative Assembly and State Legislative Council. State Judiciary-High court. Local Government-Panchayat Raj system with special reference to 73rd and Urban Local Self Govt. with special reference to 74th Amendment.

UNIT-IV

Election provisions, Emergency provisions, Amendment of the constitution: Election Commission of India-composition, powers and functions, and electoral process. Types of emergency grounds, procedure, duration, and effects. Amendment of the constitution- meaning, procedure, and limitations.

Course Objectives: Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. 2. To address the growth of Indian opinion regarding modern Indian intellectuals‟ constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes: Students will be able to:

CCO1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

CO3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership

of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4. Discuss the passage of the Hindu Code Bill of 1956. The examination of the regular students will be conducted by the concerned college/Institute internally.

References:

1. M.V.Pylee, “Introduction to the Constitution of India”,4th Edition, Vikas publication,2005.
2. Durga Das Basu(DD Basu) , “Introduction to the constitution of India”,(Student Edition),19th edition,Prentice-Hall EEE, 2008.

Textbooks Reference Book

1. Merunandan, “Multiple Choice Questions on Constitution of India”, 2nd Edition, Meraga publication,2007.

Semester 4

S. No.	Course Code	Category	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	PCC		Applied Thermodynamics	3	0	0	**3**	**30**	**70**	**100**
2	PCC		Machine Tools and Machining	3	0	0	**3**	**30**	**70**	**100**
3	PCC		Kinematics of Machine	3	0	0	**3**	**30**	**70**	**100**
4	PCC		Instrumentation and Control	3	0	0	**3**	**30**	**70**	**100**
5	PCC		Production Process-II	3	0	0	**3**	**30**	**70**	**100**
6	PCC		Computer Aided Design and Manufacturing	3	0	0	**3**	**30**	**70**	**100**
7	LC		Kinematics of Machine_LAB	0	0	2	**1**	**50**	**50**	**100**
8	LC		Instrumentation and Control_ Lab	0	0	2	**1**	**50**	**50**	**100**
9	LC		Production Process-II_Lab	0	0	0	**1**	**50**	**50**	**100**
10	LC		Computer Aided Design and Manufacturing _Lab	0	0	2	**1**	**50**	**50**	**100**
11	MC		Scientific and Technical writing Skills	0	0	2	**0**	**30**	**70**	**100***
			Total				**22**			**1000**

NOTE:

1. Scientific and Technical writing Skills: The examination of the regular students will be conducted by the concerned college/Institute internally. Each student will be required to score a minimum of 40% marks to qualify in the paper. The marks will not be included in determining the percentage of marks obtained for the award of a degree

2. At the end of 4th semester each student has to undergo Practical Training of 4/6 weeks in an Industry/Institute/ Professional Organization/Research Laboratory/ training centre etc. and submit typed report along with a certificate from the organization and its evaluation shall be carried out in the 5th Semester.

Course code					
Course title	**Applied Thermodynamics**				
Category	**Engineerimg Science Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	IV
Marks for Sessional	30 Marks				
Marks for End Term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To learn about of I law for reacting systems and heating value of fuels
2. To learn about gas and vapor cycles and their first law and second law efficiencies
3. To understand about the properties of dry and wet air and the principles of psychrometry
4. To learn about gas dynamics of air flow and steam through nozzles
5. To learn the about reciprocating compressors with and without intercooling
6. To analyze the performance of steam turbines

UNIT-I

Introduction to solid, liquid and gaseous fuels–Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy.

UNIT-II

Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Supercritical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.

UNIT-III

Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point. Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, supersaturation compressible flow in diffusers, efficiency of nozzle and diffuser.

UNIT-IV

Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors. Analysis of steam turbines, velocity and pressure compounding of steam turbines

Course Outcomes: After completing this course, the students will be able to
CO1 Understand various practical power cycles and heat pump cycles.
CO2 Analyze energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors
CO3 Understand phenomena occurring in high speed compressible flows
CO4

Text Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd

Course code					
Course title	**Machine Tools and Machining**				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	IV
Marks for Sessional	30 Marks				
Marks for End Term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To provide students with a comprehensive understanding of machine tools, their operations, and the machining processes involved.
2. Knowledge and skills necessary to operate machine tools effectively and efficiently, and to perform various machining operations with precision

Unit I

Basic Kinematic Structure of Centre Lathe- Kinematic analysis of: Speed Gear Box, Feed Gear Box, Apron Mechanism, Thread Cutting. Tool Geometry- Detailed discussions restricted to ASA, ORS and MRS and for single point cutting tool as well as WRS, Introduction to NRS.Introduction to tool geometry of milling cutters and drills.

Unit II

Introduction To Grinding-Need and different methods of grinding, Wheel specifications, Mechanics of grinding, Similarities and differences between grinding and machining.Basic Kinematic systems and operations of Other Machine Tools- Kinematic system and operations of drilling machines.Kinematic system and operations of milling machines.Construction, working principle and applications of shaping, planing and slotting.

Unit III

Screw Thread Measurement- Standard thread profiles, Different Thread Elements, Effective diameter, 2 wire and 3 wire methods as applied to standard and non-standard thread profiles, Best wire size, Virtual Effective Diameter. Surface Roughness-Sources of surface irregularities in manufacturing, Different elements of surface roughness, Definition of center line and related roughness parameters, Measurement Instruments, Profilometers, Analysis of roughness signal in frequency domain

Unit IV

Gear Metrology- Different types of gears, Basic elements of a gear, Involute function, Relations between different gear elements of spur and helical gears, Virtual number of teeth, Use of gear tooth Vernier for chordal and constant chordal measurements,Span measurement using Base Tangent Micrometers. Coordinate Measuring Machines-Introduction to Coordinate Measuring Machines.

Course Outcomes:

Upon completing the Machine Tool and Machining course, students should be able to:

CO1. Demonstrate a clear understanding of different types of machine tools, their components, and

their functions.
CO2. Identify the various types of machine tools commonly used in machining operations. Interpret engineering drawings
CO3. Interpret geometric dimensions and tolerances (GDandT) and select appropriate machining strategies accordingly.
CO4. Understand the principles of cutting tool technology and select appropriate cutting tools for different machining operations.
CO5. Optimize machining processes for improved productivity and quality.
CO6. Analyze and troubleshoot machining issues:

TextBook :

1. Sen, G. C., and Bhattacharyya, A. Principles of Machine Tools: New Central Book Agency
2. Bhattacharyya A, Theory and Practice Of Metal Cutting, New Central Book Agency

Reference Books:

3. Boothroyd, G., and Knight, W. A. Fundamentals of machining and machine tools: Taylor and Francis. 92
4. Trent, E. M. Metal cutting: Butterworth Heinemann
5. Stephenson, D. A., and Agapiou, J. S. Metal cutting theory and practice: CRC Taylor and Francis.
6. Dotson, C. Fundamentals of dimensional metrology: Thomson Delmar.
7. Kelly, P. Metrology: BiblioBazaar.
8. Jain, R.K., Engineering Metrology, Khanna Publisher
9. Smith, G. T. Industrial metrology: surfaces and roundness: Springer.
10. Griffiths, B. Manufacturing surface technology: surface integrity and functional performance:Taylor and Francis.

Course code					
Course title	**Kinematics of Machine**				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	IV
Marks for Sessional	30 Marks				
Marks for End Term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1 To understand the kinematics and rigid- body dynamics of kinematically driven machine components.\
2 To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link.
3 To be able to design some linkage mechanisms and cam systems to generate specified output motion.
4 To understand the kinematics of gear trains.

UNIT-I

Introduction: mechanism and machines, kinematics links, kinematics pairs, kinematics chains, degree of freedom, Grubler's rule, kinematics inversion, equivalent linkages, four link planar mechanisms, straight line mechanisms, steering mechanisms, pantograph, problems. Kinematics Analysis of Plane Mechanisms: displacement analysis, velocity diagram, velocity determination, relative velocity method, instantaneous center of velocity, Kennedy's theorem, graphical and analytical methods of velocity and acceleration analysis, problems.

UNIT-II

Cams: Classification of cams and followers, disc cam nomenclature, construction of displacement, velocity and acceleration diagrams for different types of follower motions, analysis of follower motions, determination of basic dimension, synthesis of cam profile by graphical methods, cams with specified contours, problems. Gears: fundamental law of gearing, involute spur gears, characteristics of involute and cycloidal action, Interference and undercutting, center distance variation, path of contact, arc of contact, non standard gear teeth, helical, spiral bevel and worm gears, problems.

UNIT-III

Gear Trains: synthesis of simple, compound and reverted gear trains, analysis of epicylic gear trains, problems Kinematics synthesis of Mechanisms: function generation, path generation, Freudenstein's equation, two and three position synthesis of four bar and slider crank mechanisms by graphical and analytical methods, precision positions, structural error; Chebychev spacing, transmission angle, problems.

UNIT-IV

Friction : Types of friction, laws of friction, motion along inclined plane, screw threads, efficiency on inclined plane, friction in journal bearing, friction circle and friction axis, pivots and collar friction, uniform pressure and uniform wear. Belts and pulleys: Open and cross belt drive, velocity ratio, slip,

material for belts, crowning of pulleys, law of belting, types of pulleys, length of belts, ratio of tension, centrifugal tension, power transmitted by belts and ropes, initial tension, creep, chain drives, chain length, classification of chains.

Course Outcomes : Students would be able :

CO1 - To understand about the applications of mechanism and machines.

CO2 - To understand about the basics Cams and Friction

CO3 - Familiarize about power transmitted with Belts and pulleys and also Gears and Gear Trains. CO4 - Students having familiarization with calculate Kinematics Analysis of Plane Mechanisms

CO5 - Students would be able to know the Kinematics synthesis of Mechanisms.

CO6- Perform kinematics synthesis of mechanisms

TEXT BOOKS:

1. Theory of Mechanisms and Machines: Amitabha Ghosh and Ashok kumar Malik, Third Edition Affiliated East-West Press. 2. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Second Edition, MGH, New York.

References:

1. Mechanism and Machine Theory : J.S. Rao and R.V. Dukkipati Second Edition New age International. 2. Theory and Machines: S.S. Rattan, Tata McGraw Hill. 3. Theory of Machines, Beven, Pearson Indian Education Service Pvt. Ltd. India.

Course code					
Course title	**Instrumentation and Control**				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	IV
Marks for Sessional	30 Marks				
Marks for End Term Examination	70 Marks				
Total	100 Marks				

Course Objectives:

1. To provide a basic knowledge about measurement systems and their components
2. To learn about various sensors used for measurement of mechanical quantities
3. To learn about system stability and control
4. To integrate the measurement systems with the process for process monitoring and control

UNIT-I

Measurement systems and performance – accuracy, range, resolution, error sources; Instrumentation system elements – sensors for common engineering measurements; Signal processing and conditioning; Instruments and Their representation : Introduction, Typical Applications of Instrument Systems, Functional Elements of a Measurement System, Classification of Instruments, Standards and Calibration.

UNIT-II

Transducer Elements : Introduction, Analog and Digital Transducers, Electromechanical; Potentiometric, Inductive Self Generating and Non-Self Generating Types, Electromagnetic, Electrodynamic, Eddy Current, Magnetostrictive, Variable Inductance, Linearly Variable Differential Transformer, Variable Capacitance, PiezoElectric Transducer and Associated Circuits, Unbonded and Bonded Resistance Strain Gages. Strain Gage Bridge circuits, Single Double and Four Active Arm Bridge Arrangements, Temperature Compensation, Balancing and Calibration, Ionisation Transducers, Mechano Electronic Transducers, Opto-Electrical Transducers, Photo Conductive Transducers, Photo Volatic Transducers, Digital Transducers, Frequency Domain Transducer, Vibrating String Transducer, Binary codes, Digital Encoders.

UNIT-III

Motion, Force and Torque Measurement : Introduction, Relative motion Measuring Devices, Electromechanical, Optical, Photo Electric, Moire-Fringe, Pneumatic, Absolute Motion Devices, Seismic Devices, Spring Mass and Force Balance Type, Calibration, Hydraulic Load Cell, Pneumatic Load Cell, Elastic Force Devices, Separation of Force Components, Electro Mechanical Methods, Strain Gage, Torque Transducer, Toque Meter. Intermediate, Indicating and Recording Elements : Introduction Amplifiers, Mechanical, Hydraulic, Pneumatic, Optical, Electrical Amplifying elements, Compensators, Differentiating and Integrating Elements.

Temperature Measurement : Introduction, Measurement of Temperature, Non Electrical Methods – Solid Rod Thermometer, Bimetallic Thermometer, Liquid-in-Glass thermometer, Pressure Thermometer, Electrical Methods – Electrical Resistance Thermometers, Semiconductor Resistance Sensors (Thermistors), Thermo–Electric Sensors, Thermocouple Materials, Radiation Methods (Pyrometry), Total Radiation Pyrometer, Selective Radiation Pyrometer.

UNIT-IV

Control systems – basic elements, open/closed loop, design of block diagram; control method – P, PI, PID, when to choose what, tuning of controllers; System models, transfer function and system response, frequency response; Nyquist diagrams and their use.
Practical group based project utilizing above concepts.
Pressure and Flow Measurement : Pressure and Flow Measurement, Introduction : Moderate Pressure Measurement, Monometers, Elastic Transducer, Dynamic Effects of Connecting Tubing, High Pressure Transducer, Low Pressure Measurement, Calibration and Testing, Quantity Meters, Positive Displacement Meters, Flow Rate Meters, Variable Head Meters, Variable Area Meters, Rotameters, Pitot-Static Tube Meter, Drag Force Flow Meter, Turbine Flow Meter, Electronic Flow Meter, Electro Magnetic Flow meter. Hot-Wire Anemometer.

Course Outcomes:

Upon completion of this course, the students will be able

CO1. Understand the measurement of various quantities using instruments, their accuracy and range, and the techniques for controlling devices automatically.

CO2. Identify and select appropriate sensors for common engineering measurements, such as temperature, pressure, flow, and displacement

CO3. Design and configure instrumentation systems for specific measurement tasks

CO4. Analyze transducer performance and calibration

CO5. Explore ionization and mechano-electronic transducers

CO6. Design and analyze block diagrams to represent control systems

Text Books:

1.Instrumentation and control systems by W. Bolton, 2nd edition, Newnes, 200

2.Thomas G. Beckwith, Roy D. Marangoni, John H. LienhardV , Mechanical Measurements (6th Edition) 6th Edition, Pearson Education India, 2007

3.Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York,1999.

Course code					
Course title	Production Process-II				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	IV
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives (COs): At the end of the course, the student shall be able to:

1- Acquire knowledge about mechanics of chip formation and to identify the factors related to tool wear and machinability.
2- Learn about different gear manufacturing and gear finishing operations.
3- Select the proper cutting tool material and components of jigs and fixtures.
4- Understand the basics principles of non-conventional machining processes and their applications.
5- Identify and select different measuring instruments for the inspection of different components.

UNIT-I

Mechanism of Metal Cutting: Deformation of metal during machining, nomenclature of lathe, milling tools, mechanics of chip formation, built-up edges, mechanics of orthogonal and oblique cutting, Merchant cutting force circle and shear angle relationship in orthogonal cutting, factors affecting tool forces. Cutting speed, feed and depth of cut, surface finish. Temperature distribution at tool chip interface. Numerical on cutting forces and Merchant circle. Cutting Tool Materials and Cutting Fluids: Characteristics of tool materials, various types of cutting tool materials, coated tools, cutting tool selection, Types of tool wear, tool life, factors governing tool life, Purpose and types of cutting fluids, basic actions of cutting fluids, effect of cutting fluid on tool life, selections of cutting fluid.

UNIT-II

Unconventional Machining Processes: Abrasive jet machining: Principles, applications, process parameters. Ultrasonic machining: Principles, applications, analysis of process parameters. Electrochemical machining and grinding: Principles, classifications, choice of electrolytes, applications. Electric discharge machining: Principles, selection of tools materials and dielectric fluid. Electron beam machining: Generation of electron beam, relative merits and demerits. Laser beam machining: Principles and applications. Jigs and Fixtures: Introduction, location and location devices, clamping and clamping devises, Drill Jigs, Milling Fixtures.

UNIT-III

Numerical Control of Machine Tools; Introduction, Numerical Control and its growth, NC Machines tools, Axes of NC Machines, Classification of NC System, CNC, DNC and Machining Centre. Machine Control unit, NC tools and Tool changer.

UNIT-IV

Group Technology; Definition and concept, Group and Family, working of group technology, Stages for Adopting Group Technology, Advantages of Group Technology. Component Classification and Coding,

Personnel and Group Technology, Planning the introduction of Group Technology, Group Technology layout.

Course Outcomes:

At the end of the course, the student shall be able to: CO

CO 1-Acquire knowledge about mechanics of chip formation and to identify the factors related to tool wear and machinability.

CO 2- Learn about different gear manufacturing and gear finishing operations.

CO 3- Select the proper cutting tool material and components of jigs and fixtures.

CO 4- Understand the basics principles of non-conventional machining processes and their applications.

CO 5- Identify and select different measuring instruments for the inspection of different components.

Text Books

1. Manufacturing Technology – Vol. –
2. 2, P.N. Rao, T.M.H, New Delhi 2. Computer Aided Manufacturing: S Kumar and B Kant Khan, Satya Prakashan, New Delhi .

References:

1. Principles of Machine Tools – G.C. Sen and A. Bhattacharya, Tata McGraw Hill, New Delhi
2. Manufacturing Engg.and Tech, Kalpakian, Serope Addison -Wisly Publishing Co. New York.
3. Modern Machining Processes: P.C. Pandey and H.S. Shan, T.M.H. Company, New Delhi
4. Text Book of Production Engineering: P.C. Sharma, S.Chand and Sons.
5. Production Engineering by KC Jain and AK Chilate, PHI, New Delhi

Course code					
Course title	Computer Aided Design and Manufacturing				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	1	0	3	IV
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1 Understand the fundamentals of various Computer Aided Design, basics of geometric modeling, curves surfaces, solids and Additive Manufacturing Technologies for application to various industrial needs.
2 Learn what Advanced/Additive manufacturing (AM) is and understand why it has become one of the most important technology trends in decades for product development and innovation.
3 Differentiate between subtractive and Additive manufacturing.

UNIT-I

Introduction: Introduction to CAD/CAM/CAE, Design Process, Importance and Necessity of CAD, Applications of CAD, Hardware and Software requirement of CAD. Fundamentals of Additive Manufacturing (AM), Basic steps to perform AM, Classification of AM, Applications of AM: Aerospace, Biomedical, Automotive, Bio-printing, Tissue and Organ Engineering, Architectural Engineering, Surgical simulation, Art, Health care.

UNIT-II

Basics of geometric and solid modeling, coordinate systems. Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations. Curves: Algebraic and geometric forms, reparametrization, Analytical and Synthetic curves, cubic splines, Bezier curves and B-spline curves. Surfaces and Solids: Plane surface, ruled surface, surface of revolution, tabulated cylinder, bicubic surface, Bezier surface, B-spline surface, Solid models and representation scheme, boundary representation, constructive solid geometry, sweep representation, cell decomposition.

UNIT-III

Finite Element Method: Introduction, Procedure, Finite Element Analysis, Finite Element Modeling, Analysis of 1D, 2D structural problems. Design for Additive Manufacturing, Software issues for AM, Direct Digital Manufacturing. Difference between machining and additive manufacturing. Photo polymerization Processes, Powder bed fusion processes, Extrusion Based systems, Printing Processes, Effects of significant parameters.

UNIT-IV

Flexible Manufacturing Systems and Computer aided process planning: Introduction, FMS components, types of FMS, FMS layouts, planning for FMS, advantages and applications Conventional process planning, types of CAPP, Steps in variant process planning, planning for CAPP.

COURSE OUTCOMES: Upon completion of this course the student will be able to:
CO1. Demonstrate the knowledge of Computer Aided design and Additive Manufacturing.
CO 2. Understand the concept of wireframe modeling, surface modeling and solid modeling.
CO3. Understand the method of manufacturing of liquid based, powder based and solid based techniques
CO4. Apply the FEM to perform structural analysis and solve engineering problems
CO5. Analyze 1D and 2D structural problems
CO6. Evaluate the benefits and challenges of implementing FMS in manufacturing environments.

Text Books
1. CAD/ CAM by Groover and Zimmer, Prantice Hall.
2. CAD/ CAM Theory and Practice by Zeid, McGraw Hill

Reference Books

1. Numerical Control and Computer Aided Manufacturing by Kundra, Rao and Tiwari, TMH.
2. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2nd Ed, 2014.

Course code					
Course title	Kinematics of Machine_ Lab				
Category	**Laboratory Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	0	0	2	1	IV
Marks for Sessional	50 Marks				
Marks for End term Examination	50 Marks				
Total	100 Marks				

Course Objectives:

1 To understand the kinematics and rigid- body dynamics of kinematically driven machine components.
2 To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link.
3 To be able to design some linkage mechanisms and cam systems to generate specified output motion.
4 To understand the kinematics of gear trains.

List of Experiments:

1. To study various types of Kinematic links, pairs, chains and Mechanisms.
2. To study inversions of 4 Bar Mechanisms, Single and double slider crank mechanisms.
3. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism.
4. To find coefficient of friction between belt and pulley.
5. To study various type of cam and follower arrangements.
6. To plot follower displacement vs cam rotation for various Cam Follower systems.
7. To study various types of Steering Mechanism.
8. To study various types of gears – Helical, cross helical worm, bevel gear.
9. To study various types of gear trains – simple, compound, reverted, epicyclic and differential.
10. To study the working of Screw Jack and determine its efficiency.
11 To study various types of Belt, Rope and Chain Drives.

Course Outcomes (COs): After studying this course, students will be able:

CO 1- Understand the various practical demonstrations of mechanism.
CO 2- Knowledge of Motions in mechanism with practical demonstration.
CO 3- Learning the Special purpose machine members used in designing of a machine.
CO 4- Synthesis of working model using the various linkages.
Note: 1. At least ten experiments are to be performed in the Semester.

Course code					
Course title	Computer Aided Design and Manufacturing _Lab				
Category	**Laboratory Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	0	0	2	1	IV
Marks for Sessional	50 Marks				
Marks for End term Examination	50 Marks				
Total	100 Marks				

Note: 1. At least Six experiments are to be performed in the Semester.

Course Objectives:

At the end of the course, the student shall be able to: Display of the basic fundamentals of modeling package. Explore the surface and solid modeling features. Learning the techniques of 3D modeling of various mechanical parts.

List of Experiments:

The students will be required to carry out the following exercises using software packages (e.g. Solid works / Pro Engineer/AutoCAD/ I-Deas/ Solid Edge/CURA etc.)

1. CAD Modeling Assignments

(i) Use and learn import/export techniques and customization of software.

(ii) Construction of simple machine parts and components like Coupling, Crankshaft, Pulley, Piston , Connecting rod, nuts, bolts, gears and helical springs

(iii) Assembly drawing with sectioning and bill of materials from given detailed drawings of assemblies: Lathe Tail stock, Machine vice, Pedestal bearing, Drill jigs and Milling fixture.

(iv) Make the part family/family table of a bolt.

2. CAM Assignments Tool path generation, Part programming, G and M codes development for machining operations, Physical interpretation of machining features and tool geometries.

3. To perform reverse engineering of a product using 3D scanner.

4. To print coupling, crankshaft, pulley, piston, connecting rod, nuts, bolts with FDM 3D printer with suitable filament like Nylon, ABS etc.

5. To print a product with FDM 3D printer which is developed with reverse engineering.

6. To Draw Orthographic projection Drawings (Front, Top and side) of boiler safety valve giving name the various components of the valve.

7. Make an Isometric dimensioned drawing of a connecting Rod using isometric grid and snap.

8. Draw 3D models by extruding simple 2D objects, dimension and name the objects.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Display of the basic fundamentals of modeling package.

CO 2- Explore the surface and solid modeling features.

CO 3- Learning the techniques of 3D modeling of various mechanical parts.

CO 4- To expedite the procedure and benefits of FEA and CAE.

Course code				
Course title	Production Process-II _Lab (P)			
Category	**Laboratory Course**			
Semester and Credits	L	T	P	**Credits**
	0	0	2	1
Marks for Sessional	50 Marks			
Marks for End term Examination	50 Marks			
Total	100 Marks			

Note: 1. At least Six experiments are to be performed in the Semester.

Course Objectives:

To study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines,NC,CNC machine etc.

To understanding with the practical knowledge required in the core industries and different types of components using the machine tools

List of Experiments:

1. Study and Practice of Orthogonal and Oblique Cutting on a Lathe.
2. Machining time calculation and comparison with actual machining time while cylindrical turning on a Lathe and finding out cutting efficiency.
3. Study of Tool Life while Milling a component on the Milling Machine.
4. Study of Tool Wear of a cutting tool while Drilling on a Drilling Machine.
5. Study of Speed, Feed, Tool, Preparatory (Geometric) and miscellaneous functions for N. C part programming.
6. Part Programming and proving on a NC lathe for:- a. Outside Turning b. Facing and Step Turning c. Taper Turning d. Drilling e. Outside Threading
7. Part Programming and Proving on a NC Milling Machine:-

a. Point to Point Programming
b. Absolute Programming
c. Incremental Programming

8. Part Programming and Proving for Milling a Rectangular Slot.

Course Outcome (COs): At the end of the course, the student shall have practical exposure of:

CO 1- vapour power cycles and find and compare different cycles based on their performance parameters and efficiencies.
CO 2- steam boilers, their types and components.
CO 3- fundamentals of flow of steam through a nozzle.
CO 4- steam turbines and can calculate their work done and efficiencies.
CO 5- types and working of condensers and compressors and define their different types of efficiencies

Course code				
Course title	Instrumentation and Control _Lab			
Category	**Laboratory Course**			
Semester and Credits	L	T	P	**Credits**
	0	0	2	1
Marks for Sessional	25 Marks			
Marks for End term Examination	25 Marks			
Total	50 Marks			

Course Objectives :

1. To understand about the applications of measurement systems.
2. To understand about the basics and working principle of pressure, temperature and flow measurement.
3. Identify the different variation of measurement parameter with various input conditions.
4. To analyze the primary, secondary and tertiary measurements.
5. To learn about the various control devices and parts of measurement systems

List of Experiments :

1. To Study various Temperature Measuring Instruments (a) Mercury – in glass thermometer (b) Thermocouple
2. To study the working of Bourdon Pressure Gauge and to check the calibration of the gauge in a dead-weight pressure gauge calibration set up.
3. To study a Linear Variable Differential Transformer (LVDT) and use it in a simple experimental set up to measure a small displacement.
4. To measure load (tensile/compressive) using load cell on a tutor.
5. To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer.
6. To measure the speed of a motor shaft with the help of non-contact type pick-ups (magnetic or photoelectric).
7. To measure the stress and strain using strain gauges mounted on simply supported beam/cantilever beam.
8. To measure static/dynamic pressure of fluid in pipe/tube using pressure transducer/pressure cell.
9. To test experimental data for Normal Distribution using Chi Square test.
10. Vibration measurement.
11. To study various types of measurement Error

Note: 1. At least eight experiments are to be performed in the Semester.

Course Outcomes:

CO1 - To understand about the applications of measurement systems.
CO2 - To understand about the basics and working principle of pressure, temperature and flow measurement.
CO3 - Identify the different variation of measurement parameter with various input conditions.
CO4 - To analyze the primary, secondary and tertiary measurements.
CO5 - To learn about the various control devices and parts of measurement systems

Course code				
Course title	Scientific and Technical writing Skills*			
Category	**Mandatory Course**			
Semester and Credits	L	T	P	**Credits**
	0	0	2	0
Marks for Sessional	30 Marks			
Marks for End Term Examination	70 Marks			
Total	100 Marks			

COURSE OBJECTIVES: The Course prepares second semester engineering and Technology students to:
1 Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
2 Foster their ability to write convincing job applications and effective reports.
3 Develop their speaking skills to make technical presentations , participate in group discussions.
4 Strengthen their listening skill which will help them comprehend lectures and talks in their areas of sp

UNIT I INTRODUCTION TECHNICAL ENGLISH
Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- Speaking –Asking for and giving directions- Reading – reading short technical texts from journals-newspapers- Writing- purpose statements – extended definitions – issue- writing instructions – checklists-recommendations-Vocabulary Development- technical vocabulary Language Development –subject verb agreement - compound words

UNIT II READING AND STUDY SKILLS
Listening- Listening to longer technical talks and completing exercises based on them-Speaking – describing a process-Reading – reading longer technical texts- identifying the various transitions in a text- paragraphing-Writing- interpreting cgarts, graphs- Vocabulary Development-vocabularyused in formal letters/emails and reports Language Development- impersonal passive voice, numerical adjectives

UNIT III TECHNICAL WRITING AND GRAMMAR
Listening- Listening to classroom lectures/ talkls on engineering/technology -Speaking – introduction to technical presentations- Reading – longer texts both general and technical, practice in speed reading; Writing-Describing a process, use of sequence words- Vocabulary Development- sequence words-Misspelled words. Language Development- embedded sentences

UNIT IV REPORT WRITING
Listening- Listening to documentaries and making notes. Speaking – mechanics of presentations- Reading – reading for detailed comprehension- Writing- email etiquette- job application – cover letter –Résumé preparation(via email and hard copy)- analytical essays and issue based essays-- Vocabulary Development-finding suitable synonyms-paraphrasing-. Language Development- clauses- if conditionals

UNIT V GROUP DISCUSSION AND JOB APPLICATIONS
Listening- TED/Ink talks; Speaking –participating in a group discussion -Reading– reading and understanding technical articles Writing– Writing reports- minutes of a meeting- accident and survey-Vocabulary Development- verbal analogies Language Development- reported speech

COURSE OUTCOMES: At the end of the course learners will be able to:

1 Read technical texts and write area- specific texts effortlessly.
2 Listen and comprehend lectures and talks in their area of specialisation successfully.
3 Speak appropriately and effectively in varied formal and informal contexts.
4 Write reports and winning job applications. ecialisation.

REFERENCES

1. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice.Oxford University Press: New Delhi,2014.
2. Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015
3. Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
4. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007
5. Means, L. Thomas and Elaine Langlois, English and Communication For Colleges. Cengage Learning, USA: 2007

Semester 5

S. No.	Course Code	Category	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	PCC		Dynamics of Machines	**3**	**1**	**0**	**3**	**30**	**70**	**100**
2	PCC		Internal Combustion Engines and Gas Turbines	**3**	**1**	**0**	**3**	**30**	**70**	**100**
3	PCC		Design of machine element-I	**3**	**1**	**0**	**3**	**30**	**70**	**100**
4	PCC		Heat Transfer	3	1	0	3	**30**	**70**	**100**
5	OEC		Open Elective -I	3	0	0	3	**30**	**70**	**100**
6	PEC		Professional Elective-I	3	0	0	3	**30**	**70**	**100**
7	LC		Dynamics of Machines _Lab	**0**	**0**	**2**	**1**	**30**	**70**	**100**
8	LC		Internal Combustion Engines and Gas Turbines _Lab	**0**	**0**	**2**	**1**	**50**	**50**	**100**
9	LC		Heat Transfer Lab	**0**	**0**	2	1	**50**	**50**	**100**
10	PT		Practical Training	**0**	**0**	**2**	**1**	**50**	**50**	**100**
		Total					**22**			**1000**

NOTE :

1. Practical Training: The evaluation will be based on internal evaluation by the examiner. According to performance, the students are awarded grades A, B, C, F. A student who is awarded 'F' grade is required to repeat the course. Excellent: A; Good: B; Satisfactory: C; Not Satisfactory: F
2. Choose any one from Professional Elective Course-I
3. Choose any one from Open Elective Course-I

Professional Elective-I

Sr. No.	Code	Subject	Credit
1		Strength of Material-II	3
2		Welding Technology	3
3		Tribology	3
4		Robotics Engineering	3

Course code					
Course title	Dynamics of Machines				
Category	**Professional Engineering Course**				
Semester and Credits	L	T	P	**Credits**	Semester V
	3	0	0	3	
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To understand the student with fundamental knowledge of dynamics of machines so that student can appreciate problems of dynamic force balance, transmissibility of forces, isolation of systems, vibrations.
2. Develop knowledge of analytical and graphical methods for calculating balancing of rotary and reciprocating masses.
3. To understand the Special purpose mechanism (governor, Gyroscope Cam and followers etc.) used in designing of a machine.

UNIT-I

Static and Dynamic Force Analysis: Static force analysis of planer mechanisms, dynamic force analysis including inertia and frictional forces of planer mechanisms.
Dynamics of Reciprocating Engines: engine types, indicator diagrams, gas forces, equivalent masses, inertia forces, bearing loads in a single cylinder engine, crankshaft torque, engine shaking forces.

UNIT-II

Balancing of Rotating Components: static balance, dynamic balance, balancing of rotating masses, two plane balancing, graphical and analytical methods, balancing of rotors, balancing machines, field balancing.
Balancing of Reciprocating Parts: Balancing of single cylinder engine, balancing of multi cylinder; inline, radial and V type engines, firing order.

UNIT-III

Governors: introduction, types of governors, characteristics of centrifugal governors, gravity controlled and spring controlled centrifugal governors, hunting of centrifugal governors, inertia governors.
Dynamometers: types of dynamometers, Prony brake, rope brake and band brake dynamometers, belt transmission dynamometer, torsion dynamometer, hydraulic dynamometer.

UNIT-IV

Gyroscope: gyroscopes, gyroscopic forces and couples, gyroscopic stabilization, ship stabilization, stability of four wheel and two wheel vehicles moving on curved paths.

Course Outcomes (COs): At the end of the course, the student shall be able to:
CO 1- Understand the Static and Inertia Force Analysis.

CO 2- Explore the concept of Balancing of rotating and reciprocating masses.
CO 3- Knowledge of concept of Mechanical Governor.
CO 4- Develop the concept of Gyroscope and its application.
CO 5- Explore the concept of Mechanical Vibration.
CO 6- Analyze and understand the different types of mechanical inversion.

Text Books:

1. Theory of Mechanisms and Machines: Amitabha Ghosh and Ashok kumar Mallik, Third Edition Affiliated East-West Press.
2. Theory of Machine: S.S. Rattan, McGraw Hill Higher Education.

References:

1. Mechanism and Machine Theory: J.S. Rao and R.V. Dukkipati, New age International.
2. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Second Edition Mc Graw Hill, Inc .
3. Theory of Machines, Beven, Pearson Indian Education Services, Pvt. Ltd.

Course code					
Course title	Internal Combustion Engines and Gas Turbines				
Category	**Professional Engineering Course**				
Semester and Credits	L	T	P	**Credits**	Semester V
	3	0	0	3	
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Course Objectives:

1. Familiarize with the terminology associated with IC engines.
2. Understanding the basics of IC engines.
3. Evaluate various parameters and variables affecting it in IC engines.
4. Analyzing about various systems used in IC engines and the type of IC engine required for various applications.
5. Understanding the calculation of efficiency of IC engines.
6. Analyze and evaluate the performance of IC engines.

UNIT-I

Air Standard Cycles: Internal and external combustion engines; classification of I.C. Engines, Cycles of operation in four stroke and two stroke I.C. Engines, Wankel Engines, Assumptions made in air standard cycle; Otto cycle; diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles; sterling and Ericsson cycles; air standard efficiency, specific work output, specific weight; work ratio; mean effective pressure; deviation of actual engine cycle from ideal cycle. Problems.

Carburetion, fuel Injection and Ignition systems: Mixture requirements for various operating conditions in S.I. Engines; elementary carburetor, Requirements of a diesel injection system; types of inject systems; petrol injection, Requirements of ignition system; types of ignition systems ignition timing; spark plugs. Problems.

UNIT-II

Combustion in I.C. Engines: S.I. engines; Ignition limits; stages of combustion in S.I. Engines; Ignition lag; velocity of flame propagation; detonation; effects of engine variables on detonation; theories of detonation; octane rating of fuels; pre-ignition; S.I. engine combustion chambers, Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.

Lubrication and Cooling Systems: Functions of a lubricating system, Types of lubrication system; mist, wet sump and dry sump systems; properties of lubricating oil; SAE rating of lubricants, engine performance and lubrication, Necessity of engine cooling; disadvantages of overcooling; cooling systems; air-cooling, water cooling; radiators.

UNIT-III

Engine Testing and Performance: Performance parameters: BHP, IHP, mechanical efficiency, brake mean effective pressure and indicative mean effective pressure, torque, volumetric efficiency; specific fuel consumption (BSFC, ISFC), thermal efficiency; heat balance; Basic engine measurements; fuel and air consumption, brake power, indicated power and friction power, heat lost to coolant and exhaust gases; performance curves. Problems.

Air pollution from I.C. Engine and Its remedies: Pollutants from S.I. and C.I. Engines, Methods of emission

control; alternative fuels for I.C. Engines; the current scenario on the pollution front.

UNIT-IV

Rotary Compressors: Root and vane blowers; Static and total head values; Centrifugal compressorsVelocity diagrams, slip factor, ratio of compression, pressure coefficient, pre-whirl; Axial flow compressor- Degree of reaction, polytropic efficincy, surging, choking and stalling, performance characteristics, Problems.

Gas Turbines: Brayton cycle; Components of a gas turbine plant; open and closed types of gas turbine plants; Optimum pressure ratio; Improvements of the basic gas turbine cycle; multi stage compression with intercooling; multi stage expansion with reheating between stages; exhaust gas heat exchanger, Applications of gas turbines. Problems.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO1: Understand the working principles and thermodynamic cycles of internal combustion engines and gas turbines.

CO2: Analyze the performance characteristics of internal combustion engines and gas turbines, including power output, efficiency, and emissions.

CO3: Develop skills in designing and optimizing internal combustion engines and gas turbines for specific applications and operating conditions.

CO4: Demonstrate proficiency in diagnosing and troubleshooting engine and turbine performance issues and proposing effective solutions.

CO5: Apply knowledge of combustion processes, fuel systems, and heat transfer in the design and operation of internal combustion engines and gas turbines.

CO6: Evaluate the environmental impact of internal combustion engines and gas turbines, and explore alternative fuels and technologies for reducing emissions.

Text Books:

1. Internal Combustion Engines –V. Ganesan, Pub.-Tata McGraw-Hill.
2. Gas Turbines - V. Ganesan, Pub.- Tata McGraw Hill.
3. Engineering fundamental of the I.C.Engine – Willard W. Pulkrabek Pub.-PHI,India

References:

1. Internal Combustion Engines and Air pollution- Obert E.F, Pub.-Hopper and Row Pub., New York
2. Internal Combustion Engines Fundamentals- John B. Heywood, Pub.-McGraw Hill, New York
3. Fundamentals of Internal Combustion Engines-H.N. Gupta, PHI, New Delhi

Course code					
Course title	Design of Machine Element-I				
Category	**Professional Engineering Course**				
Semester and Credits	L	T	P	**Credits**	Semester V
	3	0	0	3	
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

1. A strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components.
2. An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations.
3. An overview of codes, standards and design guidelines for different elements.
4. An appreciation of parameter optimization and design iteration.
5. An appreciation of the relationships between component level design and overall machine system design and performance

UNIT-I

Design Philosophy: Problem identification- problem statement, specifications, constraints, Feasibility study technical feasibility, economic and financial feasibility, societal and environmental feasibility, Generation of solution field (solution variants), Brain storming, Preliminary design, Selection of best possible solution, Detailed design, Selection of Fits and tolerances and analysis of dimensional chains.

Selection of Materials: Classification of Engg. Materials, Mechanical properties of the commonly used engg. Materials, hardness, strength parameters with reference to stress-strain diagram, Factor of safety.

UNIT-II

Mechanical Joints: ISO Metric Screw Threads, Bolted joints in tension, Eccentrically loaded bolted joints in shear and under combined stresses, Design of power screws, Design of various types of welding joints under different static load conditions.

Riveted Joints, Cotter and Knuckle Joints: Design of various types of riveted joints under different static loading conditions, eccentrically loaded riveted joints, design of cotter and knuckle joints.

UNIT-III

Belt rope and chain drives: Design of belt drives, Flat and V-belt drives, Condition for Transmission of max. Power, Selection of belt, design of rope drives, design of chain drives with sprockets.

Keys, Couplings and Flywheel: Design of Keys – Flat, Kennedy Keys, Splines, Couplings design – Rigid and Flexible coupling, turning Moment diagram, coefficient of fluctuation of energy and speed, design of flywheel – solid disk and rimmed flywheels.

UNIT-IV

Clutches: Various types of clutches in use, Design of friction clutches – Disc. Multidisc, Cone and Centrifugal, Torque transmitting capacity.
Brakes: Various types of Brakes, Self energizing condition of brakes, Design of shoe brakes – Internal and external expanding, band brakes, Thermal Considerations in brake designing.

Course Outcomes: At the end of the course, the student shall be able to:
CO 1- Exploration of different concepts and considerations of machine design.
CO 2- Understanding design of different types of mechanical joints.
CO 3- Learning of design of different types of keys and couplings.
CO 4- Design procedure of transmission of shafts.
CO 5- Design of different types springs.
CO 6- Analysis of the various types of clutches and brakes.

Text Books:
1. Mechanical Engg. Design - First Metric Editions: Joseph Edward Shigley-MGH, New York.
2. Design of Machine Elements – V.B. Bhandari – Tata McGraw Hill, New Delhi. 5. PSG Design Data Book

References:
1. Engineering design – George Dieter, MGH, New York.
2. Product Design and Manufacturing, A.K.Chitale and R.C.Gupta, PHI.
3. Machine Design An Integrated Approach: Robert L.Norton, Addison Wesley.
4. Machine Design : S.G. Kulkarini - Tata MacGraw Hill.
5. Design of machine elements-C S Sharma, Kamlesh Purohit, PHI.

Course code					
Category	**Professional Engineering Course**				
Course title	Heat Transfer				
Semester and Credits	L	T	P	**Credits**	Semester V
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
2. Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
3. The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers

UNIT-I

Basics and Laws: Definition of Heat Transfer, Reversible and irreversible processes, Modes of heat flow, Combined heat transfer system and law of energy conservation. Steady State Heat Conduction: Introduction, I-D heat conduction through a plane wall, long hollow cylinder, hollow sphere, Conduction equation in Cartesian, polar and spherical co-ordinate systems, Numericals.

UNIT-II

Steady State Conduction with Heat Generation: Introduction, 1 – D heat conduction with heat sources, Extended surfaces (fins), Fin effectiveness 2-D heat conduction , Numericals. Transient Heat Conduction: Systems with negligible internal resistance, Transient heat conduction in plane walls, cylinders, spheres with convective boundary conditions, Chart solution, Relaxation Method, Numericals.

UNIT-III

Convection: Forced convection-Thermal and hydro-dynamic boundary layers, Equation of continuity, Momentum and energy equations, Some results for flow over a flat plate and flow through tube, Fluid friction and heat transfer (Colburn analogy), Free convection from a vertical flat plate, Empirical relations for free convection from vertical and horizontal o\planes and cylinders, Numericals. Thermal Radiation: The Stephen-Boltzmann law, The black body radiation, Shape factors and their relationships, Heat exchange between non black bodies, Electrical network for radiative exchange in an enclosure of two or three gray bodies, Radiation shields, Numericals.

UNIT-IV

Heat Exchangers: Classification, Performance variables, Analysis of a parallel/counter flow heat exchanger, Heat exchanger effectiveness, Numericals. Winglets, Types of Winglets, Heat Transfer Augmentation Process,

effect of heat treatment augmentation, Application of heat treatment augmentation process, Heat transfer augmentation in a channel flow. Heat Transfer with Change of Phase: Laminar film condensation on a vertical plate, Drop-wise condensation, Boiling regimes, Free convective, Nucleate and film boiling, Numericals

Course Outcome (COs): At the end of the course, the student shall be able to:
CO 1- Understand the basic concept of conduction, convection and radiation heat transfer.
CO 2- Formulation of one dimension conduction problems.
CO 3- Application of empirical correlations for both forced and free convection for determines the value of convection heat transfer coefficient.
CO 4- Expedite basic concept of the radiation heat transfer for black and grey body.
CO 5- Learning of thermal analysis and sizing of Heat exchangers.
CO 6- Understanding the design of heat exchanger.

Text Books:
1. Heat Transfer – J.P. Holman, John Wiley and Sons, New York.
2. Fundamentals of Heat and Mass Transfer–Incropera, F.P. and Dewill, D.P –John Willey New York.
3. Heat Transfer-Principles and Applications-Binay K. Dutta, PHI, New Delhi

References:
1. Conduction of Heat in Solids – Carslow, H.S. and J.C. Jaeger – Oxford Univ. Press.
2. Conduction Heat Transfer – Arpasi, V.S. – Addison – Wesley.
3. Compact Heat Exchangers – W.M. Keys and A.L. Landon, Mc. Graw Hill.
4. Thermal Radiation Heat Transfer – Siegel, R. and J.R. Howell, Mc. Graw Hill.
5. Heat Transmission – W.M., Mc.Adams, Mc Graw Hill.
6. Heat and Mass Transfer, Mohan, Pearson Indian Education Services, Pvt. Ltd. In

Course code					
Course title	Strength of Materials-II				
Category	**PEC-I**				
Semester and Credits	L	T	P	**Credits**	Semester V
	3	0	0	3	
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
2. To provide a detailed interpretation of equilibrium phase diagrams
3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

UNIT-I

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

UNIT-II

Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stressintensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT)

UNIT-III

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.TTT-curve

UNIT-IV

Heat treatment of Steel: Annealing, tempering, normalizing and spheroidizing, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable

and spheroidal cast irons- copper and copper alloys; brass, bronze and cupronickel; Aluminum and Al-Cu – Mg alloys-Nickel based superalloys and Titanium alloys

Course Outcomes:
CO1. Student will be able to identify crystal structures for various materials and understand the defects in such structures
CO2. Understand how to tailor material properties of ferrous and non-ferrous alloys
CO3.How to quantify mechanical integrity and failure in materials.
CO4. Interpret the phase diagrams of materials.
CO5. Describe the concept of heat treatment of steels and strengthening mechanisms.
CO6: Develop skills in characterizing and testing materials to determine their mechanical, thermal, electrical, and optical properties.

Text Books:
1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

Course code	

Course title	Welding Technology				
Category	**PEC I**				
Semester and Credits	L	T	P	**Credits**	Semester V
	3	0	0	3	
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Corse Objectives:

The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.Apply and use energy methods to find force, stress and displacement in simple structures and springs.Understand and determine the stresses and strains in pressure vessels. Knowledge of stress functions, and calculate stresses in rotating rings, discs, and curved beams.

UNIT-I

Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a body when load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's & Maxwell's theorems, Numericals. Theories of Elastic Failure: Various theories of elastic failures with derivations and graphical representations, applications to problems of 2- dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading, Numericals.

UNIT-II

Unsymmetrical Bending: Properties of beam cross section, product of inertia, ellipse of inertia, slope of the neutral axis, stresses & deflections, shear center and the flexural axis Numericals. Springs: Stresses in open coiled helical spring subjected to axial loads and twisting couples, leaf springs, flat spiral springs, concentric springs, Numericals.

UNIT-III

Derivation of Lame's equations, Radial & Hoop Stresses in compound spherical shells subjected to internal fluid pressure only, wire wound cylinders, hub shrunk on solid shaft, Numericals. Rotating Rims & Discs: Stresses in uniform rotating rings & discs, rotating discs of uniform strength, stresses in (I) rotating rims, neglecting the effect of spokes, (ii) rotating cylinders, hollow cylinders & solids cylinders. Numericals.

UNIT-IV

Bending of Curved Bars : Stresses in bars of initial large radius of curvature, bars of initial small radius of curvature, stresses in crane hooks, rings of circular & trapezoidal sections, deflection of curved bars & rings, deflection of rings by Castigliano's theorem stresses in simple chain link, deflection of simple chain links, Problems.

Course Outcomes:

After studying this course, students will be able:

CO 1 Apply and use energy methods to find force, stress and displacement in simple structures and springs.

CO 2 Understand and determine the stresses and strains in pressure vessels.

CO 3 Knowledge of stress functions, and calculate stresses in rotating rings, discs, and curved beams.

CO 4 Evaluate the behaviour and strength of structural elements subjected to three dimensional stress system.

CO5 Evaluate the properties and behavior of helical springs

CO6 Develop problem-solving skills by working on numerical examples and exercises

Text Books:

1. Strength of Materials – G.H.Ryder, Third Edition in SI Units 1969 Macmillan, India.
2. Strength of Materials – Sadhu Singh, Khanna Publishers

References:

1. Book of Solid Mechanics – Kazmi, Tata Mc Graw Hill
2. Strength of Materials – D.S. Bedi - S. Chand & Co. Ltd.
3. Strength of Materials – U.C Jindal - Pearson India Ltd.

Course code					
Course title	Tribology				
Category	**PEC I**				
Semester and Credits	L	T	P	**Credits**	Semester V
	3	0	0	3	
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To provide the knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components.
2. To select proper grade lubricant for specific application.
3. To understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
4. To introduce the concept of surface engineering and its importance in tribology.
5. To understand the behavior of Tribological components.

UNIT- I

Fundamentals of Tribology: Introduction to tribology and its historical background, Industrial importance, factors influencing Tribological phenomenon. Engineering surfaces- surface characterization, computation of surface parameters. Surface measurement techniques, statistical description.

UNIT- II

Friction of Surfaces: Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, various laws and theory of friction, friction of elastomers, friction of various materials, friction measurement methods, friction of non metallic materials.

UNIT- III

Wear Mechanism: Introduction, types of wear, wear mechanism, minor forms of wear, wear debris analysis, wear testing method, wear of metals, ceramics, polymers, system approach for wear reduction.

UNIT-IV

Theory of Lubrication: Basic principal of lubrication, choice of lubricant type, selection of lubrication oils, oil changing and oil conservation, oil feed system, Greece and anti seizes, gas bearing, lubricating sealing, lubricating testing and specifications, lubrication monitoring, Additives in lubricants.

UNIT- V

Design for Tribological Elements: An overview of engineering materials having potential for tribological application, characterization and evaluation of ferrous materials for tribological requirements/application, selection of ferrous materials for rolling element bearings, Basic Equation for fluid film lubrication, Boundary lubrication, Hydrodynamic lubrication, electrohydrodynamic lubrication.

Course Outcomes:

CO1: Understand the different techniques used to solve mechanical engineering problems.
CO2: Derive and use 1-D and 2-D element stiffness matrices and load vectors from various methods to solve for displacements and stresses.
CO3: Apply mechanics of materials and machine design topics to provide preliminary results used for testing the reasonableness of finite element results.
CO4: Explain the inner workings of a finite element code for linear stress, displacement, temperature and modal analysis.
CO5: Use commercial finite element analysis software to solve complex problems in solid mechanics and heat transfer.
CO6: Interpret the results of finite element analyses and make an assessment of the results in terms of modeling (physics assumptions) errors, discretization (mesh density and refinement toward convergence) errors, and numerical (round-off) errors.

Text Books

1. Moore F Desmond ,Principals and application of Tribology, ,Pergamon press,1975
2. Sahoo Prashant Engineering Tribology, Prentice-Hall of India, New Delhi, 2005
3. Lansdown A R ,Lubrication, A practical Guide to Lubricant selection, Pergamon Press1982
4. Majumdar BC, Introduction to Tribology of Bearings, Wheeler Publishing, New Delhi,1999.

Course code					
Course title	Robotics Engineering				
Category	**PEC I**				
Semester and Credits	L	T	P	**Credits**	Semester V
	3	0	0	3	
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

This course introduces the basic concepts, standard terminologies, applications, design specifications, and the mechanical design aspects of robotics related to kinematics, trajectory planning, dynamics, control and simulation of serial industrial robotic manipulators.

UNIT-I

Definition of robot, types and classifications, standard terminologies related to robotics, key design specifications used for selection of serial robotic manipulators for various applications, robotic applications in modern automated industries, research and non-industrial environments.

UNIT-II

Homogeneous co-ordinates and co-ordinate transformations, Forward and inverse kinematics for serial robotic manipulators, the concept of Jacobian, kinematics simulation in MATLAB environment and using Robo Analyser.

UNIT-III

Robot Dynamics: Introduction to Lagrangian formulations for serial robotic manipulators, actuator dynamics.
Trajectory Generation: Joint-Space trajectory generation, Cartesian space trajectory generation, Path generation at run time, simulation of trajectory-related problems.

UNIT-IV

Robot Control: Open-loop and Closed-loop control, Model-based control, Trajectory following control.

Course Outcomes :

The students will be able to:

CO1. Identify and formulate the desired robotic design specifications for a particular application.
CO2. Develop and simulate the forward kinematics model using D-H conventions..
CO3. Develop the inverse kinematics model of a serial manipulator.
CO4. Develop and analyze the mathematical model for robotics trajectory planning, resolved motion rate control and dynamics for a given serial robotic manipulator.
CO5. Apply the joint- and Cartesian-based schemes to control the manipulators in different applications.
CO6. Interpret and analyze the results obtained from Robo Analyser for robot motion and positioning.

Text books:

1. Schilling, R.J., Fundamentals of Robotics Analysis and Control, Prentice Hall of India (2006).
2. Fu, K.S., Gonzalez, R.C. and Lee, C.S.G., Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill (1987).
3. Craig, J.J., Introduction to Robotics: Mechanics and Control, prentice Hall (2004).

Reference Books:

1. Deb, S.R., Robotics and Flexible Automation, McGraw Hill (2004).
2. Saha, S.K., Introduction to Robotics, McGraw Hill (2008).
3. Niku, S.B., Introduction to Robotics: Analysis, system, application, Dorling kingsley (2006).

Course code					
Course title	Dynamics of Machines _Lab (P)				
Category	**Laboratory Course**				
Semester and Credits	L	T	P	**Credits**	Semester V
	0	0	2	1	
Marks for Sessional	50 Marks				
Marks for End term Examination	50 Marks				
Total	`100 Marks				

Note :
1. Ten experiments are to be performed in the Semester.
2. At least seven experiments should be performed from the above list. Remaining three experiments should be performed as designed and set by the concerned Institution as per the scope of the sylLabus.

Course Objectives:
1. To understand the student with fundamental knowledge of dynamics of machines so that student can appreciate problems of dynamic force balance, transmissibility of forces, isolation of systems, vibrations.
2. Develop knowledge of analytical and graphical methods for calculating balancing of rotary and reciprocating masses.

List of Experiments:
1. To perform experiment on Watt and Porter Governors to prepare performance characteristic Curves, and to find stability and sensitivity.
2. To perform experiment on Proell Governor to prepare performance characteristic curves, and to find stability and sensitivity.
3. To perform experiment on Hartnell Governor to prepare performance characteristic Curves, and to find stability and sensitivity.
4. To study gyroscopic effects through models.
5. To determine gyroscopic couple on Motorized Gyroscope.
6. To perform the experiment for static balancing on static balancing machine.
7. To perform the experiment for dynamic balancing on dynamic balancing machine.
8. Determine the moment of inertial of connecting rod by compound pendulum method and triflair suspension pendulum.

Course Outcomes: At the end of the course, the student shall be able to:
CO 1- Understand the various practical demonstrations of forces in mechanism.
CO 2- Knowledge of various Design features of mechanism with practical demonstration.
CO 3- Learning the Special purpose mechanism (governor, Gyroscope Cam and followers etc) used in designing of a machine
CO 4- Prepare practical model using the various linkages.

Course code					
Course title	I.C. ENGINES and GAS TURBINES LAB				
Category	**Laboratory Course**				
Semester and Credits	L	T	P	**Credits**	Semester V
	0	0	2	1	
Marks for Sessional	50 Marks				
Marks for End term Examination	50 Marks				
Total	100 Marks				

NOTE:
1 At least ten experimentsare tobe performed in the Semester.
2 At least seven experiments should be performed from the above list. Remaining three experiments may either be performed from the above list or designed and set by the concerned institution as perthe scope of the sylLabus.

Course Objectives:
After studying this course, students will be able: Understand the how to prepare the graph between bhp, ihp, fhp vs speed by using variable compression test rig. Knowledge of functions of 4 stroke and two stroke engines and Combustion System of IC Engines with Lubrication and Cooling system

List of Experiments:
1. To study the constructional details and working principles of two-stroke/ four stroke petrol engine.
2. To study the constructional detail and working of two-stroke/ four stroke diesel engine.
3. Analysis of exhaust gases from single cylinder/multi cylinder diesel/petrol engine by Orsat Apparatus.
4. To prepare heat balance sheet on multi-cylinder diesel engine/petrol engine.
5. To find the indicated horse power (IHP) on multi-cylinder petrol engine/diesel engine by Morse Test.
6. To prepare variable speed performance test of a multi-cylinder/single cylinder petrol engine/diesel engine and prepare the curves (i) bhp, ihp,fhp, vs speed (ii) volumetric efficiency and indicated specific specific fuel consumption vs speed.
7. To find fhp of a multi-cylinder diesel engine/petrol engine by Willian's line method and by motoring method.
8. To perform constant speed performance test on a single cylinder/multi-cylinder diesel engine and draw curves of (i) bhp vs fuel rate, air rate and A/F and (ii) bhp vs mep, mech efficiency and sfc.
9. To measure CO and Hydrocarbons in the exhaust of 2- stroke / 4-stroke petrol engine.
10. To find intensity of smoke from a single cylinder / multi-cylinder diesel engine.
11. To draw the scavenging characteristic curves of single cylinder petrol engine.
12. To study the effects of secondary air flow on bhp, sfc, Mech. Efficiency and emission of a twostroke petrol engine.

Course Outcomes (COs): After studying this course, students will be able:
CO 1- Understand the how to prepare the graph between bhp, ihp, fhp vs speed by using variable compression test rig.
CO 2- Knowledge of functions of 4 stroke and two stroke engines.

CO 3- Learn Combustion System of IC Engines with Lubrication and Cooling system.
CO 4- Familiarization of the pollution control system.

Course code					
Category	Professional Engineeringcourse				
Course title	Heat Transfer Lab				
Semester and Credits	L	T	P	**Credits**	Semester V
	0	0	2	1	
Classwork	50 Marks				
Exam	50 Marks				
Total	100 Marks				

Note: 1. At least ten experiments are to be performed in the semester. 2. At least seven experiments should be performed from the above list. Remaining three experiments may either be performed from the above list or designed and set by the concerned institute as per the scope of the sylLabus.

Courses Objectives:

(1) The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.

(2) The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

List of Experiments:

1. To determine the thermal conductivity of a metallic rod.
2. To determine the thermal conductivity of an insulating power.
3. Measurement of heat transfer rate in a channel flow using winglets.
4. To determine the thermal conductivity of a solid by the guarded hot plate method.
5. To find the effectiveness of a pin fin in a rectangular duct natural convective condition and plot temperature distribution along its length.
6. To find the effectiveness of a pin fin in a rectangular duct under forced convective and plot temperature distribution along its length.
7. To determine the surface heat transfer coefficient for a heated vertical tube under natural convection and plot the variation of local heat transfer coefficient along the length of the tube. Also compare the results with those of the correlation.
8. To determine average heat transfer coefficient for a externally heated horizontal pipe under forced convection and plot Reynolds and Nusselt numbers along the length of pipe. Also compare the results with those of the correlations.
9. To measure the emmisivity of the gray body (plate) at different temperature and plot the variation of emmisivity with surface temperature.
10. To find overall heat transfer coefficient and effectiveness of a heat exchange under parallel and counter flow conditions. Also plot the temperature distribution in both the cases along the length of heat of heat exchanger.
11. To verify the Stefen-Boltzmann constant for thermal radiation.
12. To demonstrate the super thermal conducting heat pipe and compare its working with that of the best conductor i.e. copper pipe. Also plot temperature variation along the length with time or three pipes.
13. To study the two phases heat transfer unit.
14. To determine the water side overall heat transfer coefficient on a cross-flow heat exchanger.
15. Design of Heat exchanger using CAD and verification using thermal analysis package eg. IDeas etc.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Understanding the conduction heat transfer coefficient.

CO 2- Design and analyze heat transfer system with practical demonstration.
CO 3- Selection of equipments and their practical demonstration in heat transfer design.
CO 4- Knowledge of development about mass transfer

Course code	

Course title	Practical Training				
Category	**PT**				
Semester and Credits	L	T	P	**Credits**	Semester V
	0	0	2	0	
Marks for Sessional					
Marks for End term Examination					
Total					

PRACTICAL TRAINING VIVA-VOCE:

1) Assessment of Practical Training-I, undergone at the end of IV semester, will be based on seminar, viva-voce, report and certificate of practical training obtained by the student from the industry/ Professional organization/ Research Laboratory with the prior approval of the Director-Principal/ Mechanical Software /Automobile Workshop.

   According to performance letter grades A, B, C, F are to be awarded:
   1)Excellent : A ; Good : B ; Satisfactory : C ; Not satisfactory : F. A student who has been awarded ' F' grade will be required to repeat the practical training.
   2) Each student has to undergo practical training of 4/6 weeks during summer vacation and its evaluation shall be carried out in the V semester.

Course Objectives:

1. Achieving the objectives of the University and its colleges and departments in practical training.
2. Providing students with practical skills, which match the requirements of the job market and allow them to directly enter the work community in a serious and constructive manner.
3. Providing students with experience to help them take decisions pertaining to their future career objectives.
4. Providing college students the full opportunity to apply theoretical knowledge (gained during their studies) in a real work environment at a later stage of their studies
5. Developing the student's understanding of the needs of the job market and reaching this understanding successfully.

Semester 6

S. No.	Course Code	Category	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	HSC		Entrepreneurship Development	**3**	**0**	**0**	**3**	**30**	**70**	**100**
2	PCC		Fluid Machines	**3**	**0**	**0**	**3**	**30**	**70**	**100**
3	PCC		Design of machine element-II	**3**	**0**	**0**	**3**	**30**	**70**	**100**
4	PCC		Operation Research	**3**	**0**	**0**	**3**	**30**	**70**	**100**
5	OEC		Open Elective-II	**3**	**0**	**0**	**3**	**30**	**70**	**100**
6	PEC		Elective-I	**3**	**0**	**0**	**3**	**30**	**70**	**100**
7	PEC		Elective-II	**3**	**0**	**0**	**3**	**30**	**70**	**100**
8	LC		Fluid Machines _Lab	**0**	**0**	**2**	**1**	**50**	**50**	**100**
9	HSMC		Economics for Engineers	**2**	**0**	**0**	**0**	**30**	**70**	**100**
10	PROJ-1		Project_I	**0**	**0**	**2**	**2**	**30**	**70**	**100**
		Total					**24**			**1000**

NOTE

1. The examination of the regular students will be conducted by the concerned college/Institute internally. Each student will be required to score a minimum of 40% marks to qualify in the paper. The marks will not be included in determining the percentage of marks obtained for the award of a degree.
2. Choose any one from each of the Professional Elective Course-II and III .
3. Choose any one from Open Elective Course-II

Professional Elective-II

Sr. No.	Code	Subject	Credit
1		Power Plant Engineering	3
2		Solar Energy Engineering	3
3		Artificial Intelligence and Machine Learning	3
4		Automobile Engineering	3

Professional Elective-III

Sr. No.	Code	Subject	Credit
1		Additive Manufacturing	3
2		Finite Element Method	3
3		System Modelling And Simulation	3
4		Noise and Vibrations	3
		Hydraulics and Pneumatics	3

Course code					
Course title	Entrepreneurship Development				
Category	**HSC**				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

The objectives of the course are to

1. Introduce various qualities required for entrepreneurship
2. Explain various entrepreneurship models
3. Organize interaction with successful entrepreneurs
4. Introduce to various tools as Six hat techniques, Five S.

UNIT-I

Entrepreneurship : Concept and Definitions; Entrepreneurship and Economic Development; Types of Entrepreneurs; Factor Affecting Entrepreneurial Growth – Economic, Non-Economic Factors; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs; Manager Vs. Entrepreneur, types of entrepreneurships, Entrepreneurial myths.

UNIT-II

Opportunity Identification and Product Selection: Entrepreneurial Opportunity Search and Identification; Criteria to Select a Product; Conducting Feasibility Studies; Sources of business ideas, launching a new product; export marketing, Methods of Project Appraisal, Project Report Preparation; Project Planning and Scheduling. Sources of finance for entrepreneurs.

UNIT-III

Small Enterprises and Enterprise Launching Formalities : Definition of Small Scale; Rationale; Objective;Scope; SSI; Registration; NOC from Pollution Board; Machinery and Equipment Selection , Role of SSI in Economic Development of India; major problem faced by SSI,MSMEs – Definition and Significance in Indian Economy; MSME Schemes, Challenges and Difficulties in availing MSME Schemes.

UNIT-IV

Role of Support Institutions and Management of Small Business : Director of Industries; DIC; SIDO;SIDBI; Small Industries Development Corporation (SIDC); SISI; NSIC; NISBUD; State Financial Corporation SIC; Venture Capital : Concept, venture capital financing schemes offered by

various financial institutions in India, Legal issues – Forming business entity, considerations and criteria, requirements for formation of a Private/Public Limited Company.

Course Outcomes: At the end of the course, the student shall be able to:

CO1 - Students will be able understand who the entrepreneurs are and what competences needed

CO2 - Students will be able to understand insights into the management, opportunity search, identification of a product, market flexibility studies, project finalization etc. required for small business enterprise.

CO3- Students will be able to write a report and do oral presentation on the topics such as product identification, business ideas, export marketing etc.

CO4 - Students will be able to know the different financial and other assistance avaiLable for establishing small industrial units.

CO5- Analyze and evaluate the legal and regulatory frameworks relevant to entrepreneurship and business establishment.

CO6- ColLaborate in multidisciplinary teams to develop and pitch entrepreneurial ideas, fostering creativity, teamwork, and leadership skills.

Text Books and Reference Books :

1. "Entrepre neurship deve lopme nt sma ll bus iness enterprises", Pearson, Poornima M Charantimath,2013.
2. Roy Rajiv, "Entrepreneurship", Oxford University Press, 2011.
3. "Innovation and Entrepreneurship",Harper business- Drucker.F, Peter, 2006.
4. "Entre preneurship", Tata Mc-graw Hill Publishing Co. ltd new Delhi- Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, 8th Edition, 2012
5. Enterpreneurship Development- S.ChandandCo.,Delhi- S.S.Khanka 1999
6. Small-Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi –Vasant Desai 2003.
7. Entrepreneurship Management -Cynthia, Kaulgud, Aruna, Vikas Publishing House, Delhi, 2003.
8. Entrepreneurship Ideas in Action- L. Greene, Thomson Asia Pvt. Ltd., Singapore, 2004.

Course code					
Course title	Fluid Machines				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	0	0	3	VI
Marks for Sessional	30 Marks				
Marks for End term Examination	70 Marks				
Total	100 Marks				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

The students completing this course are expected to understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

1. Study working of different types of hydraulic machines and their design principles.
2. Study the development of hydropower and its advantages over other types of power development.

UNIT-I

Impact of free jets: Impulse – momentum principle, jet impingement - on a stationary flat plate, inclined plate and a hinged plate, at the center of a stationary vane, on a moving flat plate, inclined plate, a moving vane and a series of vanes, Jet striking tangentially at the tip of a stationary vane and moving vane(s), jet propulsion of ships, Problems.

Impulse Turbines: Classification – impulse and reaction turbines, water wheels, component parts, construction, operation and governing mechanism of a Pelton wheel, work done, effective head, avaiLable head and efficiency of a Pelton wheel, design aspects, speed ratio, flow ratio, jet ratio, number of jets, number of buckets and working proportions, Performance Characteristics, governing of impulse turbines, Problems.

UNIT-II

Francis Turbines: Component parts, construction and operation of a Francis turbine, governing mechanism, work done by the turbine runner, working proportions and design parameters, slow, medium and fast runners, degree of reaction, inward/outward flow reaction turbines, Performance Characteristics, Problems.

Propeller and Kaplan turbines: Component parts, construction and operation of a Propeller, Kaplan turbine, differences between the Francis and Kaplan turbines, draft tube - its function and different forms, Performance Characteristics, Governing of reaction turbine, Introduction to new types of turbine, Deriaz (Diagonal), Bulb, Tubular turbines, Problems.

UNIT-III

Dimensional Analysis and Model Similitude: Dimensional homogeneity, Rayleigh's method and Buckingham's πtheorem, model studies and similitude, dimensionless numbers and their significance. Unit quantities, specific speed and model relationships for turbines, scale effect, cavitations – its causes, harmful effects and prevention, Thomas cavitation factor, permissible installation height, Problems.

Centrifugal Pumps: Classification, velocity vector diagrams and work done, manometric efficiency, vane

shape, head capacity relationship and pump losses, pressure rise in impeller, minimum starting speed, design considerations, multi-stage pumps. Similarity relations and specific speed, net positive suction head, cavitation and maximum suction lift, performance characteristics. Brief introduction to axial flow, mixed flow and submersible pumps, Problems.

UNIT-IV

Reciprocating Pumps: Construction and operational details, discharge coefficient, volumetric efficiency and slip, work and power input, effect of acceleration and friction on indicator diagram (pressure – stroke length plot), separation, air vessels and their utility, rate of flow into or from the air vessel, maximum speed of the rotating crank, characteristic curves, centrifugal vs reciprocating pumps, brief introduction to screw, gear, vane and radial piston pumps, Problems.

Hydraulic systems: Function, construction and operation of Hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic lift and hydraulic press, Fluid coupling and torque converter, Hydraulic ram, Problems.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Application of momentum equation and its application.
CO 2- Understand the construction, working principle and design analysis of hydraulic turbines.
CO 3- Expedite construction, working principle and design analysis of pumps.
CO 4- Knowledge of the design of a prototype on the basis of dimensional analysis.
CO 5- Understanding of use of different fluid flow measuring devices.
CO 6- Apply appropriate equations and principles to analyze pipe flow problems.

Text Books:

1. Fluid Mechanics and Hydraulic Machines – Mahesh Kumar, Pearson Indian Education Service Pvt. Ltd. India.
2. Hydraulics and Fluid Mechanics – Modi and Seth, Pub. - Standard Book House, N.Delhi
3. Hydraulic Machines – Jagdish Lal, Metropolitan

References:

1. Fluid Mechanics and Hydraulic Machines – S S Rattan, Khanna Publishers
2. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas, Tata McGraw Hill
3. Fluid Mechanics and Fluid Power Engineering – D S Kumar, S K Kataria and Sons.

Course code					
Category	Professional Core course				
Course title	Design of Machine Element -II				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. Develop an ability to apply knowledge of mechanics and materials
2. Develop an ability to design a system / component to meet desired needs within realistic constraints using suitable design methodology.
3. Utilize various standards and methods of standardization.
4. Apply the concept of design and validation by strength analysis.

UNIT-I

Design for Production ; Erogonomic and value engineering considerations in design, Role of processing in design, Design considerations for casting, forging and machining. Variable Loading : Different types of fluctuating/ variable stresses, Fatigue strength considering stress concentration factor, surface factor, size factor, reliability factor etc., Fatigue design for finite and infinite life against combined variable stresses using Goodman and Soderberg‟s Criterion, Fatigue design using Miner‟s equation, Problems.

UNIT-II

Shafts: Detailed design of shafts for static and dynamic loading, Rigidity and deflection consideration. Springs: Types of Springs, Design for helical springs against tension and their uses, compression and fluctuating loads, Design of leaf springs, Surging phenomenon in springs, Design Problem.

UNIT-III

Bearings: design of pivot and collar bearing, Selection of ball and roller bearing based on static and dynamic load carrying capacity using load-life relationship, Selection of Bearings from manufacturer's catalogue, types of lubrication – Boundary, mixed and hydrodynamic lubrication, Design of journal bearings using Raimondi and Boyd's Charts, Lubricants and their properties, Selection of suitable lubricants, Design Problems.

UNIT-IV

Gears : Classification, Selection of gears, Terminology of gears, Force analysis, Selection of material for gears, Beam and wear strength of gear tooth, Form or Lewis factor for gear tooth, Dynamic load on gear teeth -Barth equation and Buckingham equation and their comparison, Design of spur, helical, bevel and worm gear including the Consideration for maximum power transmitting capacity, Gear Lubrication, Design Problems

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Expose the students to the Design for Production and for variable loading.

CO 2- Impart in depth knowledge of designing of screws and different types of fasteners.

CO 3- Design bearings, selection of bearings for different aspects and lubricants with their properties.
CO 4- Knowledge of gears, design of different types of gears with consideration of maximum power transmission and gear lubrication.
CO 5- Learn in depth knowledge of flywheels and their design.
CO 6-Experties in the gear and gear train design.

Text Books:

1. Mechanical Engg. Design- Joseph Edward Shigley-Mc Graw Hill Book Co.
2. Design of Machine Elements – V.B. Bhandari – Tata McGraw Hill, New Delhi.

Reference Books :

1. Engineering design – George Dieter, McGraw Hill, New York.
2. Product Design and Manufacturing –: A.K.Chitale and R.C.Gupta, PHI, New Delhi.
3. Machine Design An Integrated Approach: Robert L.Norton,Second Edition –Addison Wisley Longman 8. Machine Design : S.G. Kulkarni , TMH , New Delhi.

Course code					
Category	Professional Core course				
Course title	Operation Research				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives :

To provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems.

UNIT I

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

UNIT II

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

UNIT III

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT IV

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

UNIT V

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life – Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem.

Course Outcomes :

Upon completion of this course, the students can able

1. optimization techniques for use engineering and Business problems
2. Understand the simplex algorithm and its application in solving linear programming problems.
3. Analyze project networks using CPM (Critical Path Method) and PERT (Program Evaluation and Review Technique)
4. Comprehend stochastic inventory models and their application in uncertain demand scenarios
5. Analyze queueing models with Poisson input and exponential service times

6. Analyze replacement models based on service life, economic life, and other relevant factors

Text Book:

1. Hillier and Libeberman, “Operations Research”, Holden Day, 2005
2. Taha H.A., “Operations Research”, Sixth Edition, Prentice Hall of India, 2003

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References:

1. Bazara M.J., Jarvis and Sherali H., “Linear Programming and Network Flows”, John Wiley, 2009.
2. Budnick F.S., “Principles of Operations Research for Management”, Richard D Irwin, 1990.
3. Philip D.T. and Ravindran A., “Operations Research”, John Wiley, 1992. 4. Shennoy G.V. and Srivastava U.K., “Operation Research for Management”, Wiley Eastern, 1994.

Course code					
Category	**Professional Elective Course-II**				
Course title	Power Plant Engineering				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. Basic knowledge of Different types of Power Plants, site selection criteria of each one of them.
2. Understanding of Thermal Power Plant Operation, turbine governing, different types of high pressure boilers including supercritical and supercharged boilers, Fluidized bed combustion systems.
3. Design of chimney in thermal power plants, knowledge of cooling tower operation, numerical on surface condenser design.
4. Basic knowledge of Different types of Nuclear power plants including Pressurized water reactor, Boiling water reactor, gas cooled reactor, liquid metal fast breeder reactor.
5. Understanding of Power Plant Economics, Energy Storage including compressed air energy and pumped hydro etc.
6. Discussing environmental and safety aspects of power plant operation

UNIT I

Introduction-Analysis of steam cycles, optimization of reheat pressure and degree of regeneration, coupled cycles and combined plants, process heat and power. Fuels and their properties, stoichiometric and actual air requirements, flue gas analysis.

UNIT II

Boilers- Different types of boilers, boiler mountings, feed water treatment, boiler loading and manner of operation. boiler energy balance, draft system. Different types of furnaces for burning coal, fuel oil and gas. Circulation theory, down-comers and risers, economizers and super-heaters, air pre-heater, drum and its internals.

UNIT III

Steam Turbines- Convergent and convergent-divergent nozzles - theory and design. Impulse and reaction turbines, compounding of turbines, optimum velocity ratio, reheat factor and condition line, parallel exhaust, losses in steam turbines, steam turbine governing.

UNIT IV

Plant Components- Theory and design of condensers, air ejector and cooling towers. Types and applications.

UNIT V

Power Plant Economics & Environmental Considerations- Plant energy studies: concepts and resources, procedures and implementation. Energy accounting. Various thermal systems and energy management.

Electrical load management. Economic analysis. Waste heat recovery. Multi objective energy management-conservation, pollution control and evaluation of alternative energy sources. Cost of energy management and payback.

Course Outcomes:

CO 1: Understand the principles of power generation and the different types of power plants, including thermal, hydroelectric, nuclear, and renewable energy sources.
CO 2: Analyze the components and systems of power plants, including boilers, turbines, generators, and electrical systems, and their operation and maintenance requirements.
CO 3: Develop skills in designing and optimizing power plant layouts and configurations to maximize efficiency, reliability, and safety.
CO 4: Demonstrate knowledge of environmental considerations and regulatory requirements related to power plant operations, emissions control, and waste management.
CO 5: Apply engineering principles to solve power plant engineering problems, such as heat transfer, fluid mechanics, thermodynamics, and control systems.
CO 6: Evaluate the economic feasibility of power plant projects, including cost analysis, energy efficiency assessment, and risk management.

Text/Reference Books:

1. Nag.P.K. Power plant engineering: Tata McGraw-Hill.
2. Arora, S. C., & Domkundwar, S. A course in power plant engineering: Dhanpat Rai.
3. Elanchezhian, C. Power Plant Engineering: I.K. International Pub. House.

Course code					
Category	**Professional Elective Course-II**				
Course title	Solar Engineering				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To provide a fundamental understanding of solar energy principles and technologies for effective engineering and design.
2. To develop the skills necessary to assess, analyze, and optimize solar energy systems for maximum efficiency and sustainability.
3. To equip students with the knowledge and tools to design and manage solar energy projects, considering site-specific factors and integration into existing energy systems.
4. To explore and stay updated with the latest advancements and emerging trends in solar energy engineering, fostering innovation and problem-solving in the field.

UNIT-I

Solar Radiation: Introduction, solar system – sun, earth and earth-sun angles, time, derived solar angles, estimation of solar radiation (direct and diffuse), measurement systems – pyrheliometers and other devices. Effect of Solar radiation upon structures: Steady state heat transmission, solar radiation properties of surfaces, shading of surfaces, periodic heat transfer through walls and roofs.

UNIT-II

Solar Collectors: Flat plate and concentrating – comparative study, design and materials, efficiency, selective coatings, heliostats. Heating Applications of Solar Energy: Air and Water heating systems, thermal storages, solar bonds, solar pumps, solar lighting systems, solar cookers, solar drying of grains.

UNIT-III

Cooling Applications of Solar Systems: Continuous and Intermittent vapour absorption systems for cooling applications, absorbent – refrigerant combination, passive cooling systems.

UNIT-IV

Solar Electric Conversion Systems: Photovoltaics, solar cells, satellite solar power systems. Effects on Environment, economic scenario, ozone layer depletion, greenhouse effect, global warming, Remedial measures by international bodies.

Course Outcomes:

CO 1: Understand the principles of solar energy and its conversion into usable forms of power, including photovoltaic (PV) systems and solar thermal technologies.

CO 2: Analyze the design, installation, and operation of solar energy systems, including PV arrays, solar collectors, energy storage, and grid integration.
CO 3: Develop skills in assessing site suitability, solar resource estimation, and system sizing for efficient utilization of solar energy.
CO 4: Demonstrate proficiency in modeling and simulating solar energy systems using software tools and techniques.
CO 5: Apply knowledge of electrical and electronic engineering principles to optimize the performance and reliability of solar energy systems.
CO 6: Evaluate the economic viability and environmental impact of solar energy projects, considering factors such as cost analysis, life cycle assessment, and policy frameworks.

Text Books:

1. Solar Energy – S P Sukhatme, Tata McGraw Hill
2. Solar Energy Process – Duffie and Bechman, John Wiley

References Books:

1. Applied Solar Energy – Maniel and Maniel, Addison Wiley
2. Solar Energy: Fundamentals and Applications – R P Garg and Jai Prakash, TMH.

Course code					
Category	**Professional Elective Course-II**				
Course title	Artificial Intelligence and Machine Learning				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. Acquaint with fundamentals of artificial intelligence and machine learning.
2. Llearn feature extraction and selection techniques for processing data set.
3. Understand basic algorithms used in classification and regression problems.
4. Outline steps involved in development of machine learning model.
5. Familiarize with concepts of reinforced and deep learning.
6. Implement and Analyze machine learning model in mechanical engineering problems

UNIT-I

History of AI, Comparison of AI with Data Science, Need of AI in Mechanical Engineering, Introduction to Machine Learning. Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation. Approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical. Approaches to ML: Supervised learning, Unsupervised learning, Reinforcement learning

UNIT-II

Feature extraction: Statistical features, Principal Component Analysis. Feature selection: Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Mechanical Engineering

UNIT-III

Classification: Decision tree, Random forest, Naive Bayes, Support vector machine. Regression: Logistic Regression, Support Vector Regression. Regression trees: Decision tree, random forest, K-Means, K-Nearest Neighbor (KNN). Applications of classification and regression algorithms in Mechanical Engineering.

UNIT-IV

Problem identification: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions

UNIT-V

Characteristics of reinforced learning; Algorithms: Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning; Models: Markov Decision Process, Q Learning. Characteristics of Deep Learning, Artificial Neural Network, Convolution Neural Network. Application of Reinforced and Deep Learning in Mechanical Engineering

Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Dynamic System Order Reduction, Image based part classification, Process Optimization, Material Inspection, Tuning

of control algorithms.

Course Outcomes:

On completion of the course, learner will be able to

CO1. Demonstrate fundamentals of artificial intelligence and machine learning.
CO2. Apply feature extraction and selection techniques.
CO3. Apply machine learning algorithms for classification and regression problems.
CO4. Devise and develop a machine learning model using various steps.
CO5. Explain concepts of reinforced and deep learning.
CO6. Simulate machine learning model in mechanical engineering problems

Text Books:

1.Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003

Reference Books:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

Course code					
Category	**Professional Elective Course-II**				
Course title	Automobile Engineering				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To provide a comprehensive understanding of automobile engineering principles, including vehicle design, manufacturing, and operation.
2. To develop the skills necessary to analyze and optimize automotive systems, considering factors such as performance, efficiency, and safety.
3. To equip students with the knowledge and tools to design and innovate automobile components and systems, incorporating emerging technologies and sustainable practices.
4. To foster an understanding of industry trends and advancements in automobile engineering, preparing students for the dynamic and evolving automotive sector.

UNIT-I

Vehicle Structure and Engines-Types of Automobiles, Vehicle Construction – Chassis, Frame and Body ,Aerodynamics, Components of Engine – Their forms, Functions and Materials, Review of Cooling and Lubrication systems in Engine, Turbo Chargers, Engine Emission Control by 3–Way Catalytic Controller, Electronic Engine Management System.

UNIT-II

Engine Auxiliary Systems- Carburettor–working principle, Electronic fuel injection system – Mono-point and Multi - Point Injection Systems, Electrical systems – Battery generator – Starting Motor and Drives – Lighting and Ignition (Battery, Magneto Coil and Electronic Type)- Regulators-cut outs.

UNIT-III

Transmission Systems-Clutch – Types and Construction, Gear Boxes-Manual and Automatic, Simple Floor Mounted Shift Mechanism, Over Drives, Transfer Box Fluid flywheel- Torque convertors, Propeller shaft – Slip Joint – Universal Joints, Differential and Rear Axle, Hotchkiss Drive and Torque Tube Drive.

UNIT-IV

Steering, Brakes and Suspension- Wheels and Tires – Wheel Alignment Parameters ,Steering Geometry and Types of steering gear box, Power Steering, Types of Front Axle – Suspension systems. Braking Systems – Types and Construction – Diagonal Braking System – Antilock Braking System.

UNIT-V

Alternative Energy Sources-Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles, Electric and Hybrid Vehicles, Fuel Cells.

Course Outcomes:

CO1: Understand the fundamental principles of automobile engineering, including vehicle dynamics, powertrain systems, and vehicle design.

CO2: Analyze and evaluate the performance characteristics of automotive components and systems, such as engines, transmissions, suspension, and braking systems.

CO3: Develop skills in designing and optimizing vehicle structures and systems for improved safety, fuel efficiency, and environmental sustainability.

CO4: Demonstrate proficiency in using computer-aided design (CAD) and simulation tools to model and analyze automotive systems.

CO5: Apply knowledge of automotive engineering principles to diagnose and troubleshoot common vehicle problems and propose effective solutions.

CO6: Evaluate the impact of emerging technologies, such as electric and autonomous vehicles, on the future of automobile engineering and transportation systems.

Text/Reference Books:

1. Crolla, D. Automotive Engineering: Powertrain, Chassis System and Vehicle Body: Butterworth-Heinemann.
2. Heisler, H. Advanced vehicle technology: Butterworth-Heinemann.
3. Happian-Smith, J. An introduction to modern vehicle design: Butterworth-Heinemann.
4. Newton, Steeds and Garet, Motor vehicles, Butterworth Publishers.
5. Crouse, W. H., and Anglin, D. L. Automotive Mechanics, Study Guide: McGraw-Hill.

Course code					
Category	**Professional Elective Course-III**				
Course title	Additive Manufacturing				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications

Unit I

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM and CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM. Vat Photo polymerization AM Processes: Stereo lithography (SL), Materials, Process Modelling, SL resin curing process, SL scan patterns, Micro-stereo lithography, Mask Projection Processes, Two-Photon vat photo polymerization, Process Benefits and Drawbacks, Applications of Vat Photo polymerization, Material Jetting and Binder Jetting AM Processes.

Unit II

Extrusion - Based AM Processes: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, BioExtrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes. Sheet Lamination AM Processes: Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

Unit III

Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process 11 Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

Unit IV

Directed Energy Deposition AM Processes: Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structureproperties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes. Materials science for AM - Multifunctional and graded materials in AM, Role of solidification rate, Evolution of nonequilibrium structure, microstructural studies, Structure property relationship.

Unit V

Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques. Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.

Course Outcomes:

CO1: Understand the working principle and process parameters of AM processes
CO2: Explore the applications of AM processes in various fields
CO3: Select the suitable material and process for fabricating a given product
CO4: Apply the knowledge in Material science in Additive Manufacturing Components.
CO5: Design and develop a product for AM Process.
CO6: Expertise in the field of 3D modelling and printing.

Text Books:

1. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.
2. Patri K. Venuvinod and Weiyin Ma, "Rapid Prototyping: Laser-based and Other Technologies", Springer, 2004.

Reference Books:

1. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles and Applications", 4th Edition, World Scientific, 2015.
2. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.
3. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley and Sons, 2006.

Course code					
Category	**Professional Elective Course-III**				
Course title	Finite Element Method				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To provide a solid foundation in the principles and concepts of the finite element method (FEM) for numerical analysis and simulation of engineering problems.
2. To develop the skills necessary to discretize and model complex engineering systems using FEM, allowing for accurate prediction of structural behavior and performance.
3. To equip students with the knowledge and tools to analyze and optimize engineering designs through FEM, considering factors such as stress distribution, deformation, and heat transfer.
4. To explore advanced applications of FEM, such as nonlinear analysis, dynamic response, and multiphysics simulations, enabling students to tackle real-world engineering challenges.

Unit I

Basic concepts- The standard discrete system, Finite elements of an elastic continuum displacement approach, Generalization of the finite element concepts- weighted residual and variational approaches.

Unit II

Element Types- Triangular, rectangular, quadrilateral, sector, curved, iso-parametric elements and numerical integration. Automatic mesh generation schemes.

Unit III

Application to structural mechanics problems- Plane stress and plane strains, Axisymmetric stress analysis, three dimensional stress analyses, bending of plates.

Unit IV

FEM in Steady State Field Problems- Introduction, heat conduction, fluid flow and nonlinear material problems, plasticity, creep etc. Computer procedures for Finite element analysis.

Course Outcomes:

CO1: Understand the theoretical foundations and mathematical principles of the finite element method (FEM) for solving engineering problems.
CO2: Develop skills in constructing finite element models and discretizing complex geometries for structural and thermal analysis.
CO3: Demonstrate proficiency in using FEM software tools to solve linear and nonlinear problems, including static and dynamic structural analysis.
CO4: Apply FEM techniques to analyze and optimize the behavior of engineering structures and components under various loading and boundary conditions.
CO5: Evaluate the accuracy and reliability of FEM results through verification and validation techniques, including convergence studies and comparison with experimental data.
CO6: Evaluate and interpret FEM results to assess structural integrity, optimize designs, and make informed engineering decisions.

Text/Reference Books:

1. Chandrupatla T.R., and Belegundu A.D., Introduction to Finite Elements in Engineering, Pearson Education
2. David V Hutton, Fundamentals of Finite Element Analysis McGraw-Hill Int. Ed.
3. Rao S.S. The Finite Element Method in Engineering, Pergammon Press.
4. Logan D.L., A First course in the Finite Element Method, Third Edition, Thomson Learning,
5. Robert D.Cook., David.S, Malkucs Michael E Plesha , Concepts and Applications of Finite Element Analysis.
6. Reddy J.N, An Introduction to Finite Element Method, McGraw-Hill International Student Edition
7. O.C.Zienkiewicz and R.L.Taylor, The Finite Element Methods, Vol.1. The basic formulation and linear problems, Vol.1, Butterworth Heineman.

Course code					
Category	**Professional Elective Course-III**				
Course title	System Modelling And Simulation				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To provide a comprehensive understanding of system modeling and simulation techniques for analyzing and predicting the behavior of complex systems.
2. To develop the skills necessary to create mathematical models of systems and simulate their dynamic behavior using appropriate simulation tools and software.
3. To equip students with the knowledge and tools to analyze and optimize system performance, considering factors such as efficiency, reliability, and cost-effectiveness.
4. To foster an understanding of the application of system modeling and simulation across various disciplines, including engineering, business, and healthcare, enabling students to tackle diverse real-world problems.

Unit I

Introduction-Systems, System types, System Modeling, Types of system modelling, Classification and comparison of simulation models, attributes of modelling, Comparison of physical and computer experiments, Application areas and Examples.

Unit II

Mathematical and Statistical Models- Probability concepts, Queuing Models, Methods for generating random variables and Validation of random numbers.

Unit III

Language-System modelling, programming languages, comparison of languages, Identifying and selection of programming language, feasibility study of programming language for the given application.

Unit IV

Experiments-Simulation of different systems, Analysis, validation and verification of input and output simulated data, study of alternate techniques.

Unit V

Case study-Developing simulation model for information centers, inventory systems and analysis of maintenance systems.

Course Outcomes:

CO1: Understand the principles and techniques of system modeling and simulation for representing and analyzing complex systems.
CO2: Develop skills in selecting appropriate modeling methodologies and simulation tools based on system characteristics and objectives.
CO3: Apply mathematical and computational modeling techniques to represent system behavior, dynamics, and interdependencies.
CO4: Demonstrate proficiency in using simulation software to create and execute system models, analyzing system performance and behavior under different scenarios.
CO5: Evaluate the validity and reliability of simulation results through verification and validation techniques, including sensitivity analysis and comparison with real-world data.
CO6: ColLaborate effectively in multidisciplinary teams to design and conduct system simulations, interpret results, and make informed decisions for system optimization and improvement.

Text Books:

1. Geoffrey Gordon, “System Simulation”, Second edition, Prentice Hall, India, 2002.
2. Jerry Banks and John S.Carson, Barry L.Nelson, David M.Nicol, “Discrete Event System Simulation”, Third edition, Prentice Hall, India, 2002.

Reference Books:

1. Robert E. Shannon, “System Simulation The art and science”, , Prentice Hall, New Jersey, 1995.
2. D.S. Hira, “System Simulation”, S.Chand and company Ltd, New Delhi, 2001.

Course code					
Category	**Professional Elective Course-III**				
Course title	Noise and Vibrations				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To provide a comprehensive understanding of noise and vibration principles, their generation mechanisms, and their effects on human health and the environment.
2. To develop the skills necessary to measure, analyze, and mitigate noise and vibration problems in various engineering applications.
3. To equip students with the knowledge and tools to design and implement effective noise and vibration control strategies in engineering systems and structures.
4. To foster an understanding of relevant regulations and standards related to noise and vibration, ensuring compliance and promoting sustainable and comfortable environments.

UNIT-I

Introduction: Periodical motion, harmonic motion, period, cycle, circular frequency, amplitude and phase angles of vibration motion, non-harmonic periodic motions. classification of vibration: free and forced vibration, undamped and damped vibration, linear and non linear vibration Harmonic analysis, the vector method of representing vibrations, displacement, velocity and acceleration in harmonic motion, super position of simple harmonic, beats, work done in harmonic motion.

UNIT-II

System with One Degree of Freedom: System having single degree of freedom, free vibration of systems without damping, equilibrium and energy method for determining natural frequency. Raleigh's method, equivalent systems (systems with compound spring, shafts of different dia. Equivalent length, effect of mass of springs and shaft). Free vibration of systems with viscous, coulomb and structural damping. Equations of motions-discussion of solutions. Forced vibrations of systems with and without viscous and coulomb damping,, frequency response plots, Phase shift plots, Equivalent viscous damping, power consumption of vibration systems, forced isolation, commercial isolators, transmissibility.

UNIT-III

Systems with Two Degree of Freedom: System having two degree of freedom system, Normal mode of vibrations, Torsional systems, undamped and damped vibration in two degree of freedom system with free and forced vibration. Vehicle suspension, Undamped dynamic vibration absorber. Centrifugal absorber, friction damper. Vibration Instruments: Principle of frequency, Amplitude, Velocity and acceleration measuring instruments, Analysis of vibration records. Electrical Analogies: Electric circuit principles, equivalent circuits.

UNIT-IV

Whirling of Shafts: Whirling of light flexible shaft with an unbalance disk at the Centre of its length with and without damping, discussion of speeds above and below the critical speed, Uniform shaft with and without unbalanced masses attached along its length (by Rayleigh method) for simple supported and fixed ends.

UNIT-V

Noise Control: Noise and its causes, sound pressure /intensity/ power level and their interrelation, Decibel scale, Loudness and equal loudness contours, Sound spectra and octave band analysis. Background noise. Weighted networks. Measurement of noise, effect of machine/ process noise on operators, employees and local resident's, standard of noise level and exposure limits. Methods of industrial noise control.

Course Outcomes:

CO1: Understand the principles and theories of noise and vibration generation, transmission, and control in engineering systems.
CO2: Analyze and evaluate the sources and characteristics of noise and vibrations in mechanical, electrical, and structural components.
CO3: Develop skills in designing and implementing effective noise and vibration control strategies to minimize their adverse effects.
CO4: Demonstrate proficiency in using measurement and analysis tools to quantify and assess noise and vibration levels in various environments.
CO5: Apply knowledge of acoustics and vibration engineering to solve real-world problems in industries like automotive, aerospace, and construction.
CO6: ColLaborate in multidisciplinary teams to develop innovative solutions for noise and vibration reduction, improving overall product performance and user experience.

Text Books:

1. Ambekar A.G. "Mechanical Vibrations and Noise Engineering" Prentice-Hall of India, New-Delhi, 2e, 2006.
2. Singh V.P., "Mechanical Vibration" Dhanpat Raiand Co.(p)Ltd., Delhi, 3e, 2001
3. Thomson W.T "Theory of Vibration with Application" CBS Publishers and Distriburors, Delhi, 3e, 1990. Grover G.K."Mechanical Vibrations" Nem Chand and Brothers, 2e, 2007.
4. Pujara K. " Vibration and Noise for Engineers", Dhanpat Rai and Sons, Delhi, 2e,1992.

Course Code					
Category	**Professional Elective-III**				
Course Title	**Hydraulic & Pneumatics**				
Semester and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Class Work	50 Marks				
Examination	50 Marks				
Total	100 Marks				
Duration of Exams	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objective

Students will able to understand the basic concepts of fluid power, including hydraulic and pneumatic systems, their components, and their advantages and limitations. They will be studying the properties of fluids, including viscosity, pressure, flow rate, and temperature, and their impact on fluid power systems amd will able to explore the hydraulic components such as pumps, actuators, valves, and reservoirs, as well as hydraulic circuit design and analysis.

Unit-I

Fluid Power Principles and Fundamentals and Hydraulic motors

Introduction to fluid power, Advantages and applications, Fluid power systems, Types and Properties of Hydraulic fluids, Basics of hydraulics, Principles of flow, Work, Power and Torque, Reynolds number, Influence of temperature on viscosity, High water based fluid, Fluid preparation, Common fire resistant fluid, Biodegradable oils. Vane Motor, Gear Motor, Piston motor, Selection of hydro motor, Hydraulic or electrical motor, Hydraulic motor in circuits, Types of hydraulic transmission, Pump motor combination, Open loop and close loop system, Application of hydrostatic transmission

Unit II

Hydraulic Linear Actuators

Hydraulic cylinder, Construction of cylinders, Seals in cylinders, Cylinder reliability, Cylinder force, Acceleration and losses, Calculation of cylinder forces, Flow velocity, Cylinder efficiency, Sizing of cylinder tubes, Piston rod design, Mounting style of cylinders, Cushioning of hydraulic cylinder, Hydraulic cylinder and their characteristic application.

Unit III

Hydraulic Circuits

Hydraulic circuits, Manual or Automatic Hydraulic systems, Regenerative circuits, Use of check Valve in hydraulic circuits, Standards in circuit diagram representation, Speed variation in cylinder motion, Some basic circuits, Functional diagram, Application of functional diagram, Electrical control of hydraulic system.

UNIT IV

Hydro Pneumatic

Compressibility, Solution, Types of hydro Pneumatic systems, Hydraulic check unit, Hydro pneumatic cylinder, Parallel check unit, Integral air oil cylinder, Types of feed, Intensifier, Comparison of Hydro pneumatic, Hydraulic and pneumatic system. Maintenance need of Pneumatic systems, Common problems in Pneumatic system, Maintenance schedule of Pneumatic system

Course Outcomes:

CO1 Develop the ability to design and analyze hydraulic and pneumatic circuits
CO2 Gain insights into real-world applications of fluid power technology across various industries
CO3 Develop critical thinking and problem-solving skills to identify and resolve challenges related to fluid power systems
CO4 understanding of fluid power principles, including the properties and behavior of fluids

Suggested Books:

1. S.R. Majumdar, **Oil Hydraulic Systems-Principles and Maintenance**, Tata McGraw Hill.
2. S.R. Majumdar, **Pneumatic Systems-Principles and Maintenance**, Tata McGraw Hill.
3. Farel Bradbury, **Hydraulic Systems and Maintenance,** Butterworth & Co (Publishers) Ltd.
4. R. Srinivasan, **Hydraulic and Pneumatic Controls**, Vijay Nicole.
5. Anthony Esposito, **Fluid Power with Applications**, PHI/Pearson Education.

Course code					
Course title	Fluid Machines _Lab				
Category	**Laboratory Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	0	0	2	1	VI
Marks for Sessional	50 Marks				
Marks for End term Examination	50 Marks				
Total	`100 Marks				

NOTE:
1. At least ten experiments are to be performed in the Semester.
2. At least seven experiments should be performed from the above list. Remaining three experiments may either be performed from the above list or designed and set by the concerned institution as per the scope of the sylLabus.

List of Experiments:
1. To study the constructional details of a Pelton turbine and draw its fluid flow circuit.
2. To draw the following performance characteristics of Pelton turbine-constant head, constantspeed and constant efficiency curves.
3. To study the constructional details of a Francis turbine and draw its fluid flow circuit.
4. To draw the constant head, constant speed and constant efficiency performance characteristics of Francis turbine.
5. To study the construction details of a Kaplan turbine and drawits fluid flow circuit.
6. To drawthe constant head, speed and efficiency curves for a Kaplan turbine.
7. To study the constructional details of a Centrifugal Pump and draw its characteristic curves.
8. To study the constructional details of a Reciprocating Pump and draw its characteristics curves.
9. To study the construction details of a Gear oil pump and its performance curves.
10. To study the constructional details of a Hydraulic Ram and determine its various efficiencies..
11. To study the constructional details of a Centrifugal compressor.
12. To study the model of Hydro power plant and draw its layout.

Course Objectives:
(1) To understand the principles and performance characteristics of flow and thermal devices.
(2) To know about the measurement of the fluid properties.
(3) To understand the theory, working and performance characteristics of various hydraulic machines like pumps and turbines.

Course Outcomes (COs): At the end of the course, the student shall be able to:
CO 1- Understand the concept of momentum equation.
CO 2- Knowledge of construction, working principle and performance of hydraulic turbines.
CO 3- Learn construction, working principle and performance of pumps.

CO4- Explore construction, working principle and performance of hydraulic ram.

Course code					
Category	Management Course				
Course title	Economics for Engineer				
Semester and Credits	L	T	P	**Credits**	Semester VI
	3	0	0	3	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objectives:
To teach students different tools to optimize profits, minimize costs, analyze various scenarios, forecast fluctuations in business cycles, and more

Unit I

Economic Decisions Making – Overview, Problems, Role, Decision making process.
Engineering Costs and Estimation – Fixed, Variable, Marginal and Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement and Learning Curve, Benefits. Case Study - Price and Income Elasticity of Demand in the real world.

Unit II

Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories and Computation, Time Value of Money, Debt repayment, Nominal and Effective Interest

Unit III

Cash Flow and Rate Of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits and drawbacks. Case Study – Tata Motors

Unit IV

Inflation And Price Change – Definition, Effects, Causes, Price Change with Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates. Case Study – Competition in the Advertise Segment in India
Present Worth Analysis: End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation and Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives

Course Outcomes:

CO-1 Describe the principles of economics that govern the operation of any organization under diverse market conditions

CO-2 Comprehend macroeconomic principles and decision making in diverse business set up

CO-3 Explain the Inflation and Price Change as well as Present Worth Analysis

CO-4 Apply the principles of economics through various case studies

CO-5 Apply knowledge of economic policies and regulations to understand the impact on engineering projects and industry competitiveness.

CO-6 ColLaborate in multidisciplinary teams to consider economic perspectives and trade-offs in engineering project planning, design, and implementation.

Reference Books:

1. James L.Riggs,David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e , Tata McGraw-Hill

2. Donald Newnan, Ted Eschembach, Jerome Lavelle : Engineering Economics Analysis, OUP

3. John A. White, Kenneth E.Case,David B.Pratt : Principle of Engineering Economic Analysis, John Wiley

4. Sullivan and Wicks: Engineering Economy, Pearson 5. R.Paneer Seelvan: Engineering Economics, PHI 6. Michael R Lindeburg : Engineering Economics Analysis, Professional Pub

Course code					
Category	Project				
Course title	Project-I				
Semester and Credits	L	T	P	**Credits**	Semester VI
	0	0	2	2	
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				

COURSE OBJECTIVE

1. To prepare the student to gain major design and or research experience as applicable to the profession
2. Apply knowledge and skills acquired through earlier coursework in the chosen project.
3. Make conversant with the codes, standards, application software and equipment
4. Carry out the projects within multiple design constraints
5. Incorporate multidisciplinary components
6. Acquire the skills of comprehensive report writing

Students will be assigned projects (Applications/Research based) individually or in a group of not more than 3 students depending on the efforts required for completion of the project.

The project will have 4 stages: (*Marks for internal evaluation are given in brackets)

1. Synopsis submission (5 marks),
2. 1st mid-term progress evaluation (Literature Survey in case of research project) (5 marks)
3. 2nd mid-term progress evaluation (Paper Publishing/acceptance in a reputed Journal or Conference acceptance/ Presenting) (5 marks)
4. Final submission evaluation

The external examiner will evaluate the project on the basis of idea/quality of project, implementation of the project, project report and/or publication and viva.

Course outcomes

On successful completion of the course students will be able to:

CO1. Demonstrate a sound technical knowledge of their selected project topic.

CO2. Undertake problem identification, formulation and solution.
CO3. Design engineering solutions to complex problems utilising a systems approach.
CO4. Conduct an engineering project.
CO5. Communicate with engineers and the community at large in written an oral forms.
CO6. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Semester 7

S. No.	Category	Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	PCC		Non-Conventional Energy Resources	3	1	0	3	30	70	100
2	PCC		Refrigeration And Air Conditioning	3	0	0	3	30	70	100
3	OEC		Open Elective-III	3	0	0	3	30	70	100
4	OEC		Open Elective-IV	3	0	0	3	30	70	100
5	PEC		Professional Elective-IV	3	1	0	3	30	70	100
6	LC		Refrigeration And Air Conditioning_Lab	0	0	2	1	50	50	100
7	PROJ-II		Project-II	0	0	2	2	100	100	200
		Total					**18**			**800**

NOTE:
1. Choose any one from Professional Elective Course-IV
2. Choose any one from each of the Open Elective Course-III and IV

Professional Elective IV

Sr. No.	Code	Subject	Credit
1		Composite Materials	3
2		Gas Dynamics and Turbo machine	3
3		Non-Destructive Evaluation and Testing	3
4		Computational Fluid Dynamics	3

Course code					
Course title	**Non conventional Energy Resource**				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	0	0	3	VII
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

The main purpose of fuel is to store energy, which should be in a stable form and can be easily transported to the place of use. The user employs this fuel to generate heat or perform mechanical work, such as powering an engine. It may also be used to generate electricity, which is then used for heating, lighting, or other purposes.

UNIT-I

Principles Of Solar Radiation: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT-II

Solar Energy Collection:Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria.

UNIT-III

Direct Energy Conversion: Need for DEC, Carnot cycle, limitations, principles of DEC. Thermoelectric generators, seebeck, peltier and joul Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faradays laws, thermodynamic aspects, selection of fuels and operating conditions.

UNIT-IV

Bio-Mass:Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation and economic aspects..

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India.

Course Outcomes:

At the end of the course, the student shall be able to:

CO1 : Understanding of fuel is to store energy

CO2 : Employs fuel to generate heat or perform mechanical work, such as powering an engine.

CO3: Explain the classification of concentrating collectors based on their design and focusing mechanisms

CO4: Evaluate the advantages and limitations of flat plate collectors and concentrating collectors in different applications

CO5: Analyze the generation of power using MHD generators and the operation of MHD accelerators and engines.

CO6: Identify suitable fuels and operating conditions for different types of fuel cells

Reference Book:

1) Renewable energy resources/ Tiwari and Ghosal/Narosa.

2) Non-Conventional Energy / Ashok V Desai /Wiley Eastern.

3) Non-Conventional Energy Systems / K Mittal/Wheeler

Text books:

1) Raja etal, “Introduction to Non-Conventional Energy Resources” Scitech Publications.

2) John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006.

3) M.V.R. Koteswara Rao, “Energy Resources: Conventional and Non-Conventional” BSP Publications,2006.

4) D.S. Chauhan,”Non-conventional Energy Resources” New Age International.

5) C.S. Solanki, “Renewal Energy Technologies: A Practical Guide for Beginners” PHI Learning.

6) Peter Auer, "Advances in Energy System and Technology". Vol. 1 and II Edited by Academic Press. 7) Godfrey Boyle,“ Renewable Energy Power For A Sustainable Future”, Oxford University Press.

Course code					
Course title	**Refrigeration and Air Conditioning**				
Category	**Professional Core Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	0	0	3	VII
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives:

1. To familiarize with the terminology associated with refrigeration systems and air conditioning
2. To understand basic refrigeration processes
3. To understand the basics of psychrometry and practice of applied psychrometrics .
4. To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

UNIT-I

Introduction: Definition of refrigeration and air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP), Fundamentals of air-conditioning system; Refrigerants-Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants; Introduction to Cryogenics.

Air Refrigeration System: Carnot refrigeration cycle. Temperature. Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems, problems.

UNIT-II

Vapour Compression (VC) Refrigeration Systems: (A) Simple Vapour Compression (VC) Refrigeration systems-Limitations of Reversed Carnot cycle with vapour as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP; Comparison of VC cycle with Air Refrigeration cycle. Multistage Ref. Systems- Necessity of compound compression, Compound VC cycle , Intercooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter-cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves; Individual compression systems with individual or multiple expansion valves but with and without intercoolers. Other Refrigeration Systems: (A) Vapour Absorption Refrigeration Systems – Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; Problems. Steam Jet Refrigerating System- Introduction, Analysis,

Relative merits and demerits, Performance Applications, Problems.

Unit-III

Psychrometry of Air and Air Conditioning Processes: Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer, Problems. Air- Conditioning Load Calculations: Outside and inside design conditions; Sources of heating load; Sources of cooling load; Heat transfer through structure, Solar radiation, Electrical applications, Infiltration and ventilation, Heat generation inside conditioned space; Apparatus selection; Comfort chart, Problems.

Unit-IV

Air Conditioning Systems with Controls and Accessories: Classifications, Layout of plants; Equipment selection; Air distribution system; Duct systems Design; Filters; Refrigerant piping; Design of summer air-conditioning and Winter air conditioning systems; Temperature sensors, Pressure sensors, Humidity sensors, Actuators, Safety controls; Accessories; Problems. Refrigeration and Air Conditioning Equipments: Type of compressors and their performance curves; Types of Condensers, Heat transfer in condensers; Types of expansion devices; types of evaporators, Cooling and Dehumidifying coils, Problems.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Understand the air refrigeration, vapour compression refrigeration, vapour absorption, steam jet refrigeration systems and different type of refrigerants.

CO 2- Expedite the working of single stage, multistage and cascade refrigeration.

CO 3- Knowledge of psychrometry and different psychrometric processes. Understand and evaluate cooling and heating load and design of HVAC system.

CO 4- Develop and design RAC systems and evaluate different expansion and control devices.

CO5- Familiarize with various accessories used in RAC systems

CO6- Design and select components for both summer and winter air-conditioning systems

Text Books :

1. Refrigeration and Air conditioning –R.C. Jordan and G.B. Priester, Prentice Hall of India. .
2. Refrigeration and Air conditioning –C.P. Arora, TMH, New Delhi.

Reference Books:

1. A course in Refrigeration and Air Conditioning – Arora and Domkundwar, Dhanpat Rai and Sons.
2. Refrigeration and Air conditioning –W.F. Stocker and J.W. Jones, TMH, New Delhi.
3. Refrigeration and Air conditioning- Manohar Prasad Wiley Estern limited, New Delhi

Course code					
Course title	**Composite Materials**				
Category	**Professional Elective-IV**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	0	0	3	VII
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course objectives:

1. To understand the mechanical behaviour of composite materials
2. To get an overview of the methods of manufacturing composite materials and their fabrication methods and testing.

UNIT-I

Definition and applications of composite materials, Fibers- glass, carbon, ceramic and aramid fibers; Matrices- polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices. Lamina-assumptions, macroscopic viewpoint, generalized Hooke;s law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness. Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes .

UNIT-II

Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill‟s criterion for anisotropic materials, TsaiHill‟s criterion for composites, prediction of laminate failure, thermal analysis of composite laminates Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies

UNIT-III

Fabrication methods: Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resintransplant method, pltrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films

UNIT-IV

Testing of Composites: Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.

Course Outcomes:

Upon completion of this course, the students will have

CO1: An overview of the mechanical behaviour and application of composite materials and their fabrication methods and testing

CO2: Learn the concept of the transformation matrix and its application in predicting the properties of a transformed composite laminate

CO3: Comprehend the concept of a lamina in composite materials, including assumptions made for lamina behavior.

CO4: Identify and analyze symmetric laminates, which have identical stacking sequences on the top and bottom of the laminate

CO5: Determine lamina stresses using the laminate strain-displacement equations and lamination theory

CO6: Understand the concept of laminate structural moduli, including the calculation of in-plane stiffness, bending stiffness, and coupling stiffness

Text Books:

1. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
2. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 1998
3. Materials characterization, Vol. 10, ASM hand book
4. Mechanical Metallurgy by G. Dieter Mc-Graw Hill
5. Thermal Analysis of Materials by R.F. Speyer, Marcel Decker
6. Engineering Materials: Polymers, Ceramics and Composites A.K Bhargava Prentice Hall India

Course code					
Course title	**Gas Dynamics and Jet Propulsion**				
Category	**Professional Elective IV**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	0	0	3	VII
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objective:

1. To understand the features of compressible isentropic flows and irreversibilities like shocks.
2. To provide a basic knowledge of jet and rocket propulsion technologies.

UNIT-I

Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow, Isentropic flow through variable area ducts, nozzle s and diffusers, subsonic and supersonic flow I variable area ducts, choked flow, AreaMach number relations for isentropic flow .

UNIT-II

Non-isentropic flow in constant area ducts, Rayleigh and Fanno flows, Normal shock relations, oblique shock relations, isentropic and shock tables.

UNIT-III

Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

UNIT-IV

Types of rocket engines, propellants and feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights

Course Outcomes:

Upon completion of this course, the students will be able to apply gas dynamics principles to jet and space propulsion systems

Text Books:

1. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press, 2008.
2. H.S. Mukunda, “Understanding Aerospace Chemical Propulsion”, Interline Publishing, 2004.
3. Hill P. and Peterson C., Mechanics and Thermodynamics of Propulsion, Addison Wesley, 1992.
4. Zucrow N. J., Aircraft and Missile Propulsion, Vol.Iand II, John Wiley, 1975.
5. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986

Course code					
Course title	**Computational Fluid Dynamics**				
Category	**Professional Elective IV**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	0	0	3	VII
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives: This course introduces the basic knowledge of governing equations for fluid flow and different turbulence models. The course also introduces the concept of numerical methods used to solve the partial differential equation. Further, solve the fluid flow problem using CFD tool

Unit 1

Introduction: Motivation and role of computational fluid dynamics, concept of modeling and simulation. Benefits and limitations of CFD software tools.

Unit II

Governing equations of fluid dynamics: Continuity equation, momentum equation, energy equation, various simplifications, dimensionless equations and parameters, convective and conservation forms, incompressible hermos flows, source panel method and vortex panel method.

Unit III

Nature of equations: Classification of PDE, general Thermos of parabolic, elliptic and hyperbolic equations, boundary and initial conditions. **Finite difference method:** Discretization, various methods of finite differencing, stability, method of
solutions. **Finite Volume methods:** Integral Approach, discretization and Higher order scheme.

Unit IV

Turbulence modelling: Turbulence, effect of turbulence on N-S equations, different turbulent modelling scheme, Error and uncertainty. **Incompressible Viscous Flows:** Stream function-vorticity formulation, solution for pressure, applications to internal flows and boundary layer flows

.

Course Outcomes (CLOs):

The students will be able to:

1. derive and analyse the various types of fluid flow governing equations.
2. analyse the internal fluid flow phenomena of thermal and fluid system.
3. simulate engineering problems using commercial CFD tools

Text books:

1. Ghosdastidar, P. S., Computer Simulation of Flow and Heat Transfer, McGraw Hill (1998)
2. Roache, P. J., Computational Fluid Dynamics, Hermosa (1998).
3. Wendt, J. F., Computational Fluid Dynamics An Introduction, Springer-Verlag (2008).

Reference Books:

1. Muralidhar, K. and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Narosa (2008) 2nd ed.
2. Jaluria, Y. and Torrance, K. E., Computational Heat Transfer, Taylor and Francis (2003).
3. Patankar, S. V., Numerical Heat Transfer and Fluid Flow, Taylor and Francis (2007).

Course code					
Course title	**Non Destructive Evaluation and Testing**				
Category	**Professional Elective IV**				
Semester and Credits	L	T	P	**Credits**	Semester
	3	0	0	3	VII
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have seven parts of 2 marks each from all units, and the remaining eight questions of 14 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Course Objectives

1. Provide an overview of various non-destructive testing methods and their applications.
2. Understand the principles and processes of different non-destructive testing methods.
3. Identify the advantages, limitations, and specific techniques associated with each method.
4. Learn about the equipment and instruments used for non-destructive testing.
5. Understand the safety precautions and considerations for each testing method.

Unit 1

Introduction and Visual Methods- Optical aids, In-situ metallography, Optical holographic methods, Dynamic inspection; Penetrant Flaw Detection- Principles: Process: Penetrant systems: Liquid penetrant materials: Emulsifiers: cleaners, developers: sensitivity: Advantages: Limitations: Applications;

Unit II

Radiographic Methods- Limitations: Principles of radiography: sources of radiation, Ionising radiation - X-rays sources, gama-rays sources Recording of radiation: Radiographic sensitivity: Fluoroscopic methods: special techniques: Radiation safety; Ultrasonic Testing of Materials- Advantages, disadvantages, Applications, Generation of. Ultrasonic waves, general characteristics of ultrasonic waves: methods and instruments for ultrasonic materials testing: special techniques;

Unit III

Magnetic Methods- Advantages, Limitations, Methods of generating fields: magnetic particles and suspending liquids Magnetography, field sensitive probes: applications. Measurement of metal properties; Electrical Methods- Eddy current methods: potential-drop methods, applications.

Unit IV

Electromagnetic Testing- Magnetism: Magnetic domains: Magnetization curves: Magnetic Hysteresis: Hysteresis loop tests: comparator - bridge tests Absolute single-coil system: applications.

Unit V

Other Methods- Acoustic Emission methods, Acoustic methods: Leak detection: Thermal inspection.

Course Outcomes:

By the end of the course, students should be able to:
CO1. Identify and select appropriate non-destructive testing methods for specific applications.
CO2. Perform non-destructive testing using visual methods, penetrant flaw detection, radiographic methods, ultrasonic testing, magnetic methods, electrical methods, and other relevant techniques.
CO3. Analyze and interpret test results accurately and effectively.
CO4. Understand and apply safety practices and precautions associated with non-destructive testing methods.
CO5. Demonstrate knowledge of the principles, advantages, limitations, and specific techniques of different non-destructive testing methods.
CO6. Operate and utilize the necessary equipment and instruments for non-destructive testing.

Text/Reference Books:

1. P. Halmshaw ;Non-Destructive Testing
2. Metals Handbook Vol. II, Non-destructive inspection and quality control

Course code					
Course title	**Refrigeration and Air Conditioning Lab**				
Category	**Laboratory Course**				
Semester and Credits	L	T	P	**Credits**	Semester
	0	0	2	2	VII
Classwork	30 Marks				
Exam	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objectives:

1. Understand the vapour compression refrigeration system and vapour absorption system.
2. Application of different compressors used in refrigeration system.
3. Understand functioning of various control devices
4. Evaluate the COP of various refrigeration system such as vapour compression refrigeration system and vapour absorption system.
5. Knowledge of how the loading condition changes the COP of the system

List of Experiments : (Refrigeration and Air Conditioning Lab)

1) To study the vapour compression Refrigeration System and determine its C.O.P. and draw P-H and T-S diagrams.
2) To Study the Mechanical heat pump and find its C.O.P.
3) To study the Air and Water heat pump and find its C.O.P.
4) To study the cut- sectional models of Reciprocating and Rotary Refrigerant compressor.
5) To study the various controls used in Refrigerating and Air Conditioning systems.
6) To study the Ice- plant, its working cycle and determine its C.O.P and capacity.
7) To study the humidification, heating, cooling and dehumidification processes and plot them on Psychrometric charts.
8) To determine the By-pass factor of Heating and Cooling coils and plot them on Psychrometric charts on different inlet conditions.
9) To determine sensible heat factor of Air on re-circulated air-conditioning set up.
10) To study the chilling plant and its working cycle.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Understand the vapour compression refrigeration system and vapour absorption system.
CO 2- Application of different compressors used in refrigeration system.
CO 3- Understand functioning of various control devices
CO 4- Evaluate the COP of various refrigeration system such as vapour compression refrigeration system and vapour absorption system.
CO 5- Knowledge of how the loading condition changes the COP of the system

Course Code					
Category	**PT**				
Course title	**Practical Training-II**				
Scheme	**L**	**T**	**P**	**Credits**	**Semester: VII**
	0	**0**	**2**	**2**	
Class Work	100 Marks				
Exam					
Total	100 Marks				
Duration of Exam					

The students are required to undergo practical training of duration not less than 1.5 months in a reputed organization or concerned institute. The students who wish to undergo practical training, the industry chosen for undergoing the training should be at least a private limited company. The students shall submit and present the midterm progress report at the institute. the presentation will be attended by a committee. alternately the teacher may visit the industry to get the feedback of the student.

The final Viva voice of the practical training will be conducted by an external examiner and one external examiner appointed by the institute. External examiner will be from the panel of examiners submitted by the concerned institute approved by the board of studies in engineering and technology. Assessment of industrial training will be based on seminar, viva-voice, report and certificate of practical training or institutional project work obtained by the student from the industry or institute.

The internal marks distribution for the students who have undergone industrial training consist of 100 marks internally.

Course code					
Course title	Project-II				
Category	**PROJ-II**				
Semester and Credits	L	T	P	**Credits**	Semester
	0	0	3	2	VII
Classwork	100 Marks				
Exam	100 Marks				
Total	200 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVE

1. To prepare the student to gain major design and or research experience as applicable to the profession
2. Apply knowledge and skills acquired through earlier coursework in the chosen project.
3. Make conversant with the codes, standards, application software and equipment
4. Carry out the projects within multiple design constraints
5. Incorporate multidisciplinary components
6. Acquire the skills of comprehensive report writing

Students will be assigned projects (Applications/Research based) individually or in a group of not more than 3 students depending on the efforts required for completion of the project.

The project will have 4 stages: (*Marks for internal evaluation are given in brackets)

1. Synopsis submission (5 marks),
2. 1st mid-term progress evaluation (Literature Survey in case of research project) (5 marks)
3. 2nd mid-term progress evaluation (Paper Publishing/acceptance in a reputed Journal or Conference acceptance/ Presenting) (5 marks)
4. Final submission evaluation

The external examiner will evaluate the project on the basis of idea/quality of project, implementation of the project, project report and/or publication and viva.

Course outcomes

On successful completion of the course students will be able to:

CO1. Demonstrate a sound technical knowledge of their selected project topic.
CO2. Undertake problem identification, formulation and solution.
CO3. Design engineering solutions to complex problems utilising a systems approach.
CO4. Conduct an engineering project.
CO5. Communicate with engineers and the community at large in written an oral forms.
CO6. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Gurugram University Scheme of Studies and Examination

Bachelor of Technology Semester 8

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	Elective		MOOC1	3	0	0	3	30	70	100
2	Elective		MOOC2	3	0	0	3	30	70	100
3	PROJECT		Industrial Project/ Project III	0	0	16	8	150	150	300
Total							**16**			**500**

MAJOR PROJECT/INDUSTRIAL TRAINING

Course Code					**Semester: VIII**
Category	**Project**				
Course title	**Major Project /Industrial Training**				
Scheme	**L**	**T**	**P**	**Credits**	
	0	**0**	**16**	**8**	
Class Work	150 Marks				
Exam	150 Marks				
Total	300 Marks				
Duration of Exam	3Hrs				

The students are required to undergo industrial training or institutional project work of duration not less than 4 months in a reputed organization or concerned institute. The students who wish to undergo industrial training, the industry chosen for undergoing the training should be at least a private limited company. The students shall submit and present the midterm progress report at the institute. the presentation will be attended by a committee. alternately the teacher may visit the industry to get the feedback of the student.

The final Viva voice of the industrial training on institutional project work will be conducted by an external examiner and one external examiner appointed by the institute. External examiner will be from the panel of examiners submitted by the concerned institute approved by the board of studies in engineering and technology. Assessment of industrial training or institutional project work will be based on seminar, yiva-voice, report and certificate of industrial training or institutional project work obtained by the student from the industry or institute.

The internal marks distribution for the students who have undergone industrial training consist of 150 marks internally and 150 marks buy an external examiner.

Elective

Course Code					**Semester: VIII**
Category	**Elective**				
Course title	**MOOC-1/Swayam/Nptel**				
Scheme	**L**	**T**	**P**	**Credits**	
	3	**0**	**0**	**3**	
Class Work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	3Hrs				

A student has to complete NPTEL Courses of 12 Weeks respectively through MOOCs. For registration to MOOCs Courses, the students shall follow NPTEL Site http://nptel.ac.in/ as per the NPTEL policy and norms. The students can register for these courses through NPTEL directly as per the course offering in Odd/Even Semesters at NPTEL. These NPTEL courses (recommended by the University) may be cleared during the B. Tech degree program (not necessary one course in each semester). After successful completion of these MOOCS courses the students, shall, provide their successful completion NPTEL status/certificates to the University (COE) through their college of study only.

Elective

Course Code					**Semester: VIII**
Category	**Project**				
Course title	**MOOC-2/swayam/NPTEL**				
Scheme	**L**	**T**	**P**	**Credits**	
	3	**0**	**0**	**3**	
Class Work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	3Hrs				

A student has to complete NPTEL Courses of 12 Weeks respectively through MOOCs. For registration to MOOCs Courses, the students shall follow NPTEL Site http://nptel.ac.in/ as per the NPTEL policy and norms. The students can register for these courses through NPTEL directly as per the course offering in Odd/Even Semesters at NPTEL. These NPTEL courses (recommended by the University) may be cleared during the B. Tech degree program (not necessary one course in each semester). After successful completion of these MOOCS courses the students, shall, provide their successful completion NPTEL status/certificates to the University (COE) through their college of study only.