THE ASSAM
ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF ENGINEERING & TECHNOLOGY
(RSET)

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE & SYLLABUS FOR UNDERGRADUATE DEGREE IN MECHANICAL ENGINEERING

FOR

Bachelor of Technology
in
Mechanical Engineering

W.E.F

AY - 2025 – 26

VISION, MISSION, AND OBJECTIVES OF DEPARTMENT

VISION

To evolve into a centre of excellence by imparting professional education in mechanical engineering with a unique academic and research ambience that promotes inquisitiveness, creativity, innovation and excellence.

MISSION

1. To have state-of-the-art infrastructure facilities.
2. To have highly qualified and experienced faculty from academics, research organizations and industry.
3. To develop students as socially committed professionals with sound engineering knowledge, creative minds, leadership qualities and practical skills.
4. Conduct basic and applied research, provide consultancy services and cultivate the spirit of entrepreneurship.
5. Develop the habit of continuous learning, team work and fulfill the societal needs.

OBJECTIVES

1. Achieve excellence in learning and research through continual improvement in both content and delivery of the academic programmes.
2. Promote close interaction among industry, faculty and students to enrich the learning process and enhance career opportunities for students.
3. Develop state - of - the - art laboratories and other infrastructure commensurate with the need of delivering quality education and research services.
4. Strengthen the Institution through network of alumni and optimize use of resources by leveraging inter - departmental capabilities.
5. Provide opportunities and ensure regular skill. Upgradation of faculty and staff through structured training programmes.

PREAMBLE

Mechanical engineering involves scientific analysis, problem-solving and knowledge integration using appropriate tools to model, design, produce and maintain products or systems containing mechanical elements to meet the desired requirements.

The curriculum revision committee included representation from various engineering institutes, government R&D labs and manufacturing sector. The committee members met multiple times in 2021-2022 to deliberate the curriculum. They studied existing curricula at well-known universities across the world, and had extensive discussions with domain experts representing a wide range of backgrounds and experience.

A brainstorming workshop on 'Future of Mechanical Engineering' organized by IISc Bangalore on 10th July 2021 in the beginning, and Mechanical Engineering Education Leadership Summit organized by ASME India Chapter on 10th March 2022, enabled obtaining and consolidating multiple views.

The revised model curriculum takes into cognizance the prevailing and emerging requirements of the industry and society. It provides a balanced mix of courses related to science, engineering, technology and practice (labs, projects), as well as humanities.

Given the rising importance of electronics, information and communication technology in all aspects of life, the relevant courses have been introduced or strengthened.

Students are provided greater flexibility in electives based on their career aspirations. They can suitably orient themselves toward academics, research, innovation, industry, entrepreneurship or any other direction.

The revised model curriculum is aligned with the New Education Policy, which promotes holistic, experiential and inter-disciplinary education. Hands-on learning, relevant lab experiments and examples from industry have been emphasised.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Programme Educational Objectives (PEO) of the under-graduate programme Bachelor of Technology (B.Tech.) in Mechanical Engineering offered by The Assam Royal Global University, Guwahati-35, Assam are:

No.	PEO
PEO1	Plan, design, construct, maintain and improve mechanical engineering systems that are technically sound, economically feasible and socially acceptable..
PEO2	Apply analytical, computational and experimental techniques to address the challenges faced in mechanical and allied engineering streams.
PEO3	Communicate effectively using conventional platforms as well as innovative / online tools and demonstrate collaboration, networking & entrepreneurial skills

PEO4	Exhibit professionalism, ethical attitude, team spirit and pursue lifelong learning to achieve career, organizational and societal goals
PEO5	To develop problem solving approach using analytical abilities, effective communication skills and team work.
PEO6	To create awareness and understanding related to societal issues, apart from developing a sense of commitment to the community and profession with sincere involvement.

PROGRAMME OUTCOMES (POs)

On successful completion of the under-graduate programme, i.e. B.Tech. in Mechanical Engineering, the Mechanical Engineering graduates will be able to,

No.	POs
PO1	Apply knowledge of mathematics, science and engineering to arrive at solutions.
PO2	Identify, formulate and analyze engineering problems through technical literature.
PO3	Design a component, a process and a system to meet desired needs considering economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
PO4	Conduct experiment, analyze and interpret data to arrive valid conclusions.
PO5	Use the techniques, skills, and modern engineering tools for modeling and prediction of problems by understanding the limitations.
PO6	Recognize the importance of health and safety, societal, cultural responsibility in the design and implementation of engineering projects.
PO7	Know and apply societal and environmental context to engineering solutions for sustainable development.
PO8	Apply the standards and professional ethics in engineering practice.
PO9	Function effectively as a member or leader of a team.
PO10	Express effectively, comprehend and write reports on the engineering activities.
PO11	Apply engineering and management principles to manage projects in multidisciplinary environments.
PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO-1	Apply mechanical and interdisciplinary knowledge to analyze, design and manufacture products to address the needs of the society
PSO-2	Apply state of the art tools and techniques to conceptualize, design and introduce new products, processes, systems and services.

GENERAL COURSE STRUCTURE & THEME

A. Definition of Credit:

1 Hr. Lecture (L) per week	**1 Credit**
1 Hr. Tutorial (T) per week	**1 Credit**
1 Hr. Practical (P) per week	**0.5 Credit**
2 Hours Practical (P) per week	**1 Credit**

B. Range of Credits:

In the light of the fact that a typical Model Four-year Under Graduate degree program in Engineering has about 160 credits, the total number of credits proposed for the four-year B. Tech/B.E. in Mechanical Engineering (Engineering & Technology) is kept as 160.

C. Structure of UG Program in ME:

The structure of UG program in Mechanical Engineering shall have essentially the following categories of courses with the breakup of credits as given:

S.No.	Category	Suggested Breakup of Credits (Total 160)
1	Humanities and Social Sciences including Management courses	12*
2	Basic Science courses	29*
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	27*
4	Professional core courses	58*
5	Professional Elective courses relevant to chosen specialization/branch	9*
6	Open subjects – Electives from other technical and /or emerging subjects	9*
7	Project work, seminar and internship in industry or elsewhere	16*
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)
Total		**160***

Minor variation is allowed as per need of the respective disciplines

STRUCTURE OF THE SYLLABUS FOR A 4 YEAR UG PROGRAMME

FIRST YEAR

SEMESTER I

Sl.No	Course Title	Course code	L	T	P	Credits
1.	Chemistry -I	CHY022C101	3	1	0	4
2	Chemistry Lab	CHY022C111	0	0	2	1
2	Mathematics-I	MAT022C101	3	1	0	4
3	Programming for problem solving	CSE022C104	3	0	2	4
4	Biology For Engineers	MEE022C103	3	0	0	3
5	Manufacturing Practice Workshop	MEE022C115	0	0	4	2
6	Universal Human Values	BHS022A103	2	0	0	2
7	Sports and Yoga/NSS/NCC	CEE022S117	0	0	2	1
Total Credit						21

SEMESTER II

Sl.No	Course Title	Course code	L	T	P	Credits
1.	Physics -I	PHY022C201	3	1	0	4
2	Physics Lab	PHY022C211	0	0	2	1
3	Mathematics-II	MAT022C201	3	1	0	4
4	Basic Electrical Engineering	CSE022C203	2	1	0	3
5	Basic Electrical Engineering Lab	CSE022C215	0	0	2	1
6	Engineering Graphics & Design	CEE022C204	1	0	4	3
7	English For Technical Writing	CEN022A201	2	0	0	2
8	Design Thinking	COD022S216	0	0	2	1
9	IDEA LAB	CEE022S217	0	0	2	1
Total Credit						20

SECOND YEAR

SEMESTER III

Sl.No	Course Title	Course code	L	T	P	Credits
1.	Engineering Thermodynamics	MEE022C301	3	1	0	4
2	Engineering Mechanics	MEE022C302	3	1	0	4
3	Mechanics of Deformable Solids	MEE022C303	3	1	0	4
4	Mathematics-III	MAT022C304	3	0	0	3
5	IKS-I	IKS992K301	2	0	0	2
6	Basic Electronics Engineering	ECE022C306	3	1	0	4
7	Machine Drawing Lab	MEE022C319	1	0	4	3
Total Credit						24
8	Honours (Optional) [to be applied through MOOCS]		3	0	0	3

SEMESTER IV

Sl.No	Course Title	Course code	L	T	P	Credits
1.	Fluid Mechanics & Hydraulic Machines	MEE022C401	3	1	0	4
2	Primary Manufacturing	MEE022C402	3	1	0	4
3	Applied thermodynamics	MEE022C403	3	1	0	4
4	Kinematics of Machines	MEE022C404	3	1	0	4
5	Engineering Materials and Application	MEE022C405	3	1	0	4
6	Fluid Mechanics Machines lab	MEE022C411	0	0	2	1
Total Credit						20
7	Honours (Optional) [to be applied through MOOCS]		3	0	0	3

THIRD YEAR	SEMESTER V						
	Sl.No	**Course Title**	**Course code**	**L**	**T**	**P**	**Credits**
	1.	Machine element and system design	MEE022C501	3	1	0	4
	2	Manufacturing Process	MEE022C502	3	0	0	3
	3	Measurements and Metrology	MEE022C503	3	1	0	4
	4	Heat Transfer and Thermal Machines	MEE022C504	3	1	0	4
	5	Heat Transfer Lab	MEE022C514	0	0	2	1
	6	Robotics & Control	MEE022C506	3	1	0	4
	Total Credit						20
	8	Honours (Optional) [to be applied through MOOCS]		3	0	0	3
	SEMESTER VI						
	Sl.No	**Course Title**	**Course code**	**L**	**T**	**P**	**Credits**
	1.	CAD/CAM	MEE022C601	3	0	2	4
	2	Manufacturing Automation	MEE022C602	3	1	0	4
	3	IC Engine	MEE022C603	3	0	0	3
	4	Dynamics of Machinery	MEE022C604	3	0	0	3
	5	Dynamics of Machinery Lab	MEE022C614	0	0	2	1
	6	Production and Operation Management	MEE022C606	3	0	0	3
	7	Engineering Project-1 (Seminar)	MEE022C617	0	0	0	2
	Total Credit						20
	7	Honours (Optional) [to be applied through MOOCS]		3	0	0	3

FOURTH YEAR	SEMESTER VII						
	Sl.No	**Course Title**	**Course code**	**L**	**T**	**P**	**Credits**
	1.	Product Innovation & Entrepreneurship	MEE022C701	3	0	0	3
	2	Finite Element Analysis (PE1)	MEE022D702	3	0	0	3
	3	Renewable Energy Engineering (PE2)	MEE022D703	3	0	0	3
	4	Additive Manufacturing (OE1)	MEE022O704	3	0	0	3
	5	Composite Materials (OE2)	MEE022O705	3	0	0	3
	6	Internship Evaluation (Seminar)	MEE022C706	0	0	0	5
	7	Engineering Project-2 (Design & Analysis)	MEE022C717	0	0	0	5
	Total Credit						25
	8	Honours (Optional) [to be applied through MOOCS]		3	0	0	3
	SEMESTER VIII						
	Sl.No	**Course Title**	**Course code**	**L**	**T**	**P**	**Credits**
	1	Computational Fluid Dynamics (PE 3)	MEE022D801	3	0	0	3
	2	Refrigeration & Air Conditioning	MEE022C802	3	0	0	3
	3	Automobile Engineering (OE 3)	MEE022O803	3	0	0	3
	4	Engineering Project-3(Prototype)	MEE022C804	0	0	0	8
	Total Credit						17
	7	Honours (Optional) [to be applied through MOOCS]		3	0	0	3
		TOTAL CREDITS (I, II, III, IV, V, VI, VII, VIII):					**168**

DETAILED SYLLABUS OF 1st SEMESTER

Paper I/Subject Name: Chemistry-I		**Subject Code:** CHY022C101
L-T-P-C – 3-1-0-4	**Credit Units:**	**Scheme of Evaluation: TP**

Objective:
The objectives of the course are to s to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field and to understand the new developments and breakthroughs efficiently in engineering and technology.

Prerequisites: Concepts of +2 level Chemistry

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Interpret periodic properties such as ionization potential, electronegativity, oxidation states, electronegativity and bulk properties and processes using thermodynamic considerations	**BT 2**
CO 2	Experiment with major chemical reactions that are used in the synthesis of molecules.	**BT 3**
CO 3	Analyze microscopic chemistry in terms of atomic and molecular orbitals and intermolecular	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Content	Periods
I.	**Atomic and Molecular Structure**	Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field	**16**

II.	**Spectroscopic Techniques and Applications, Intermolecular Forces and Potential Energy Surfaces**	Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.	**17**

		Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.	
III.	**Use of free Energy in Chemical Equilibria and Periodic Properties**	Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and EMF. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams. 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, coordination numbers and geometries, hard soft acids and bases, molecular geometries	**16**

IV.	**Stereochemistry, Organic Reactions and Synthesis of a Drug Molecule**	Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule	**17**
		TOTAL	**66**

Chemistry Lab Syllabus

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 10 Laboratory experiments based on the following-

1. Determination of surface tension and viscosity.
2. Thin layer chromatography.
3. Ion exchange column for removal of hardness of water.
4. Determination of chloride content of water.
5. Colligative properties using freezing point depression.
6. Determination of the rate constant of a reaction.
7. Determination of cell constant and conductance of solutions.
8. Potentiometry - determination of redox potentials and EMFs.
9. Synthesis of a polymer/drug.
10. Saponification/acid value of an oil.
11. Chemical analysis of a salt.
12. Lattice structures and packing of spheres.
13. Models of potential energy surfaces.
14. Chemical oscillations- Iodine clock reaction.
15. Determination of the partition coefficient of a substance between two immiscible liquids.
16. Adsorption of acetic acid by charcoal.
17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	2 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books

- A Textbook of Physical Chemistry, Negi A.S. and Anand S.C., 2nd Edition, 2007, New Age International
- Concise Inorganic Chemistry, Lee J.D., 5th Edition, 2008, John Wiley and Sons Ltd.

Reference Books:

- Atkins, P.W. and Paula, J. De,Physical Chemistry, 10th Edition, 2014, Oxford University Press
- Huheey, J.E. Keiter, E.A. Keiter, R.L Medhi, O.K.,Inorganic Chemistry Principles of Structure and Reactivity, 4th Edition, 2006, Pearson Education

Additional Readings:

- Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition, http://bcs.whfreeman.com/vollhardtschore5e/default.asp
- NPTEL Course on Chemistry - I by Prof. Mangala Sunder Krishnan, IITM

Paper II/Subject Name: Mathematics-II		Subject Code: MAT022C101
L-T-P-C – 3-1-0-4	Credit Units: 04	Scheme of Evaluation: T

Objective:

The objectives of the course are to enable students to achieve conceptual understanding and to retain the best traditions of traditional calculus.

Prerequisites: level Concepts of Mathematics I

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Understand the applications of differential and integral calculus in different fields of Engineering.	**BT 2**
CO 2	Apply the single and multivariable differential and Integral calculus in engineering problems.	**BT 3**
CO 3	Analyze and assess the patterns in series	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	Matrices	Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.	**15**
II.	First order ordinary differential equations & Ordinary differential equations of higher orders	Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.	**15**

III.	Complex Variable – Differentiation:	Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	**15**
IV	Complex Variable – Integration:	Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.	**15**
		TOTAL	**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3*20 NCH = 60 NCH	1*30 NCH = 30 NCH	30 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Books:

1. A text book of Engineering Mathematics, Bali N. P. and Narayan Iyenger N., 9th Edition, 2016, Laxmi Publication.
2. Mathematical Methods for Physics and Engineering: A Comprehensive Guide, K. F. Riley, M. P. Hobson, 3rd Edition, 2006, Cambridge University Press
3. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
4. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.

Reference Books:

1. Grewal B. S., Higher Engineering Mathematics, 43rd Edition, 2014, Khanna Publishers.
2. Das B. C. & Mukherjee B. N., Differential Calculus, 55th Edition, U. N. Dhur & Sons Pvt. Ltd.
3. Das B. C. & Mukherjee B. N, Integral Calculus, 57th Edition, U. N. Dhur & Sons Pvt. Ltd
4. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
7. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
8. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
9. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
10. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.

Additional Readings:

1. https://mrcet.com/downloads/digital_notes/HS/Mathematics-I.
2. https://www.vidyalankar.org/gate/assets/docs/notes/maths.pdf

Paper III/Subject Name: Fundamentals of Programming		Subject Code: CSE022C104
L-T-P-C – 3-0-2-4	Credit Units:	Scheme of Evaluation: TP

Objective:

The objectives of the course are to make the students capable of using C programming to solve basic as well as advanced computing problems.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Demonstrate the working of C programming language.	BT 2
CO 2	Apply the programming concepts to solve various problems.	BT 3
CO 3	Analyze and debug the errors while writing the programs.	BT 4
CO 4	Assess and design a new algorithm to solve a new real life problem.	BT 5

Detailed Syllabus:

Modules	Topics	Course content	Hours
I	**Fundamentals of Programming**	Introduction to Programming; Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.	**15**
II	**Expressions, Conditional Operators and Loops**	Arithmetic expressions and precedence. Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops. Arrays, Arrays (1-D, 2-D), Character arrays and Strings	**15**

III	**Functions, Recursion, Sorting**	Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required). Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference. Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort	**15**
IV	**Advanced Programming Concepts using C**	Structures, Defining structures and Array of Structures, Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling.	**15**
TOTAL			**60**

Programming for Problem Solving Lab Syllabus

Detailed Syllabus:

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 20 Laboratory experiments based on the following-

1. Character set, Tokens, Keywords and Identifiers, Constants, variables, data types, statements, comments, declaration of storage class, assigning values to variables.
2. Managing I/O, reading and writing characters, formatted Input/output.
3. Arithmetic operators, relational operators, logical operators, assignment operators, increment s decrement operators, conditional operators, bitwise operators, special operators.
4. Importance of decision making, decision making with if statement, if-else statement, nested if-else statements, switch-case statement.
5. Importance of iterative statements, the while statement, do-while statement, for statement, nested for looping.
6. Significance of Arrays, creation and use of one s two-dimensional arrays
7. Declaration and use of string variables, reading and writing strings.
8. Benefits of user-defined functions, creation and use of user-defined functions, parameter passing, return types.
9. Use of Pointers, declaration s initialization of pointer variables, accessing a variable through its pointer.
10. Defining, opening s closing files in C.

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3*20 NCH = 60 NCH	1*30 NCH = 30 NCH	30 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Book:

1. *Computer Fundamentals and Programming in C*, Reema Thareja, 2nd Edition, 2016, Oxford University Press, Delhi.

Reference Books:

1. E Balaguruswamy, *Computing Fundamentals and C Programming*, 1st Edition, 2017, McGraw Hill.
2. Venugopal and Prasad, *Mastering C*, 2nd Edition, 2017, Tata McGraw Hill.
3. Yashawant Kanetkar,*Let us C*, 15th Edition, 2017, BPB.

Additional Readings:

1. https://mrcet.com/downloads/digital_notes/HS/Programming%20for%20Problem%20Solving.pdf
2. NPTEL course on Introduction to Programming in C by Prof. Satyadev Nandakumar, IIT, Kanpur
3. NPTEL course on Problem Solving Through Programming in C by Prof. Anupam Basu, IIT, Kharagpur

Paper IV /Subject Name: Biology for Engineers		Subject Code: MEE022C103
L-T-P-C – 3-0-0-3	Credit Units: 03	Scheme of Evaluation: T

Objective:

The objectives of the course are to familiarize the students with the basic biological concepts and their engineering applications and provide an appreciation of how biological systems can be re-designed as substitute products for natural systems.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Demonstrate** the basic biological concepts via relevant industrial applications and case studies.	**BT 2**
CO 2	**Apply** the concepts of biomimetics for specific requirements.	**BT 3**
CO 3	**Assess** the principles of design and development, for exploring novel bioengineering projects.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course content	Hours
I	**Biomolecules and their Applications**	Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid16, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).	**15**
II	**Human Organ Systems and Bio Designs**	Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease).Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye).Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine).Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems). Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis).	**15**

III	**Nature-Bioinspired Materials and Mechanisms**	Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).	**15**
IV	**Trends In Bioengineering**	Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Selfhealing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic).	**15**
		TOTAL	**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3*20 NCH = 60 NCH	-	30 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Book:

1. *Biology for Engineers*, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., 2012, Tata McGraw-Hill, New Delhi,
2. *Biology for Engineers*, Arthur T. Johnson, 2nd Edition, 2018, CRC Press

Reference Books:

1. Sohini Singh and Tanu Allen, *Biology for Engineers*, 2014, Vayu Education of India, New Delhi
2. Yoseph Bar-Cohen, *Biomimetics: Nature-Based Innovation*, 1st Edition, 2012, CRC Press

Additional Readings:

1. https://www.studocu.com/in/document/aryabhatta-knowledge-university/btechit-btechcse/biology-notes-for-engineers/61016774
2. https://www.aminotes.com/2017/02/biology-for-engineers-module-1-cocepts.html
3. https://topperworld.in/b-tech-biology-notes/

Paper V/Subject Name: Manufacturing Practices Workshop		Subject Code: MEE022C115
L-T-P-C – 0-0-4-2	**Credit Units: 02**	**Scheme of Evaluation: P**

Objective:

The objectives of the course are to provide exposure to the students with hands-on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the different manufacturing processes which are commonly employed in the industry	**BT 2**
CO 2	**Utilize** tools, instruments and techniques learnt to perform basic household chores in terms of house wiring, carpentry etc	**BT 3**
CO 3	**Experiment** using the tools and techniques learnt for various purposes and decide on the best prospect.	**BT 4**

Detailed Syllabus:

Total Lab Hours for the semester = 40 (4 hours per week)

Minimum 10 Laboratory experiments based on the following-

The lecture sessions will be on the following topics:

- Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
- CNC machining, Additive manufacturing.
- Fitting operations s power tools.
- Electrical s Electronics.
- Carpentry.
- Plastic moulding, glass cutting.
- Metal casting.
- Welding (arc welding s gas welding), brazing g topics:

And the lab sessions will on the topics:

- Machine shop
- Fitting shop
- Carpentry
- Electrical s Electronics
- Welding shop (Arc welding + Gas welding)
- Casting
- Smithy
- Plastic moulding s Glass Cutting

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
-	2*20 NCH = 40 NCH	20 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Books:

1. Elements of Workshop Technology, Hajra Choudhury, S K, Hajra Choudhury, A K, 14th Edition, 2007, Mumbai Media Promoters
2. Manufacturing Technology – I, Gowri P. Hariharan and A. Suresh Babu, 2008, Pearson Education.

Reference Books:

1. Roy A. Lindberg, Processes and Materials of Manufacture", 4th Edition, 1668, Prentice Hall India,

Additional Readings:

1. http://mm- coep.vlabs.ac.in/LaserSpotWelding/Theory.html?domain=Mechanical%20Engineeringslab=Welcome%20to%20Micromachining%20laboratory
2. http://fab-coep.vlabs.ac.in/exp7/Theory.html?domain=Mechanical%20Engineeringslab=Welcome%20to%20FAB%20laboratory

Paper VI/Subject Name: Universal Human Values		Subject Code: BHS022A103
L-T-P-C – 2-0-0-2	Credit Units: 02	Scheme of Evaluation: T

Objective:

The objectives of the course are to help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the importance of following the basic universal human values.	**BT 2**
CO 2	**Apply** the holistic understanding in one's day-today life so as to keep oneself happy and to socialize with nature, society, etc	**BT 3**

Detailed Syllabus:

Modules	Topics	Course content	Periods
I	**Value Education**	Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Sharing about Oneself, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Exploring Human Consciousness, Happiness and Prosperity – Current Scenario, Lectured, Method to fulfil the Basic Human Aspirations, Exploring Natural Acceptance	**11**
II	**Harmony in Human Being**	Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, Exploring the difference of Needs of Self and Body, The Body as an Instrument of the Self Understanding Harmony in the Self, Exploring Sources of Imagination in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health, Exploring Harmony of Self with the Body	**11**
III	**Harmony in the Family s Society**	Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship", Exploring the Feeling of Trust, 'Respect' – as the Right Evaluation, Exploring the Feeling of Respect, Other Feelings, Justice in Human-to- Human Relationship Understanding Harmony in the Society, Vision for the Universal Human Order, Exploring Systems to fulfil Human Goal	**11**

IV	**Harmony in Nature s Implications of Holistic Understanding**	Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Exploring the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence, Exploring Co-existence in Existence Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, Exploring Ethical Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Exploring Humanistic Models in Education, Holistic Technologies, Production Systems and Management Models- Typical Case Studies, Strategies for Transition towards Value- based Life and Profession Exploring Steps of Transition towards Universal Human Order	**11**
		TOTAL	**44**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
2 * 22 NCH = 44 NCH	-	8 * 2 NCH = 16 NCH (Seminar, Case Study, Discussion, Internship)

Text Books:

1. *A Foundation Course in Human Values and Professional Ethics,* R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi

Reference Books:

1. *Human Values*, A.N. Tripathi, 3rd Edition, 2016, New Age Intl. Publishers, New Delhi,

Additional Readings:

1. https://uhv.org.in/uhv2notes
2. https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php

Paper VII/Subject Name: Sports and Yoga		Subject Code: CEE022S117
L-T-P-C – 0-0-2-1	Credit Units: 01	Scheme of Evaluation: P

Objective:

The objectives of the course are to make the students understand the importance of sound health and fitness principles as they relate to better health, to expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness and to develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination	**BT 2**
CO 2	**Experiment with** different forms of yoga to keep oneself physically fit and mentally strong	**BT 3**
CO 3	**Assess** current personal fitness levels	**BT 4**

Detailed Syllabus:

Modules	Topics	Course content	Periods
I	**Physical Education, Olympic Movement, Fitness, Wellness s Lifestyle**	Meaning s definition of Physical Education. Aims s Objectives of Physical Education. Changing trends in Physical Education, Ancient s Modern Olympics (Summer s Winter), Olympic Symbols, Ideals, Objectives s Values, Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc., Meaning s Importance of Physical Fitness s Wellness, Components of Physical fitness, o Components of Health-related fitness, Components of wellness, Preventing Health Threats through Lifestyle Change, Concept of Positive Lifestyle.	**5**

II	**Anatomy s Physiology in Physical Education, Sports,** **Yoga s Postures**	Define Anatomy, Physiology s Its Importance, ffect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.), Meaning s Importance of Kinesiology s Biomechanics in Physical Edu. s Sports, o Newton's Law of Motion s its application in sports. o Friction and its effects in Sports, Meaning and Concept of Postures, Causes of Bad Posture. Advantages s disadvantages of weight training. Concept s advantages of Correct Posture. Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis. Corrective Measures for Postural Deformities	**5**

III	**Yoga s Lifestyle**	Meaning s Importance of Yoga, Elements of Yoga, Asanas, Pranayama, Meditation s Yogic Kriyas, yoga for concentration s related Asanas (Sukhasana; Tadasana; Padmasana s Shashankasana) Relaxation Techniques for improving concentration - Yog-nidra, Asanas as preventive measures. Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana. Obesity: Procedure, Benefits s contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana. Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana. Diabetes: Procedure, Benefits s contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana. Asthema: Procedure, Benefits s contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.	**5**
IV	**Training, Planning and Psychology in Sports**	Meaning of Training, Warming up and limbering down, Skill, Technique s Style, Meaning and Objectives of Planning. Tournament – Knock-Out, League/Round Robin s Combination. Definition s Importance of Psychology in Physical Edu. s Sports, Define s Differentiate Between Growth s Development, Adolescent Problems s Their Management, Emotion: Concept, Type s Controlling of emotions, Meaning, Concept s Types of Aggressions in Sports. Psychological benefits of exercise. Anxiety s Fear and its effects on Sports Performance. Motivation, its type s techniques. Understanding Stress s Coping Strategies	**5**
		TOTAL	**20**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
	1*20 NCH = 20 NCH	10 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Books:

1. *Modern Trends and Physical Education*, Ajmer Singh, Gill J.S, Bains J, 4th Edition, 2012, Kalyani Publishers

Reference Books:

1. B.K.S. Iyengar, *Light on Yoga*, 2006, Thorsons

DETAILED SYLLABUS OF 2ND SEMESTER

Paper I/Subject Name: Physics-1		Subject Code: PHY022C201
L-T-P-C – 3-1-0-4	Credit Units: 04	Scheme of Evaluation: TP

Objective:

The objectives of the course are to make the students enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology

Prerequisites: Concepts of Physics of +2 level

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the basic concepts of Physics	**BT 2**
CO 2	**Identify** the applications of Physics in technical field.	**BT 3**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Classical Mechanics and Dynamics**	Transformation of scalars and vectors under Rotation transformation; Forces in Nature; Newton's laws and its completeness in describing particle motion; Form invariance of Newton's Second Law; Solving Newton's equations of motion in polar coordinates; Problems including constraints and friction; Extension to cylindrical and spherical coordinates. Potential energy function; F = - Grad V, equipotential surfaces and meaning of gradient; Conservative and non- conservative forces, curl of a force field; Central forces; Conservation of Angular Momentum; Energy equation and energy diagrams; Elliptical, parabolic and hyperbolic orbits; Kepler problem; Application: Satellite manoeuvres.	**17**
II.	**Advanced Dynamics and Oscillatory Motion**	Non-inertial frames of reference; Rotating coordinate system: Five-term acceleration formula. Centripetal and Coriolis accelerations; Applications: Weather systems, Foucault pendulum; Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly- damped oscillators; Forced oscillations and resonance.	**16**
III.	**Rigid Body Dynamics and Kinematics**	Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.	**16**

IV	**Advanced Rigid Body Dynamics: Three-Dimensional Motion**	Introduction to three-dimensional rigid body motion — only need to highlight the distinction from two- dimensional motion in terms of (a) Angular velocity vector, and its rate of change and (b) Moment of inertia tensor; Three-dimensional motion of a rigid body wherein all points move in a coplanar manner: e.g. Rod executing conical motion with center of mass fixed — only need to show that this motion looks two-dimensional but is three-dimensional, and two-dimensional formulation fails.	**17**
		TOTAL	**66**

Physics Lab Syllabus

Detailed Syllabus:

Experiment	Experiment Title	Lab Hours
I	Determination of Moment of Inertia of a given solid about its own axis by using M.I.Table	2
II	Determination of Young's Modulus using Searle's Apparatus	2
III	Determination of Rigidity of Modulus of the material of the given rod by Statiscal method	2
IV	Determination of Powers of Given lenses using an Optical Bench i. Concave Lens, ii Convex Lens	2
V	Determination of Resistance of a Galvanometer using Post Office Box.	2
VI	To determine the mechanical equivalent of heat by Joule's calorimeter	2
VII	Determination of ratio of E.M.F of two cells using Potentiometer.	2
VIII	To determination of the focal length of a convex mirror with the help of an auxiliary lens.	2
IX	Determination of Horizontal Components of Earth's Magnetic field using Magnetometer	2
X	Determination of coefficient of Viscosity of water by Capillary Flow Method	2

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	2 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. Engineering Mechanics, 2nd ed. – D.S. Bedi, M.P. Poonia
2. Basic Mechanical Engineering – S.C. Sharma, M.P. Poonia
3. Engineering Mechanics, 2nd ed. — MK Harbola
4. Introduction to Mechanics — MK Verma
5. An Introduction to Mechanics — D Kleppner & R Kolenkow
6. Principles of Mechanics — JL Synge & BA Griffiths
7. Mechanics — JP Den Hartog
8. Engineering Mechanics - Dynamics, 7th ed. - JL Meriam
9. Mechanical Vibrations — JP Den Hartog
10. Theory of Vibrations with Applications — WT Thomson

Reference Books:

1. Singh A.K. and Malik Hitendra Engineering Physics, 2nd Edition, 2016, McGraw Hill Education Private Limited. New Delhi.
2. Gaur R.K and Gupta S.L, Engineering Physics, 2015, Dhanpat Rai publication, New Delhi.
3. Arthur Beiser, Shobhit Mahajan, S. Rai. Choudhury, Concept of Modern physics, 6th Edition, 2006, McGraw-Hill education Private limited. New Delhi.
4. M Ghosh s D Bhattacharya, A Textbook of Oscillations, Waves and Acoustics, 5th Edition, 2016, S. Chand publication.

Additional Readings

1. https://www.griet.ac.in/nodes/Engineering%20Physics%20Notes.pdf
2. https://mrcet.com/downloads/digital_notes/HS/R20/Engineering%20Physics.pdf
3. NPTEL Course on Introduction To Electromagnetic Theory by Prof. Manoj Harbola, IIT Kanpur
4. NPTEL Course on Engineering Mechanics by Prof. Manoj Harbola, IIT Kanpur

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	ENGINEERING MECHANICS	PROF. MANOJ HARBOLA	IIT KANPUR

Paper II/Subject Name: Mathematics II		Subject Code: MAT022C201
L-T-P-C – 3-1-0-4	Credit Units: 04	Scheme of Evaluation: T

Objective:

The objectives of the course are to teach the students Mathematics fundamentals necessary to formulate, solve and analyze engineering problems

Prerequisites: Concepts of Mathematics of +2 level

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** essential tool of calculus, multivariate differentiation and integration.	**BT 2**
CO 2	**Utilize** the essential tools in the field of applied sciences and related fields.	**BT 3**
CO 3	**Analyze** and **evaluate** the qualitative behavior of solutions of systems of differential equations and interpret in the context of an underlying model.	**BT 4 s 5**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I	**Basic Calculus:**	Curvature, evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's Theorem, Mean value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L'Hospital's rule.	**10**
II	**Sequences and Series:**	Limits of sequence of numbers, Calculation of limits, Infinite series; Tests for convergence; Power series, Taylor and Maclaurin series; Taylor theorem, convergence of Taylor series, error estimates.	**20**
III	**Multivariable Calculus (Differentiation):**	Limit, continuity and partial derivatives, directional derivatives, gradient, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.	**10**

IV	**Multivariable Calculus (Integration):**	Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Gradient, curl and divergence, Theorems of Green, Gauss and Stokes.	**20**
TOTAL			**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4 * 15 NCH = 60 NCH	2 * 15 NCH = 30 NCH	8 * 4 NCH = 32 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
2. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
3. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 6th Edition, Pearson, Reprint, 2002.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 6th Edition, John Wiley s Sons, 2006.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
6. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
7. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
8. A text book of Engineering Mathematics, Bali N. P. and Narayan Iyenger N., 6th Edition, 2016, Laxmi Publication.
9. Mathematical Methods for Physics and Engineering: A Comprehensive Guide, K. F. Riley, M. P. Hobson, 3rd Edition, 2006, Cambridge University Press

Reference Books:

1. Grewal B. S., *Higher Engineering Mathematics,* 43rd Edition, 2014, Khanna Publishers.
2. Raisinghania M.D., *Ordinary and Partial Differential Equations*, 17th Edition, 2014, S. Chand and Co., New Delhi.
3. Narayna S., *A Text Book of Vector Calculus*, Revised Edition, 2006, S. Chand s Co., New Delhi.

Additional Readings:

1. https://mrcet.com/downloads/digital_notes/HS/R-18%20Mathematics-II.pdf
2. http://www.bosecuttack.in/studentcorner/LECTURE_NOTE.MATH2.2ND_SEM__1_.pdf
3. https://www.srividyaengg.ac.in/coursematerial/Iyear/111223.pdf

Paper III/Subject Basic Electrical Engineering		Subject Code: CSE022C203
L-T-P-C – 2-1-0-3	Credit Units: 03	Scheme of Evaluation: TP

Objective:

The objectives of the course are to make students understand the basic electrical terminologies and familiarize them with the basic concepts of D.C., single-phase and three-phase A.C. networks.

Prerequisites: Basic concepts of D.C. networks of Class XII, Electromagnetic Induction and A.C. Fundamentals etc.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the concept behind basic electric and magnetic circuits.	**BT 2**
CO 2	**Apply** the working principles of electrical machines and power converters in real-life.	**BT 3**

Detailed Syllabus:

Modules	Topic	Course Content	Hours
I.	**DC Circuits**	D. C. Circuits covering, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields	**12**
II.	**AC Circuits**	Single Phase A.C. Circuits covering, Generation of sinusoidal voltage-definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits; Three Phase A.C. Circuits covering, Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;	**12**

III.	**Electrical Machines:**	Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation; working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor	**12**
IV.	**Electrical Installations:**	Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter. Sources of Electrical Power covering, Introduction to Wind, Solar, Fuel cell, Tidal, Geothermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation;	**12**
		TOTAL	**48**

Basic Electrical Engineering Lab Syllabus

Total Lab Hours for the semester = 30 (2 hours per week)

Minimum 10 Laboratory experiments based on the following-

Lab	Experiments	Hours
I	To verify Thevenin's Theorem for DC network	**2**
II	To verify Maximum Power Transfer Theorem for DC network	**2**
III	Study of R-L-C Series circuit and determine R,L,C, cos Φ,P and Q and draw the phasor diagram	**2**
IV	Study of R-L-C Parallel circuit and determine R,L,C,cos Φ,P and Q and draw the phasor diagram	**2**
V	Calibration of a milli-ammeter as a voltmeter.	**2**
VI	To determine the ohmic and effective resistance (armature winding)	**2**
VII	To study the characteristics of a filament lamp	**2**
VIII	To measure the power in a single-phase load using one wattmeter	**2**
IX	To measure the insulation resistance using Megger	**2**
X	Demonstration of house wiring	**2**
	TOTAL	**20**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 22 NCH = 66 NCH	2 * 15 NCH = 30 NCH	8 * 3 NCH = 24 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

1. A Text Book of Electrical Technology, Thereja, B.L., 1st Edition revised, 2008, S Chand s Company Ltd. Ram Nagar; New Delhi.
2. Basic Electrical Engineering, D. P. Kothari, I. J.Nagrath, 3rd Edition, 2006, Tata McGraw-Hill

Reference Books:

1. D. C. Kulshreshtha, *Basic Electrical Engineering*, 1st Edition, 2006, McGraw-Hill
2. E. Hughes, *Electrical and Electronics Technology*, 10th Edition, 2011, Pearson Publication

Additional Readings:

1. https://mrcet.com/downloads/digital_notes/HS/Basic%20Electrical%20Engineering%20R-20.pdf
2. https://www.cet.edu.in/noticefiles/231_BASIC_ELECTRICAL_ENGG-min.pdf
3. NPTEL Course on Basic Electrical Circuits by Prof. Nagendra Krishnapura, IITM
4. NPTEL Course on Fundamentals of Electrical Engineering by Prof. Debapriya Das, IIT, Kharagpur

Paper IV/Subject Name: Engineering Graphics & Design		Subject Code: CEE022C204
L-T-P-C – 1-0-4-3	Credit Units: 03	Scheme of Evaluation: TP

Objective:

The objectives of the course are to make students understand the process of drawing projections and sections and basic engineering drawing formats and to convert sketches to engineered drawings.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the dimension and figures using the drawing instruments and acquire visualisation skills, projection of points, etc.	**BT 2**
CO 2	**Utilize** engineering curves in tracing the paths of simple machine components.	**BT 3**
CO 3	**Analyse** and assess sketches to convert them to engineered drawings.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Introduction and Projections**	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; Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes; Covering 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	**11**
II.	**Angular Solids and Isometric Projections**	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). 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;	**11**

III.	**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 (Background, 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 erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]. Consisting of set up of the drawing page and the printer, including scale settings, setting up of Modules and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles.	**11**
IV	**Customisation and CAD drawing**	Covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computeraided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;	**11**
		TOTAL	**44**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
2 * 22 NCH = 44 NCH	4 * 15 NCH = 60 NCH	8 * 2 NCH = 16 NCH (Problem Solving, Seminar, Case Study, Discussion, Internship, Projects)

Text Books:

- Engineering Drawing; Bhatt, N.D, 53rd Edition, 2016, Charotar Publishing House

Reference Books:

- Jolhe Dhananjay A; Engineering drawing, 5th Edition, 2010, Tata McGraw-Hill Education Pvt. Ltd., New Delhi

Additional Readings:

https://mrcet.com/downloads/digital_notes/HS/Engineering%20Graphics%20Manual%20final.pdf
https://www.pvpsiddhartha.ac.in/autonomus14/1-1/it/IT1L3.pdf
NPTEL Course on Engineering Drawing and Computer Graphics by Prof. Rajaram Lakkaraju, IIT, Kharagpur
NPTEL Course on Engineering Graphics by Prof. Nihar Ranjan Patra, IIT, Kanpur

Paper V/Subject Name: English for Technical Writing		Subject Code: CEN022A201
L-T-P-C – 2-0-0-2	Credit Units: 02	Scheme of Evaluation: T

Objective:

The objectives of the course are to provide learning environment to practice listening, speaking, reading and writing skills, to assist the students to carry on the tasks and activities through guided instructions and materials and to effectively integrate English language learning with employability skills and training.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** basic proficiency in English.	**BT 2**
CO 2	**Develop** reading and listening comprehension, writing and speaking skills.	**BT 3**

Detailed Syllabus:

Modules	Topics	Course content	Hours
I	Vocabulary Building	The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Synonyms, antonyms, and standard abbreviations.	10
II	Basic Writing Skills	Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, creating coherence, organizing principles of paragraphs in documents, Techniques for writing precisely, Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés	10
III	Writing Practices	Nature and Style of sensible Writing, Describing, Defining 1.3. Classifying, providing examples or evidence, Writing introduction and conclusion, Comprehension, Précis Writing, Essay Writing.	10
IV	Oral Communication	Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentations	10
TOTAL			40

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
2*20 NCH = 40 NCH	-	20 NCH (Problem Solving, Internship, Seminar, Case Study, Discussion)

Text Book:

- Effective Communication Skills. Kul Bhushan Kumar, 2022, Khanna Book Publishing
- Practical English Usage, Michael Swan. 1665, OUP

Reference Books:

- F.T. Wood, Remedial English Grammar., 2007, Macmillan.
- William Zinsser, On Writing Well, 2001, Harper Resource Book.
- Liz Hamp-Lyons and Ben Heasly, Study Writing, 2006,
- Sanjay Kumar and PushpLata, Communication Skills, 2011, Oxford University Press.

Additional Readings:

- AICTE's Prescribed Textbook: English (with Lab Manual), Khanna Book Publishing Co., https://khannabooks.com/index.php?route=product/productspath=66_105sproduct_id=480
- NPTEL Course on English Language for Competitive Exams by Prof. by Aysha Iqbal, IIT, Madras
- NPTEL Course on Technical English for Engineers by Prof. by Aysha Iqbal, IIT, Madras

Paper VI/Subject Name: Design Thinking		Subject Code: COD022S216
L-T-P-C – 0-0-2- 1	Credit Units: 01	Scheme of Evaluation: P

Objective:

The objectives of the course are to provide the students with new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products which are useful for a student in preparing for an engineering career.

Prerequisites: None

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Compare** and **classify** the various learning styles and memory techniques	**BT 2**
CO 2	**Develop** new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products	**BT 3**
CO 3	**Analyze** emotional experience and inspect emotional expressions to better understand users while designing innovative products	**BT 4**
CO 4	**Perceive** individual differences and its impact on everyday decisions and further Create a better customer experience	**BT 5**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Insight to Learning, Remembering Memory and Emotions**	Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting. Understanding the Memory process, Problems in retention, Memory enhancement techniques. Understanding Emotions: Experience s Expression, Assessing Empathy, Application with Peers	**05**
II.	**Basis of Design Thinking**	Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts s Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test. Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving	**05**
III.	**Process of Prototype Design s Testing**	Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design. What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing. Understanding Individual differences s Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences	**06**

IV	**Customer-Centric Design, Feedback, Re-Design s Re-Create**	Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design. Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping s testing, final product, Final Presentation – "Solving Practical Engineering Problem through Innovative Product Design s Creative Solution"	**06**
		TOTAL	**22**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
	1 * 22 NCH = 22 NCH	8 * 1 NCH = 8 NCH (Seminar, Case Study, Discussion, Internship)

Text Books:

1. Developing Thinking Skills (The Way to Success), E. Balaguruswamy, 1st Edition, 2022, Khanna Publishing House
2. Design Thinking for Engineering: A practical guide; Iñigo Cuiñas, Manuel José Fernández Iglesias, 2023, Institution of Engineering and Technology
3. Design Thinking For Strategic Innovation: What They Can't Teach You at Business or Design School, Idris Mootee, 1st Edition, 2014, Adams Media

Reference Books:

1. Christian Müller-Roterberg; *Design Thinking For Dummies*, 1st Edition, 2020, For Dummies
2. *A Text Book of DESIGN THINKING For B.TECH. 4th Year, Semester-VII, Suitable For All The 4th Year B- Tech Students*

Additional Reading:

1. https://www.tutorialspoint.com/hi/design_thinking/design_thinking_tutorial.pdf

Paper VII/Subject Name: IDEA Lab Workshop		Subject Code: CEE022S217
L-T-P-C – 0-0-2-1	Credit Units: 01	Scheme of Evaluation: P

Objective:

The objectives of the course are to spread the culture of innovation among students, s other stakeholders, to motivate students to ideate and pursue creativity and to train students to become imaginative, creative, and capable of converting their ideas into prototypes.

Prerequisites: None

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the utility of the IDEA lab	**BT 2**
CO 2	**Apply** the concepts learnt to develop and innovate	**BT 3**

Detailed Syllabus:

The theory component will include the following:

- Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub.
- Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.
- Introduction to basic hand tools - Tape measure, combination square, Vernier calliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives
- Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits
- Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output)
- Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.
- Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc. Basic welding and brazing and other joining techniques for assembly. Concept of Lab aboard a Box.
- Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging.

- 3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering. Prototyping using subtractive cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers. Basics of IPR and patents; Accessing and utilizing patent information in IDEA Lab

Total Lab Hours for the semester = 22 (2 hours per week) Minimum 08

Laboratory experiments based on the following-

1. Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2. Machining of 3D geometry on soft material such as soft wood or modelling wax.
3. 3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4. 2D profile cutting of press fit box/casing in acrylic (3 or 6mm thickness)/cardboard, MDF (2 mm) board using laser cutter s engraver.
5. 2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6. Familiarity and use of welding equipment.
7. Familiarity and use of normal and wood lathe.
8. Embedded programming using Arduino and/or Raspberry Pi
9. Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
-	1 * 22 NCH = 22 NCH	8 * 1 NCH = 8 NCH (Seminar, Case Study, Discussion, Internship)

Text/ Reference Books

1. Chris Hackett, *The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects*, Reprint Edition, 2018, Weldon Owen
2. Paul Horowitz, Winfield Hill, *The Art of Electronics*, 3rd Edition, 2015, Cambridge University Press
3. Simon Monk, *Programming Arduino: Getting Started with Sketches*, 2nd Edition, 2016, McGraw Hill TABH
4. Simon Monk, *Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards*, 2014, McGraw Hill Education
5. Scott Chacon, Ben Straub, *Pro Git*, 2nd Edition, 2014, APress
6. Chapman W.A.J, *Workshop Technology*, 5th Edition, 2002, CBS Publishers and distributors

Additional Reading:

1. https://www.aicte-india.org/sites/default/files/IDC/idealab/AICTE%20-%20IDEA%20LAB%20User%20Manual.pdf
2. https://vignaniit.edu.in/ideaLab.php

DETAILED SYLLABUS OF 3rd SEMESTER

Paper I/Subject Name: Engineering Thermodynamics		**Subject Code: MEE022C301**
L-T-P-C – 3-1-0-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective: The objective of this course is to equip students with a fundamental understanding of thermodynamic principles, including work and heat interactions, energy balance in systems, and the application of the First Law to various energy conversion devices. Students will learn to evaluate changes in the properties of substances during different thermodynamic processes and gain insights into the distinction between high-grade and low-grade energy. Additionally, the course will highlight the limitations imposed by the Second Law of Thermodynamics on energy conversion, fostering a comprehensive perspective on energy utilization and efficiency.

Prerequisites: Concepts of +2 level Physics & Chemistry

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**understand** the fundamental concepts of thermodynamics by explaining work and heat interactions, system properties, and the laws governing energy transfer	**BT 2**
CO 2	**apply** the First and Second Laws of Thermodynamics to analyze energy conversion devices such as engines, turbines, and refrigerators,	**BT 3**
CO 3	**evaluate** the thermodynamic properties of substances using property tables, equations of state, and phase diagrams to determine changes in	**BT4**
CO 4	**differentiate** between high-grade and low-grade energy and assess the limitations of energy conversion based on entropy and irreversibility in real-world applications	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Hours
I.	**Introduction** : Role of Thermodynamics in Engineering and Science , Applications of Thermodynamics : Power Generation, Thermal Environment Control, Cooling of Electrical Systems and Electronic Devices, Analysis of Manufacturing Processes. **Basic Definitions and Units**- System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependenceof 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 & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.	**15**
II.	**Pure substance**: Definition of Pure Substance -- Facts about Pure Substances -- Vapor -- liquid -- solid Phase Equilibrium -- Equation of State for the Vapor Phase : Simple substance, Ideal Gas Characterization, Ideal Gas Equation, Compressibility Effects and Resulting Equations of State -- Real Gases. Definitions of saturated states; P-v-T surface; Use of steam tables: Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.	**15**
III.	**Heat and Work**: Definition of Thermodynamic Work -- Units for Work -- Forms of Work – Definition of Heat -- Inter Convertibility of Heat/work into Work/heat -- Governing Principles -- Sign Convention. **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 **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.	**15**
IV.	**Entropy :** 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; Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles. **Exergy Analysis** Definition of Exergy -- Exergy Analysis of System and Control volume -- Exergetic efficiency **Analysis of Power Generation Cycles** :Air-standard Power Cycles -- Concept -- Carnot Cycle -- Otto Cycles -- Diesel Cycle -- Dual Cycle -- Brayton Cycle -- Efficiency and Mean Effective Pressure and Temperature Vapor Power Cycles -- Concept -- Carnot Cycle -- The Rankine Cycle -- Effect of Temperature and Pressure on The Rankine Cycle -- The Superheat Cycle --The Reheat Cycle -- The Regenerative Cycle -- Deviation of Actual Cycle from Ideal Cycle.	**15**
Total		**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4 * 15 NCH = 60 NCH		8 * 4 NCH = 32 NCH (Problem Solving, Assignments, Quiz, Presentation, Case Study, Discussion)

Text Books:

1. Cengel and Boles, Fundamentals of Thermodynamics, 4th edition, 2001, Tata McGraw HillPublication
2. P K Nag, Engineering Thermodynamics, 6th edition, 2017, McGraw Hill Education
3. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., Fundamentals of Thermodynamics, 6thEdition, 2003, John Wiley and Sons.
4. Moran, M. J. and Shapiro, H. N., 1999, Fundamental of Engineering Thermodynamic, John Wileyand Sons.

Alternative NPTEL/SWAYAM Course

S.No.	NPTEL Course Name	Instructor	Host Institute
1	ENGINEERING THERMODYNAMICS	PROF. V. BABU	IIT MADRAS

Paper II/Subject Name: Engineering Mechanics		**Subject Code: MEE022C302**
L-T-P-C – 3-1-0-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

The objective of this course is to introduce the concepts of Engineering Mechanics useful in Mechanical Engineering applications. The course helps to develop an understanding of the concept of moment of forces and its application. It helps to understand concepts of concepts of Equilibrium of rigid bodies.

Prerequisites: High School

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**introduce** the fundamentals of forces and their effects with their governing laws.	Understand (BT2)
CO 2	**solve** trusses, frames for finding member forces and apply principles of equilibrium to forces in space.	Solve (BT3)
CO 3	**apply** various methods of area moment of inertia, Moment of inertia of plane sections from first principles, Theorems of moment of inertia.	Apply (BT3)
CO 4	**determine** virtual displacements, principle of virtual work for particle and ideal system.	Determine (BT3)

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I.	**Equilibrium of System of Forces**	Force Systems Basic concepts, equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant-Moment of Forces and its Application; Couples and Resultant of Force System. Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy	**15**

II.	**Analysis Of Structure**	Two force members, Analysis of plane trusses by Method of joints Analysis of plane trusses by method of section, Analysis of plane frames, Cables subjected to point load multi force member.	**15**
III.	**Centroid, Centre Of Gravity And Moment Of Inertia**	Centroid of simple figures from first principle, Centroid of composite sections; Centre of Gravity and its implications. Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.	**15**
IV	**Friction, Virtual Work And Energy Method**	Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack. Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.	**15**
TOTAL			**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4 * 15 NCH = 60 NCH		8 * 4 NCH = 32 NCH (Problem Solving, Assignments, Quiz, Presentation, Case Study, Discussion)

Textbooks:

1. Kraige, L. Glenn, and L. G. Meriam. Engineering mechanics. John Wiley & Sons, 1987
2. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
3. Timoshenko S, Young H.D. and Rao J.V, Engineering Mechanics, Tata McGraw Hill Publications.

References:

1. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
2. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford

3. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
4. Shames and Rao (2006), Engineering Mechanics, Pearson Education

Alternative NPTEL/SWAYAM Course:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	ENGINEERING MECHANICS	PROF. MANOJ HARBOLA	IIT KANPUR

Alternative NPTEL/SWAYAM Course:

S.No.	Experiment Name	Experiment Link(s)
1	Experiment on moment of inertia measurement.	https://vlab.amrita.edu/?sub=1&brch=74&sim=571&cnt=1

Paper III/Subject Name: Mechanics of Deformable Solids **Subject Code: MEE022C303**

L-T-P-C – 3-1-0-4 **Credit Units: 04** **Scheme of Evaluation: TP**

Objective:

The course aims to teach stress-strain analysis, material behavior under loading, structural problem-solving, energy methods, stability evaluation, failure theories, and design applications for mechanical engineering.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	**Blooms Taxonomy Level**
CO 1	Understand and explain the concepts of stress and strain in deformable solids.	**Understand (BT2)**
CO 2	Analyze engineering problems involving bending and torsion to determine stresses, strains, and deformations.	**Analyze (BT4)**
CO 3	Apply stability criteria to evaluate the behavior of columns and beams under different loading conditions	**Apply (BT3)**
CO 4	Understand and explain the principles of failure theories and their applications in the design of mechanical components	**Understand (BT2)**

Detailed Syllabus:

Modules	**Topics**	**Course Content**	**Periods**
I.	**Stress, Strain, and Axial Loading**	Concept of stress and strain, normal and shear stress, stress tensor. Hooke's Law, Poisson's ratio, and elastic constants. Stress-strain diagrams for ductile and brittle materials. Thermal stresses and strains. Deformation of axially loaded members. Statically determinate and indeterminate problems. Compatibility conditions and superposition principle.	15
II.	**Bending and Torsion**	Shear force and bending moment diagrams. Pure bending, bending stresses, and section modulus. Shear stress distribution in beams. Deflection of beams: Double integration method, Macaulay's method, and moment-area method. Torsion of circular shafts, shear stress, and angle of twist. Power transmission by shafts.	15
III.	Energy Methods and Stability	Strain energy due to axial load, bending, and torsion. Castigliano's theorems and their applications. Principle of virtual work and its applications. Euler's theory of buckling for columns. Effective length and slenderness ratio. Rankine's formula and empirical methods.	15

IV.	Failure Theories and Design	Maximum principal stress theory, maximum shear stress theory, and distortion energy theory. Factor of safety and design considerations. Applications of failure theories in mechanical component design.	15
		TOTAL	60

Textbooks and References:

Textbook:

- R.C. Hibbeler, Mechanics of Materials, Pearson Education.
- Ferdinand P. Beer, E. Russell Johnston, Mechanics of Materials, McGraw-Hill.

Reference Books:

- Timoshenko and Gere, Mechanics of Materials, Cengage Learning.
- James M. Gere, Mechanics of Materials, Brooks/Cole.

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4 * 15 NCH = 60 NCH		**8 * 4 NCH = 32 NCH (Problem Solving, Assignments, Quiz, Presentation, Case Study, Discussion)**

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Mechanics of Material	Prof. Priyanka Ghosh	IIT Kanpur

Online Link(s)
https://archive.nptel.ac.in/courses/105/106/105106172

Paper IV/Subject Name: Mathematics-III		Subject Code: MAT022C304
L-T-P-C – 3-0-0-3	Credit Units: 03	Scheme of Evaluation: T

Objective:

This course aims to provide a strong foundation in probability theory and random variables, equipping students with the ability to analyze uncertainty and statistical relationships. It covers key concepts such as estimation theory, correlation, regression, and hypothesis testing for data-driven decision-making. Additionally, students will develop numerical methods to solve algebraic and transcendental equations while learning approximation techniques to enhance computational problem-solving skills.

Prerequisites: Sets and elements of Sets, Operation on Sets, Algebra of Sets.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**understand** probability, random variables, and statistical distributions	Understand (BT2)
CO 2	**apply** statistical methods like correlation, regression, and hypothesis testing .	Solve (BT3)
CO 3	**solve** equations using numerical methods like interpolation and integration	Apply (BT3)
CO 4	**analyze** the accuracy and efficiency of numerical techniques	Analyze (BT4)

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Probability**	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.	**12**

II.	**Statistics**	Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis -Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parametersfor these three distributions, Correlation and regression – Rank correlation. Curve fitting bythe 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 fitand independence of attributes	**12**
III.	**Numerical Methods-I:**	Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae.Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.	**12**
IV	**Numerical Methods-II:**	Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson method and Regula-Falsi method. Numerical solution of ordinary differential equations: Taylor's series, Euler's methods. Runge-Kutta method of fourth order for solving first and second order equations. Predictor-corrector methods.	**12**
TOTAL			**48**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 15 NCH = 45 NCH		8 * 3 NCH = 24 NCH (Problem Solving, Assignments, Quiz, Presentation, Case Study, Discussion)

Text Books:

1. Hoel P. G., Port S. C. and Stone C. J., *Introduction to Probability Theory*, 2003, Universal BookStall.
2. Satry S. S, *Introductory Methods of Numerical Analysis,* 4th edition, 2005, PHI.

Reference Books:

1. Grewal B. S., *Higher Engineering Mathematics*, 43rd edition 2014, Khanna Publishers.
2. Bali N. P. and Narayan Iyenger N ,*A text book of Engineering Mathematics*, 9th edition, 2016, Laxmi Publication.
3. Kreyszig E. *Advanced Engineering Mathematics*, 9th edition, 2011, Wiley Eastern Ltd

Paper V / Subject Name: Indian Knowledge Systems-I		Subject Code: IKS992K301
L-T-P-C –2-0-0-2	Credit Units: 02	Scheme of Evaluation: P

Objective:

The objective of this course is to provide an understanding of Indian culture, languages, literature, fine arts**,** and the contributions of Indian scientists in medieval and modern times

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**understand** the fundamentals of Indian culture, its traditions, and historical significance.	**BT 2**
CO 2	**identify** key Indian languages, literary works, and fine arts, appreciating their evolution and influence	**BT 3**
CO3	**examine** the contributions of Indian scientists in medieval and modern India	**BT 4**
CO4	**analyze** the impact of Indian scientific and artistic advancements on global knowledge and heritage.	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Hours
I.	Introduction to Culture: Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India	**10**
II.	Indian Languages, Culture and Literature: Indian Languages and Literature-I: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature, literature of south India ,Indian Languages and Literature-II: Northern Indian languages & literature	**10**
III.	Religion and Philosophy: Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only)	**10**
IV.	Education System in India: Education in ancient, medieval and modern India, aims of education, Subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India	**10**

Text Books:

1. Kapil Kapoor, "Text and Interpretation: The India Tradition",ISBN: 81246033375,
2. "Science in Samskrit", Samskrita Bharti Publisher, ISBN 13: 978-8187276333, 2000
3. NCERT, "Position paper on Arts, Music, Dance and Theatre", ISBN 81-7450 494-X, 200
4. S. Narain, "Examinations in ancient India", Arya Book Depot, 1993

Reference Books:

1. SatyaPrakash, "Founders of Sciences in Ancient India", Vijay Kumar Publisher, 198
2. M. Hiriyanna, "Essentials of Indian Philosophy",
3. Motilal Banarsidass Publishers, ISBN 13:978-8120810990, 2014

Paper VI / Subject Name: Machine Drawing Lab		Subject Code: MEE022C319
L-T-P-C –1-0-4-3	Credit Units: 03	Scheme of Evaluation: P

Objective:

The objectives of the course are to teach the students to develop hands on skill in technical drawing required for manufacture and assembly of machine components.

Prerequisites: Engineering Graphics

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	To understand national and international standards while drawing machine component	**BT 2**
CO 2	To familiarize in drawing assembly, orthographic and sectional views of various machine components	**BT 3**

Detailed Syllabus:

Submission of one drawing sheet for each of the following topics

1. **Introduction:** Classification of Machine Drawings, Principles of Drawings, Sectioning, Dimensioning, Limits, Fits and Tolerance, Symbols and Conventional Representation
2. **Orthographic Projections**: First angle and third angle projection, conversion of isometric views to orthographic views, sectional views
3. **Screwed Fasteners**: Thread nomenclature, forms of thread, designation, representation of threads, fasteners, bolts and nuts, locknuts
4. **Keys, Cotters and Pin joints**: Types of keys, Cotter joint and Knuckle joint
5. **Shaft Coupling**: Introduction, Rigid coupling and Flexible coupling
6. **Riveted Joints**: Introduction, rivets and riveting, types of rivet heads, types of riveted joints
7. **Assembly drawings**: Introduction, machine components, stuffing box, plumber block, screw jack
8. **Assembly drawings**: Introduction to engine parts

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
1 * 15 NCH = 15 NCH	4 * 15 NCH = 60 NCH	4 * 8 NCH = 32 NCH

Textbooks:

2. N.D. Bhatt, "*Machine Drawing*", Charotar Publishing House, 2008.

Reference Books:

1. Basudeb Bhattacharya, *Machine Drawing*, Oxford University Press
2. K.L. Narayana, "*Machine Drawing*", 3rd ed., New Age International, 200

Paper VII / Subject Name: Basic Electronics Engineering		Code: ECE022C306
L-T-P-C –3-1-0-4	Credit Units: 4	Scheme of Evaluation: T

Objective:

This course aims to provide fundamental knowledge of semiconductor devices, operational amplifiers, digital electronics, and communication systems. It covers the principles, applications, and circuit design of diodes, transistors, op-amps, logic gates, and modulation techniques, preparing students for practical implementations in electronic systems.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**recall** fundamental concepts of semiconductor devices, digital electronics, and communication systems	**BT 1**
CO 2	**understand** the working principles of semiconductor devices, including diodes, transistors, and voltage regulators	**BT 2**
CO3	**apply** Boolean algebra, logic circuits, and microprocessors/microcontrollers in digital system design.	**BT 3**
CO4	**analyze** electronic circuits, modulation techniques, and transmission systems for communication applications.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Semiconductor Devices and Applications**	Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier,frequency response and bandwidth.	**10**
II.	**Operational amplifier and its applications**	Introduction to operational amplifiers, Op-amp input modes and parameters, Op- amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator. **Timing Circuits and Oscillators**: RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.	**15**

III.	**Digital Electronics Fundamentals**	Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K-map, Logic ICs, half and full adder/subtractor, multiplexers, demultiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.	**15**
IV	**Electronic Communication Systems**	The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.	**15**
TOTAL			**55**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 15 NCH = 45 NCH		8 * 3 NCH = 24 NCH (Problem Solving, Assignments, Quiz, Presentation, Case Study, Discussion)

Text /Reference Books:

1. Floyd ," *Electronic Devices"* Pearson Education 9th edition, 2012.
2. R.P. Jain , "*Modern Digital Electronics*" , Tata Mc Graw Hill, 3rd Edition, 2007.
3. Frenzel, " *Communication Electronics: Principles and Applications*" , Tata Mc Graw Hill, 3rdEdition, 2001

DETAILED SYLLABUS OF 4th SEMESTER

Paper I/Subject Name: Fluid Mechanics and Hydraulic Machines		**Subject Code: MEE022C401**
L-T-P-C – 3-1-0-4	**Credit Units: 04**	**Scheme of Evaluation: TP**

Objective:

To equip students with the fundamental principles of fluid mechanics and hydraulic machines, enabling them to analyze, design, and optimize fluid systems and machinery for real-world engineering applications.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Explain the fundamental properties of fluids and their behavior under static and dynamic conditions.	Understand (BT2)
CO 2	Analyze fluid flow problems using principles of continuity, momentum, and energy	Solve
CO 3	Evaluate the performance of hydraulic machines such as pumps and turbines.	Apply (BT3)
CO 4	Demonstrate the use of computational tools for fluid flow analysis.	(BT Level: Apply)

Detailed Syllabus:

Modules	**Topics**	**Course Content**	**Periods**
I.	Fundamentals of Fluid Mechanics	Introduction to Fluid Mechanics: Definition of fluid, fluid properties: density, viscosity, surface tension, compressibility. Newtonian and non-Newtonian fluids. Fluid Statics: Pressure variation in fluids, hydrostatic forces on surfaces, buoyancy, and stability. Applications of fluid statics in engineering (e.g.,	15
II.	Fluid Dynamics and Flow Analysis	Fluid Dynamics: Continuity equation, momentum equation, and energy equation. Bernoulli's equation and its applications. Flow Measurement:Venturimeter, Orificemeter, Pitot tube. Dimensional Analysis and Similitude: Buckingham π-theorem, dimensionless numbers (Reynolds, Froude, Weber, Mach). Similitude and model studies.Flow Through Pipes: Laminar and turbulent flow, Darcy-Weisbach	15

		equation, friction factor, Moody's chart.Minor losses in pipes, pipe network analysis (series and parallel connections).	
III.	Hydraulic Machines: Pumps	Introduction to Hydraulic Machines: Classification and working principles.Pumps:Centrifugal pumps: working principles, performance characteristics, efficiency. Reciprocating pumps: working principles, performance characteristics. Cavitation and its prevention. Selection and design considerations for pumps.	15
IV.	Hydraulic Machines: Turbines and Computational Fluid Dynamics (CFD)	Turbines: Classification: impulse (Pelton wheel) and reaction (Francis, Kaplan) turbines. Working principles, performance characteristics, efficiency. Specific speed, unit quantities, and design considerations. Applications in hydroelectric power plants. Computational Fluid Dynamics (CFD): Introduction to CFD and its applications. Governing equations of fluid flow. Overview of CFD software tools (e.g., ANSYS, COMSOL)	15
		TOTAL	60

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4 * 15 NCH = 60 NCH		**8 * 4 NCH = 32 NCH (Problem Solving, Assignments, Quiz, Presentation, Case Study, Discussion)**

Textbooks and References:

1. **Textbooks**:
    - Fluid Mechanics by R.K. Bansal.
    - Hydraulic Machines by R.K. Rajput.
    - Introduction to Fluid Mechanics by Fox and McDonald.
2. **References**:
    - Fluid Mechanics and Hydraulic Machines by Modi and Seth.
    - Computational Fluid Dynamics by John D. Anderson.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Fluid Mechanics	Prof. S.K. Som	IIT Kharagpur

Online Link(s)
https://nptel.ac.in/courses/112105129

Course: B.Tech. (M.E.)	SYLLABUS	Semester: IV
Paper II / Subject Name: Primary Manufacturing		Code: MEE022C402
L-T-P-C –3-1-0-4	Credit Units: 4	Scheme of Evaluation: T

Objective:

The objective of this course is to provide students with a fundamental understanding of casting, welding, bulk forming, and machining processes. It covers sand casting and other casting methods, gas and arc welding, advanced welding techniques, bulk deformation processes, and the working principles of lathe, shaper, and milling machines**,** equipping students with essential manufacturing knowledge.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**identify** fundamental manufacturing processes, including casting, welding, forming, and machining	**BT 1**
CO 2	**explain** the working principles and applications of various casting, welding, and machining techniques	**BT 2**
CO3	**demonstrate** the selection and application of appropriate manufacturing processes for different materials and products.	**BT 3**
CO4	**evaluate** the efficiency, advantages, and limitations of different manufacturing techniques in industrial applications	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**CASTING PROCESS**	Manufacturing; Definition and broad grouping Casting: Definition, Casting Materials Sand mould casting: Moulding sands - composition, properties & testing; Type of patterning; Design of gating system - sprue, runner, ingate & riser; Solidification – centre-line freezing Furnaces: Copula, Resistance furnace, Induction & Arc furnace. Casting Method: Centrifugal casting, Shell mould, Investment casting, Permanent mould casting, Die casting, and Slush casting. Casting defects, types, causes & remedy	**10**
II.	**WELDING PROCESS**	Major grouping of joining processes: welding, brazing and soldering. Broad classification of welding processes, types and principles Gas welding &thermit welding, Arc welding, Submerged arc welding, TIG & MIG, Plasma arc welding,	**10**

		Spot & butt welding, Hot forge welding, Friction welding, Pressure & percussion welding Ultrasonic welding, Laser beam welding, Electron beam welding Welding defects, types, causes & remedy	
III.	**FORMING**	**Metal Forming:** Hot and cold working of metals, classification of formingprocesses Rolling: Pressure and forces, Types of rolling mills, rolling defects **Forging**: Smith forging, Drop forging, Press forging, Machine forging,Forging defects **Extrusion**: Direct, Indirect, Impact, extrusion of tubes Sheet metal working: Bending, shearing, blanking & punching.	**15**
IV	**MACHINING PROCESSES**	Lathe – Functions, Classification & operations; Drilling Machine – Functions, Classification & operations Milling Machine – Functions, Classification & operations Finishing Processes	**10**
TOTAL			**45**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
3 * 15 NCH = 45 NCH		8 * 3 NCH = 24 NCH (Problem Solving, Assignments, Quiz, Presentation, Case Study, Discussion)

Text Books:

1. P.N Rao, *Manufacturing technology, Foundry, Forming & Welding,* Tata McGraw-Hill Education,1992
2. A Ghosh & A Mullick, *Manufacturing Science,* 2nd Edition, 2010, East West Press
3. Choudhury H S K, *Elements Of Workshop Technology Vol-1(Manufacturing Processes)*, MediaPromoters, 2008

Reference Books:

1. R K Jain. *Production Technology: Manufacturing Processes, Technology and Automation,* 17thedition, 2004, Khanna Publishers
2. E.P Degarmo, Black & Kohser, *Materials & processes in manufacturing,* 11th edition, 2013,Wiley
3. S.K Sharma & S Sharma, *Manufacturing processes,* I.K International, 2013
4. S Kalpakjian; *Manufacturing Engineering & Technology,* 4th edition, Pearson Education India.

Alternative NPTEL/SWAYAM Course:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	FUNDAMENTALS OF MANUFACTURING PROCESSESS	PROF. D.K DWIVEDI	IIT ROORKEE

Course: B.Tech. (M.E.)	SYLLABUS	Semester: IV
Paper III / Subject Name: Applied Thermodynamics		**Subject Code: MEE022C403**
L-T-P-C – 3-1-0-4	**Credit Units: 04**	**Scheme of Evaluation: T**

Objective:

The objectives of the course are to teach the students to apply the concepts of thermodynamics to understand and analyze thermal devices

Prerequisites: Basic Thermodynamics

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Understand various power cycles and working principles of various thermal devices	**BT 1 & BT 2**
CO 2	Utilize energy balance in thermal devices	**BT 3**
CO 3	Analyze energy conversion in various thermal devices	**BT 4**

Detailed Syllabus:

Modules	**Topics**	**Course content**	**Hours**
I	Power cycles	Vapor power cycles: Rankine cycle with superheat, reheat and regeneration. Gas power cycles, Air standard Otto, Diesel and Dual cycles, Air standard Brayton cycle: effect of reheat, regeneration and intercooling.	15
II	Boiler and Combustion	Classification of boilers, Mountings, Accessories, Evaporation capacity, Equivalent evaporation, Boiler efficiency, Heat balance sheet. Fuel & Combustion: Stoichiometry, air requirement, A/F ratio, heating value, Exhaust gas analysis.	15
III	Nozzle and Steam Turbine	Flow of steam through nozzles, critical pressure ratio, maximum mass flow rate through nozzle, effect of friction, nozzle efficiency. Impulse and reaction turbine, velocity diagram, work done and efficiencies.	15
IV	Compressor and Condenser	Reciprocating compressor, Effect of clearance, Volumetric efficiency, Compression ratio, Methods of improving Thermal efficiency, Compressor work, Multi-stage Compression, Intercooler and Aftercooler Classification of condensers, air leakage, condenser performance parameters	15
		TOTAL	**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4 * 15 NCH = 60 NCH		4 * 8 NCH = 32 NCH (Problem Solving, Seminar, Case Study, Discussion, Project)

Textbooks:

1. P K Nag, *Engineering thermodynamics*, 6th edition, 2017, McGraw Hill Education.
2. Cengel and Boles, *Fundamentals of Thermodynamics*, 4th edition, 2001, Tata McGraw Hill Publication

Reference 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, *Fundamental of Engineering Thermodynamic*, John Wiley and Sons.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Applied Thermodynamics	Prof. Niranjan Sahoo Dr. Pranab K Mondal	IIT Guwahati
Online Link: https://archive.nptel.ac.in/courses/112/103/112103307/			

Paper IV/Subject Name: Kinematics of Machines		Subject Code: MEE022C404
L-T-P-C – 3-1-0-4	Credit Units: 04	Scheme of Evaluation: TP

Objective:

The objective of this course is to provide knowledge of transfer of motions and conversion of motions using mechanisms.

Prerequisites: A course on Engineering Mechanics, Statics and Dynamics.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Understand** the basic structure and elements of machines.	Understand (BT2)
CO 2	Determine position, velocity and acceleration of linkages in mechanism at any instant.	Solve (BT4)
CO 3	**Apply** the concepts of power transfer through belts, chains and gears to **analyze** load, speed, efficiency, and maintenance for **selecting** an effective transmission mechanism.	Apply (BT3)
CO 4	**Understand** basics related to friction and its practical application in mechanical engineering	Understand (BT2)

Detailed Syllabus:

Modules	Topics	Course Content	Periods
I.	Introduction: Aims & scope of the course & Basic concepts of Mechanisms	Basic definitions, Difference between structure & Machine, Links & their types, Types of constrained motion, Kinematic pair & their classification, Grubler's mobility criteria, Inversion of a kinematic chain and applications, Hooks joint, Devis and Ackermann steering mechanism. An introduction to approximate and exact straight-line mechanism.	15
II.	Velocity and acceleration Analysis	Graphical (vector) method for velocity and acceleration of various mechanisms e.g. slider crank and four bar, Coriolis acceleration. Instantaneous Centre method, Kennedy's theorem, Klien's construction	15
III.	Transmission drives	Belt and Chain drives: Types and materials, Fundamentals of Power transmission, Phenomena of slip & creep, centrifugal and initial tensions, Tight side and slack side tensions, Conditions of max Power transmission. Classification of chain, chain length, angular speed ratio. Theory of gearing: Classification of gears and terminology, Law of gearing, gear profiles, Interference, and efficiency of gears, gear train, Torque analysis and various applications of complex gear trains.	15

IV.	Friction, Brakes and Clutches:	Introduction to friction, Law of friction, Coefficient of friction, Inclined Plane. Types of braking systems, force and torque analysis for block, band and band and block brake, disc brakes. Friction clutches: types, uniform pressure and uniform wear theory.	15
		TOTAL	60

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**Experiential Learning**
4 * 15 NCH = 60 NCH		**8 * 4 NCH = 32 NCH (Problem Solving, Assignments, Quiz, Presentation, Case Study, Discussion)**

Textbooks:

1. Thomas Bevan, "Theory of Machines," CBS Publishers & Distributors, 2005.
2. W. L. Cleghorn, "Mechanisms of Machines," Oxford University Press, 2005.
3. R. L. Norton, "Kinematics and Dynamics of Machinery," Tata McGraw Hill, 2009.
4. A. Ghosh and A.K. Mallick, "Theory of Mechanisms and Machines," Affiliated East-West Pvt. Ltd, New Delhi, 1988.

References:

1. Rattan, S.S.,"Theory of Machines", Tata McGraw-Hill Publishing Company Ltd.,New Delhi, 2009.
2. Uicker, J.J., Pennock, G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press,New Delhi, 2009
3.Khurmi, R.S., and Gupta, J.K., "Theory of Machines", S.Chand& Company, 2009.
4. Kinematics by HN Tyson
5. Rao, J.S., and Dukkipati, R.V, "Mechanism and Machine Theory", New Age International (P) Ltd Publishers. New Delhi, 2007.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Kinematics of Mechanisms and Machines	Prof. A. Dasgupta	IIT Kharagpur

Online Link(s)
https://nptel.ac.in/courses/112105268

Paper V/Subject Name: Engineering Materials and Applications		Subject Code: MEE022C405
L-T-P-C – 3-1-0-4	Credit Units: 04	Scheme of Evaluation: TP

Objective:

- The objective of the course is to provide students with a comprehensive understanding of the structure, properties, selection, and applications of engineering materials, enabling them to analyze material behavior, explore advanced materials, and apply this knowledge to solve real-world engineering problems.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Classify and describe the structure, properties, and applications of various engineering materials. (BT Level: Understand)	Understand (BT2)
CO 2	Analyze the mechanical behavior of materials under different loading and environmental conditions. (BT Level: Analyze)	Solve (BT4)
CO 3	Select appropriate materials for specific engineering applications based on their properties. (BT Level: Apply)	Apply (BT3)
CO 4	Evaluate the role of advanced materials in modern engineering applications. (BT Level: Evaluate)	Understand (BT2)

Detailed Syllabus:

Modules	Topics	Course Content	Periods
I.	**Introduction to Engineering Materials**	Classification of engineering materials: Metals, Polymers, Ceramics, Composites, and Advanced Materials. Atomic structure and bonding in materials. Crystal structures: BCC, FCC, HCP, and defects in crystals. Mechanical properties of materials: Stress-strain curves, hardness, toughness, fatigue, and creep.	15
II.	**Ferrous and Non-Ferrous Materials**	Ferrous materials: Cast iron, plain carbon steels, alloy steels, and stainless steels. Heat treatment of steels: Annealing, normalizing, hardening, tempering, and case hardening. Non-ferrous materials: Aluminum, copper, titanium, and their alloys. Applications of ferrous and non-ferrous materials in engineering.	15

III.	**Non-Metallic and Composite Materials**	Polymers: Types, properties, and applications. Ceramics: Structure, properties, and applications. Composite materials: Classification, properties, and applications. Fiber-reinforced composites: Types and manufacturing processes. Material selection for specific engineering applications	15
IV.	**Advanced Materials and Applications**	Smart materials: Shape memory alloys, piezoelectric materials, and their applications. Nanomaterials: Properties, synthesis, and applications. Biomaterials: Types and applications in medical engineering. Emerging materials: Graphene, carbon nanotubes, and their applications. Sustainability in material selection: Eco-friendly materials and recycling.	15
		TOTAL	60

1. **Textbooks and References:**
    1. **Textbooks:**
        - Callister, W. D., & Rethwisch, D. G. *Materials Science and Engineering: An Introduction*. Wiley.
        - Smith, W. F., & Hashemi, J. *Foundations of Materials Science and Engineering*. McGraw-Hill.
        - Raghavan, V. *Materials Science and Engineering: A First Course*. PHI Learning.
    2. **References:**
        - Ashby, M. F., & Jones, D. R. H. *Engineering Materials 1: An Introduction to Properties, Applications, and Design*. Elsevier.
        - Budinski, K. G., & Budinski, M. K. Engineering Materials: Properties and Selection. Pearson.
        - Askeland, D. R., & Fulay, P. P. Essentials of Materials Science and Engineering. Cengage Learning.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Introduction to Materials Science and Engineering https://nptel.ac.in/courses/112105268	Prof. Satish V. Kailas,	IISc Bangalore

Paper VII/Subject Name: Fluid Mechanics Lab		Subject Code: MEE022C411
L-T-P-C – 0-0-2-1	Credit Units: 01	Scheme of Evaluation: P

Objective:

To equip students with the fundamental principles of fluid mechanics and hydraulic machines, enabling them to analyze, design, and optimize fluid systems and machinery for real-world engineering applications.

Course Outcomes:

On successful completion of the course the students will be able to:	
SI No	**Course Outcome**
CO 1	Demonstrate the ability to measure fluid properties such as viscosity, density, and pressure.
CO 2	Analyze and interpret data from experiments related to fluid flow and hydraulic machines.
CO 3	**Evaluate the performance of hydraulic machines such as pumps and turbines.**
CO 4	Operate and evaluate the performance of hydraulic machines such as pumps and turbines.

List of Experiments:

The following experiments are designed to cover the fundamental and applied aspects of fluid mechanics:

1. **Bernoulli's Theorem Verification:** Experimental verification of Bernoulli's equation using a Bernoulli's apparatus.
2. **Performance Characteristics of Centrifugal Pump:** Determination of head, discharge, and efficiency of a centrifugal pump.
3. **Performance Characteristics of Pelton Wheel Turbine:** Determination of efficiency and power output of a Pelton wheel turbine.
4. **Performance Characteristics of Francis Turbine:** Determination of efficiency and power output of a Francis turbine.
5. **Performance Characteristics of Kaplan Turbine:** Determination of efficiency and power output of a Kaplan turbine.

Textbooks:

- Fluid Mechanics and Hydraulic Machines by R.K. Rajput
- Introduction to Fluid Mechanics by Fox and McDonald

Online Resources:

- NPTEL lectures on Fluid Mechanics.
- AICTE-approved e-learning platforms.
- **Laboratory Manuals:**

DETAILED SYLLABUS OF 5th SEMESTER

Paper I / Subject Name: Machine Element & System		**Code: MEE022C501**
L-T-P-C –3-1-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objectives:

1. To understand safety-critical design of machine components using failure criteria based on mechanics of materials
2. To understand the origins, nature and applicability of empirical design principles, relevant codes, standards and design guidelines for different machine elements
3. To appreciate the relationships between component level design and overall machine system design and performance

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**BloomsTaxonomy Level**
CO 1	Recall and explain the fundamental principles of machine elements and their roles in mechanical systems..	**BT 1**
CO 2	Describe and interpret the causes and mechanisms of failure in various machine elements.	**BT 2**
CO3	Apply appropriate design codes, standards, and guidelines for the selection and evaluation of machine components.	**BT 3**
CO4	Analyze the performance and interaction of machine elements in mechanical system assemblies.	**BT 4**

Detailed syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I.	**Introduction to Machine Elements and System Fundamentals**	Anatomy of machines; Functional dissection of motorcycle, washing machine, sewing machine, etc. into machine elements including gears, rack and pinions, cams, chains, belts, pulleys, flywheels, bearings, shafts, keys, brakes, etc.; Design considerations – Limits, fits and standardization; Friction and lubrication.	**10**
II.	**Force Analysis and Failure Theories**	Force analysis of machine elements and machine systems; Application to power screws and couplings, clutches, and brakes. Static failure theories including normal stress theory, shear stress theory, distortion energy theory; von Mises stress; Factor of safety; Stress concentration factors; Fatigue	**10**

		failure theories: mean and alternating stresses, yield, ultimate, and endurance strength; Goodman, Gerber, and Soderberg lines.	

Modules	Topics	Course Contents	Hours
III.	**Design of Machine Elements**	Springs – Helical compression, tension, torsional and leaf springs; Fasteners – threaded fasteners, bolted joints, preloaded bolts, rivets and welded joints; Shafts – shafts under static and fatigue loadings; Keys; Sliding and rolling contact bearings; Transmission elements – transmission ratio and efficiency of spur, helical, bevel and worm gears; belt and chain drives; Flywheels.	**10**
IV.	**Dynamics and Application of Mechanical Systems**	Single degree-of-freedom systems; Natural frequency and critical damping; Forced vibration; Resonance; Balancing of reciprocating and rotating masses; Torsional vibration and critical speeds of shafts. Case studies on automobile suspensions, automatic transmissions, material conveyor systems, construction machinery, etc.	**10**
TOTAL			**40**

Text /Reference Books:

1. Shigley, J.E. and Mischke, C.R., "Mechanical Engineering Design," McGraw-Hill, 1989.
2. Deutschman, D., & Wilson, C.E., "Machine Design Theory & Practice," Macmillan, 1992
3. Juvinal, R.C., "Fundamentals of Machine Component Design," John Wiley, 1994.
4. Spottes, M.F., "Design of Machine elements," Prentice-Hall India, 1994
5. R. L. Norton, "Mechanical Design – An Integrated Approach," Prentice Hall, 2009
6. Sadhu Singh, "Machine Design", Khanna Book Publishing, 2021.

Online Resources:

1 https://archive.nptel.ac.in/courses/112/105/112105124/

Paper II / Subject Name: Manufacturing Process		Code: MEE022C502
L-T-P-C –3-0-0-3	Credit Units: 3	Scheme of Evaluation: T

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

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall and describe the principles of various conventional and unconventional manufacturing processes.	**BT 1**
CO 2	Explain the selection criteria of suitable manufacturing methods for different materials and product types.	**BT 2**
CO3	Apply process parameters to plan basic operations in casting, forming, welding, and machining.	**BT 3**
CO4	Analyze and compare different manufacturing processes for their efficiency, material compatibility, and economic viability.	**BT 4**

Detailed syllabus:

Modules	Topics	Course Contents	Hours
I.	**Fundamentals of Manufacturing and Process Classification**	Additive, subtractive and shaping processes; Relative advantages and limitations; Inter-dependency of geometry, material and process; Effect on product quality and cost; Part design for manufacturability; Process selection criteria	**10**
II.	**Shaping and Joining of Materials**	Metal casting (sand, die and investment casting), Bulk forming (forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending); Thermoplastic and thermoset plastic processes (ex. injection and blow molding); Powder metallurgy; Metal injection molding; Glass and composite processes (layup)	**10**
III.	**Material Removal and Surface**	Turning, Drilling, Milling, Grinding and other finishing processes; Single and multi-point cutting tools; Cutting tool materials; Cutting fluids; Material removal rates, surface finish, accuracy, integrity and machinability	**10**

	Processes		
IV.	**Advanced, Additive, and Process Modeling Techniques**	Abrasive Jet Machining, Water Jet Machining; Ultrasonic Machining; Electrical Discharge Machining, Wire EDM; Electro Chemical Machining; Laser Beam Machining, Plasma Arc Machining and Electron Beam Machining; Micro and nano manufacturing. **Additive Manufacturing Processes:** Extrusion; vat polymerization, powder bed fusion; material jetting, binder jetting; direct energy deposition and lamination processes . **Joining and Fastening Processes:** Arc welding, gas welding, shielded metal arc welding; GMAW (MIG) and GTAW (TIG); Brazing and soldering; Solid state joining; Adhesive bonding. **Manufacturing Process Modeling** (for any one process, including simulation and industrial case study): Casting – metal flow, solidification and cooling; application to design of gating and feeding systems for quality and yield optimization; OR Forming – Plastic deformation and yield criteria; load estimation; OR Machining – Orthogonal cutting, various force components; Chip formation, Tool wear and tool life.	**10**
TOTAL			**40**

Text /Reference Books:

1. Amitabha Ghosh and A.K. Mallick, Manufacturing Science. Affiliated East-West Press Pvt. Ltd. 2010.
2. Kalpakjian and Schmid, Manufacturing Processes for Engineering Materials, Pearson India, 2014
3. M. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems 4. Degarmo, Black & Kohser, Materials and Processes in Manufacturing.

Online Resource:

https://www.mooc-list.com/tags/manufacturing

Paper III / Subject Name: Measurements and Metrology		Code: MEE022C503
L-T-P-C –3-1-0-4	Credit Units: 4	Scheme of Evaluation: T

Objectives:

1. To understand the proper use and maintenance of important instruments, such as Vernier callipers, autocollimators, slip gauges, and pyrometers
2. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Understand and describe the basic components and working principles of measurement systems.	**BT 1**
CO 2	Explain the function and application of instruments used to measure mechanical and electrical parameters.	**BT 2**
CO3	Apply measurement and instrumentation systems for process monitoring and basic control applications.	**BT 3**
CO4	Analyze and design appropriate limits, fits, and tolerances for a given engineering application.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Measurement Purpose and Parameters**	Parameters – geometry (straightness, flatness, roundness, etc.), displacement, force, speed, torque, flow, level, pressure, temperature, acceleration, etc.; Definitions: Accuracy, precision, range, resolution, uncertainly and error sources; Regression analysis. **Measurement Principles:** Structure and examples of measurement systems; Calibration principles; Linear and angular measurements; Comparators; Gauge design; Interferometry	**10**
II.	**Limits, Fit and Tolerances:**	Definitions; Tolerance zone and grades, Hole and shaft system, Geometric tolerances, Tylor's principle of gauging, Design of tolerances for various applications; Tolerance analysis in manufacturing and assembly; **Role of metrology in Design of Manufacturing.** ***Dimensional metrology*** – Vernier, micrometers, LVDT; *Form metrology* – form tester, surface profiler, CMM, 3D scanning; *Surface metrology* – optical microscopes, Laser scanning microscopes, electron microscopy (SEM/TEM), x-ray microscopy, Raman spectroscopy; Tool wear, workpiece quality and process	**10**

		metrology	
III.	**Thermal and Flow Measurement, Electrical Measurements and Instruments**	Measurement of temperature, thermal conductivity and diffusivity; Flow obstruction methods; Magnetic flow meters. Signal generators and analysis; Wave analyzer; Spectrum analyzer; *Frequency counters* – measurement errors, extending the frequency range; *Transducers* – types, strain gages, displacement transducers; *Digital data acquisition system* - interfacing transducers to electronics control and measuring system; Instrumentation amplifier; Isolation amplifier; Computer-controlled test systems.	**10**
IV.	**Design of Experiments and Statistical Analysis**	DOE techniques; Taguchi orthogonal arrays; Data acquisition, signal processing and conditioning; Error of a system of ideal elements; Error probability density function of a system of non-ideal elements; Error reduction techniques; Quality control and assurance in industry.	**10**
TOTAL			**40**

Text Books:

1. E.O Doebelin and Dhanesh Manik, "Measurement Systems", McGraw Hill, 2017
2. Bewoor & Kulkarni, "Metrology & Measurement" Tata McGraw Hill, 2009.

Reference Books:

3. D. James, and S, Meadow, "Geometric Dimensioning and Tolerancing", Marcel Dekker, 1995
4. Madhav S. Phadke, Quality Engineering using Robust Design, Prentice Hall, 1989

Online Resources:

1. Mechanical Measurements and Metrology by Prof. S P Venkateshan (IIT Madras), NPTEL Course (Link: https://nptel.ac.in/courses/112/106/112106138/).
2. Principles of Mechanical Measurement by Prof. Dipankar N Basu (IIT Guwahati), NPTEL Course (Link: https://nptel.ac.in/courses/112/103/112103261/).

Paper IV / Subject Name: Heat Transfer and Thermal Machines		Code: MEE022C504
L-T-P-C –3-1-0-4	Credit Units: 4	Scheme of Evaluation: T

Objectives:

1. 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, 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.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Identify and describe the fundamental principles of conduction, convection, and radiation.	**BT 1**
CO 2	Formulate and analyze steady and unsteady heat transfer problems involving one or more modes.	**BT 2**
CO3	Apply analytical, empirical, or approximate methods to evaluate temperature distributions and heat transfer rates.	**BT 3**
CO4	Design heat exchangers and determine insulation requirements to control thermal energy losses.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Conduction Heat Transfer**	Three modes of heat transfer; Examples of equipment (like air conditioner and air cooler) involving heat transfer; Derivation of heat balance equation. Steady 1D solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry; Concept of conduction and film resistances; Critical insulation thickness; Lumped system approximation and Biot number; Heat transfer through pin fins; 2D conduction solutions for steady and unsteady heat transfer	**10**
II.	**Convection Heat Transfer**	Basic equations; Boundary layers; Forced convection; External and internal flows; Natural convective heat transfer; Dimensionless parameters for forced and free convection heat transfer; Correlations for forced and free convection; Approximate solutions to laminar boundary layer equations	**10**

		for internal and external flow; Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection	
III.	**Radiation Heat Transfer**	Interaction of radiation with materials; Definitions of radiative properties; Stefan Boltzmann's law; Black and grey body radiation; Calculation of radiation heat transfer between surfaces using radiative properties; View factors and the radiosity method; Examples for two-body enclosures; Radiation shield.	**10**
IV.	**Heat Exchanger Design**	Function, classification and configuration of heat exchangers; Evaluation of mean temperature difference; Heat exchanger effectiveness; Analysis, design and selection of heat exchangers. **Boiling and Condensation heat transfer** Pool boiling; Flow boiling; Film and drop wise condensation	**10**
TOTAL			**40**

Text Books:

1. J.P. Holman and S. Bhattacharyya, "Heat Transfer," McGraw Hill, 2017.
2. F.P. Incropera, and D.P. Dewitt, "Fundamentals of Heat and Mass Transfer," John Wiley, 2019
3. Yunus A Cengel, "Heat Transfer: A Practical Approach," McGraw Hill, 2002.

Reference Books:

1. A. Bejan, "Heat Transfer," John Wiley, 1993

Online Resources:

1 https://onlinecourses.nptel.ac.in/noc22_ch65/preview

Paper V / Subject Name: Heat Transfer Lab		**Code: MEE022C514**
L-T-P-C –0-0-2-1	**Credit Units: 1**	**Scheme of Evaluation: P**

Course Objective

- To expose the students to the basic knowledge of heat transfer and help them to develop experimental skills.
- To study the concepts, applications of the heat transfer laboratory.

Detailed Syllabus:

EXPERIMENT NO.	AIM OF THE EXPERIMENT	HOURS
1	Heat transfer through composite wall	3
2	Emissivity measurement apparatus	3
3	Forced convection apparatus	3
4	Specific heat apparatus (Heat pipe)	3
5	Heat transfer co-efficient for vertical tube (Natural Convection)	3
6	Parallel flow / counter flow heat exchanger	3
7	Boiling heat transfer	3
8	Stefan Boltzmann apparatus	3

Paper VI / Subject Name: Robotics & Control		Code: MEE022C506
L-T-P-C –3-1-0-4	Credit Units: 4	Scheme of Evaluation: T

Objectives:

1. Model and analyze mechatronic systems for an engineering application
2. Identify sensors, transducers and actuators to monitor and control a process or product.
3. Develop PLC programs for an engineering application.
4. Evaluate the performance of mechatronic systems.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Identify and recognize common electro-mechanical systems and their applications in daily life.	**BT 1**
CO 2	Explain the role and working of sensors, actuators, and controllers in integrated mechatronic systems.	**BT 2**
CO 3	Apply control theory principles to design basic feedback control systems for automation.	**BT 3**
CO 4	Analyze measurement systems for various physical quantities in terms of accuracy, range, and their use in automatic control	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Introduction to sensors and actuators**	Electro-mechanical systems; Typical applications; Examples – automobiles, home appliances, medical instruments, etc. Transduction principles; Sensitivity, accuracy, range, resolution, noise sources; Sensors for common engineering measurements – proximity, force, velocity, temperature, etc.; Signal processing and conditioning; Selection of sensors Pneumatic and hydraulic actuators; Electric motors including DC, AC, BLDC, servo and stepper motors; Solenoids and relays; Active materials – piezoelectric and shape memory alloys	**10**
II.	**Machine Controls**	Microprocessors and their architecture; Memory and peripheral interfacing; Programming; Microcontrollers; Programmable Logic Controllers; PLC principle and operation; Analog and digital input/output modules; Memory module; Timers, internal relays, counters and data handling; Industrial automation systems; Basic PLC	**10**

		programming; Industry kits (Arduino, Raspberry Pi, etc.).	
III.	**Robotics**	Robot configurations: serial and parallel; Denavit–Hartenberg parameters; Manipulators kinematics; Rotation matrix, Homogenous transformation matrix; Direct and inverse Kinematics for robot position and orientation; Workspace estimation and path planning; Robot vision; Motion tracking; Robot programming and control; Industrial robots - Pick and place robots, sorting, assembly, welding, inspection, etc.	**10**
IV	**Control Theory and Systems**	Basic control concepts; Feedback; Open and closed loop control; Concept of block diagrams; P, PI and PID controllers; Tuning the gain of controllers; System models, transfer functions, system response, frequency response; Root Locus method and Bode plots **Computational Tools:** Demonstration and projects using simulation software (e.g., Matlab, Scilab, ROBODK) for control systems and robotics.	**10**
TOTAL			**40**

Text Books:

1. W. Bolton, "Mechatronics," Addison Wesley Longman, 2010.
2. J. J. Craig, Introduction to Robotics Mechanics and Control, Addison Wesley, 1999.

Reference books:

3. G.K. McMillan, "Process/Industrial Instruments and Controls Handbook," McGraw-Hill, 1999.
4. S. Mukherjee, "Essentials of Robotics Process Automation", Khanna Book Publishing, 2021.

Online Resources:

1. **https://nptel.ac.in/courses/107/106/107106090/**
2. **https://nptel.ac.in/courses/112/101/112101098/**
3. **https://nptel.ac.in/courses/112/107/112107289/**
4. **https://nptel.ac.in/courses/112/104/112104298/**

DETAILED SYLLABUS OF 6th SEMESTER

Paper I / Subject Name: Computer Aided Design and Analysis		**Code: MEE022C601**
L-T-P-C –3-0-2-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective:

To provide an overview of how computers can be utilized in mechanical component design

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall the fundamentals of computer-aided design and engineering tools.	**BT 1**
CO 2	Explain the basic features of CAD software for modeling mechanical components.	**BT 2**
CO 3	. Use CAD tools to model and simulate simple mechanical components and assemblies.	**BT 3**
CO 4	Analyze the behavior of modeled components using basic CAE techniques (e.g., FEA or motion analysis).	**BT 4**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I.	**Introduction**	Role of computers in design process; Computer aided design, analysis and manufacturing; Computer integrated manufacturing; Popular CAD software used in industry; Input and output devices **Transformations:** Matrix representation of points, lines and planes; 2D transformation for translation, scaling, rotation and reflection; Homogeneous representation & concatenation; 3D transformations.	**10**
II.	**Curves and Surfaces,** **Solid modelling techniques**	Representation of curves; Hermite curves, Bezier curves, B-spline curves, Rational curves; Surface modelling – parametric representation, planar surface, surface of revolution, Coons and bicubic patches, Bezier and B-spline surfaces. **Solid modelling techniques** – sweep (linear and curved), Boolean (constructive solid geometry) and other techniques; Solid model representation (Boundary and Constructive Solid Geometry); Medical modelling (pixels, scans and voxels); Exchange standards (IGES, DXF, STEP, STL etc.).	**10**

III.	**Engineering Analysis**	Introduction to finite element method; Principle of potential energy; FE analysis of 1D element problems (spring, bar, truss elements); Development of element stiffness equation and their assembly; Plain strain and plain stress problems; Domain discretization, pre-processing and post-processing; Verification and validation; Popular CAE software used in industry	**10**
IV.	**Design Optimization**	Purpose and application of optimum design, Primary and subsidiary design equations, Limit Equations, Normal, redundant and incompatible specifications problems; Computer-aided design optimization.	**10**
TOTAL			**40**

Text Books:

1. Ibrahim Zeid, "Mastering CAD CAM," Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, "CAD/CAM Principles," Pearson Education, 2nd Edition, 1999.
3. Geometric Modeling, Michael E. Mortenson, Tata McGraw Hill, 2013.

Reference Books:

4. W. M. Neumann and R.F. Sproul, "Principles of Computer Graphics," McGraw Hill, 1989.
5. D. Hearn and M.P. Baker, "Computer Graphics," Prentice Hall Inc., 1992.

Online Resources:

1. NPTEL Lecture Series:

• https://nptel.ac.in/courses/112/102/112102101/

• https://nptel.ac.in/courses/112/104/112104031/

2. MIT OCW:

https://ocw.mit.edu/courses/mechanical-engineering/2-158j-computational-geometry-spring-2003/

Paper II / Subject Name: Manufacturing Automation		Code: MEE022C602
L-T-P-C –3-1-0-4	Credit Units: 4	Scheme of Evaluation: T

Objectives:

- To understand the importance of automation in the of field machine tool based manufacturing
- To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC
- To understand the basics of product design and the role of manufacturing automation

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall and define the types, tools, and basic strategies used in manufacturing automation and CNC systems	**BT 1**
CO 2	Explain the working of automated flow lines, CNC systems, assembly systems, and various sensors and actuators.	**BT 2**
CO 3	Apply automation tools (mechanical, electrical, pneumatic, robotic) to improve productivity and process control.	**BT 3**
CO 4	Analyze manufacturing systems using automation metrics (e.g., line efficiency, production rate, feedback control) and propose improvements based on real-time data	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Fundamentals of Automation & CNC Systems**	Definition; Reasons for automating; Strategies; Types of automation; Numerical control (NC, CNC, DNC); Introduction to CNC programming and computer-aided process planning	**10**
II.	**Machine & Process Automation**	CNC machines, Automated flow lines (types, selection); Work part transport and transfer mechanisms; Feedback systems and control; Modular and reconfigurable machines, adaptive machine controls.	**10**
III.	**Automated Assembly Systems & Factory Automation**	Historical developments; Choice of assembly methods; Design for automated assembly; Transfer systems; Vibratory and non-vibratory feeders; Feed tracks, part orienting and placing mechanisms, Lean manufacturing, Automation scalability (fixed, programmable, flexible and reconfigurable); Design and analysis of automated flow lines; Average production time,	**10**

		production rate, line efficiency; Analysis of transfer lines without storage; Partial and full automation	
IV.	**Automation Tools, Digital Trends & Case Studies**	Mechanical, electro-mechanical, pneumatic and hydraulic systems; Sensors integration; Process monitoring, data analysis and control using actuators; Robots (pick, place, assembly, welding, painting, etc.); Automatic Guided Vehicles; Automated inspection and measurement (CMM and 3D Scanning); Machine vision, AI and machine learning; Human-machine interfaces; Examples and case studies Digital, inclusive, smart and distributed manufacturing; Industry 4.0; Digital transformations in shop-floors (CIM to Smart factory; Intelligent machines to Smart Machines; Factory automation to Distributed automation; Human sense to system sensed). **Examples and Case Studies:** Pick and place robots, testing and sorting based systems, etc; Orientation of parts: in-bowl and out-of-bowl toolings; Manufacturing equipment embedded with digital data and driven by adoptive controls	**10**
TOTAL			**40**

Text Books:

1. M. P. Groover, Automation, Production Systems and Computer-integrated Manufacturing, Prentice Hall, 2018.
2. S. Kalpakjian and S. R. Schmid, Manufacturing – Engineering and Technology, Pearson.

Reference Books:

3. Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill, 2005
4. CAD/CAM Principles and Applications, P.N. Rao, Tata McGraw Hill, 2010.

Online Resources:

1. https://nptel.ac.in/courses/112/104/112104289/
2. https://nptel.ac.in/courses/112/103/112103293/
3. https://nptel.ac.in/courses/112/103/112103174/

Paper III / Subject Name: IC Engine		Code: MEE022C603
L-T-P-C –3-0-0-3	Credit Units: 3	Scheme of Evaluation: T

Objectives:

- To develop the concept of heat engine design.
- To provide understanding of the working principle of designs of engine sub systems.
- To introduce and develop the concepts of engine performance evaluation and testing.
- To provide understanding knowledge of the cause, effect and control of emission from I C engine

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall and explain the fundamental principles of internal combustion engines.	**BT 1**
CO 2	Describe and interpret the function and design of various IC engine subsystems (fuel, cooling, lubrication, etc.).	**BT 2**
CO 3	Apply thermodynamic principles to analyze combustion and engine cycles.	**BT 3**
CO 4	Evaluate the performance of an IC engine through testing and interpret key parameters like efficiency and power output.	**BT 4**

Detailed Syllabus:

Modules	Topics/	Course content	Hours
I.	Introduction and Classification of Heat Engines.	Engine components and working. Two-stroke, four-stroke. Air standard cycles, analysis of Otto, Diesel and Dual engines. Fuel-air cycles and actual cycles. Measurement of speed, torque, fuel consumption, determination of IHP, BHP and FHP, specific fuel consumption, determination of indicated thermal efficiency, brake thermal efficiency and mechanical efficiency, plot of efficiency vs. speed curves. Speed-torque curve with *bsfc* muscle curve, Morse Test.	**10**
II.	Classification of	Classification and desirable characteristics of I.C. engine fuels, Rating of S.I. and C.I. engine fuels, Laboratory method of	**10**

	hydrocarbons in fuels,	determining Octane and Cetane Number. Alternative fuels (liquid, gaseous, etc.). Analysis of combustion product, HCV and LCV of the fuels. Combustion in I C Engines: Homogenous and heterogenous mixture, Stages of Combustion in S.I and C.I engines, Flame front propagation, Parameter influencing combustion, Detonation and knocking in S.I. and C.I. engines and their preventions, Combustion chamber design basics in SI Engine & CI Engines	
III.	Carburettor simple, Mechanical fuel injection system:	Analysis of simple carburettor, Mechanical fuel injection system: classification and working. Types of Injection pumps and nozzles. Mechanism of Spray formation, Calculation of fuel spray velocity. EFI system: working, sensors, MPFI, GDI Ignition systems in I.C. engines (Battery, magneto and electronic), ignition timing and spark advance.	**10**
IV.	Supercharging:	Types of superchargers, methods, effect and limitations of supercharging, Turbo charging, Downsizing and down-speeding of IC engines. Emission norms, Emission from IC Engines: classification (Exhaust and Non-exhaust), formation, control methods - catalytic and thermal converters, EURO and BS Norms Lubrication System: Function, types and working principle, properties of lubricating oil. Cooling system: Function, Types and working principle EMS (Engine Management System)	**10**
Total			**40**

Text Books:

1. V Ganesan, "Internal Combustion Engines", Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2012
2. M L Mathur, R. P. Sharma, "Internal Combustion Engines", Dhanpat Rai & Sons, 2014
3. H. N. Gupta, "Fundamentals of Internal Combustion Engines", PHI Learning Pvt. Ltd. University Press. 2nd edition, 2013
4. J. B. Heywood, "Internal Combustion Engine fundamentals", Mc Graw Hill Education, 1 edition, 2017

Paper IV / Subject Name: Dynamics of Machine		Code: MEE022C604
L-T-P-C –3-0-0-3	Credit Units: 3	Scheme of Evaluation: T

Objectives:

- To provide fundamentals of the basic components of forces acting over the machine components.
- To derive the equation motion of SDOF by using different methods such as energy method, Rayleigh's method and Newton's method.
- To provide understanding of the response of the system for various unbalances acting on the system
- To evaluate the natural frequencies of multi DOF system

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Interpret and explain turning moment diagrams for various engine and machine applications	**BT 2**
CO 2	Design a flywheel for an internal combustion engine or punching press considering energy fluctuations and cost constraints.	**BT 3**
CO 3	Analyze and contribute to vibration control solutions in mechanical systems, individually or as part of a team.	**BT4**

Detailed syllabus:

Modules	Topics	Course content	Hours
I.	**Force Analysis**	Applied and constraint forces – Free body diagrams – Static equilibrium conditions – Two, three & four members – Static force analysis of simple mechanisms – Dynamic force analysis –Inertia force and Inertia torque – D Alembert's principle – The principle of superposition –Dynamic Analysis in reciprocating engines – Gas forces – Equivalent masses – Bearing loads– Crank shaft torque – Turning moment diagrams – Fluctuation of energy – Fly Wheels –Engine shaking forces.	**08**

II.	**Free and Forced Vibration of SDOF**	Basic features of vibratory systems – Degrees of freedom–Natural frequency Derivation of equation motion – newton's method, energy method, Rayleigh's method,– Damped free vibration,- Resonance– Magnification factor, Response of rotating and reciprocating unbalance, support motion, vibration isolation, transmissibility – Critical speeds of shafts – Torsional vibration – Torsionally equivalent shaft – Two and three rotor systems.	**12**
III.	**Two Degrees and Multi Degrees of Freedom System**	Torsional vibration of two rotor system, vibrations of two DOF system, semi-definite system, Co-ordinate coupling, vibration absorber-Derivation of influence co-efficient matrix, generalized co-ordinates, Matrix method, Orthogonality principle, Matrix Iteration Method, Dunkerley's method, Holzer's Method,	**10**
IV.	**Dynamics of Governors and CAM**	Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force –. Classification of cams and followers – Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic, cycloidal and polynomial motions **Balancing of Inertia forces and Gyroscopic Action** Balancing of rotating masses, two-plane balancing, determination of balancing masses, balancing of Internal Combustion Engines. Gyro dynamics, free motion of symmetrical gyroscope, gyroscopic moment of a symmetrical gyroscope in regular precession, gyroscopic effects in machines	**10**
Total			**40**

Text Books:

1. Amitabha Ghosh, Asok Kumar Mallik, "Theory of Mechanisms and Machines", East-West Press.
2. V.P.Singh, "Mechanical Vibrations", Dhanpat Rai & Co
3. Rao.J.S. and Dukkipati.R.V. 'Mechanisms and Machine Theory', Wiley-Eastern Ltd., New Delhi, 1992.

Reference Books:

1. S S Rattan, "Theory of Machines", McGraw Hill publications.

Paper V / Subject Name: Dynamics of Machines Lab		**Subject Code: MEE022C614**
L-T-P-C – 0-0-2-1	**Credit Units: 01**	**Scheme of Evaluation: P**

Objectives:

- To understand the force-motion relationship in components subjected to External Forces.
- To analyse the force-motion characteristics of standard mechanisms

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Analyse the behaviour of bodies undergoing vibrations, both theoretically as well as practically.	**BT 4**
CO 2	Analyse and interpret data across all practical.	**BT 4**

Detailed Syllabus:

Experiment No	**Aim of the Experiment**	**Hours**
1.	To Study the undamped free vibration of spring mass system	03
2.	To study the forced vibration of spring mass system	03
3.	To find the natural frequencies of a two rotor system.	03
4.	To study the whirling phenomenon of shaft.	03
5.	To study the cam analysis by graphical method	03
Total		**15**

Paper VI / Subject Name: Production & Operations Management		Code: MEE022C606
L-T-P-C –3-0-0-3	Credit Units: 3	Scheme of Evaluation: T

Objectives:

1. To provide knowledge on machines and related tools for manufacturing various components.
2. To understand the relationship between process and system in manufacturing domain.
3. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall the fundamental principles of production and operations management	**BT 1**
CO 2	Explain the relationship between market demand and production capacity.	**BT 2**
CO 3	Apply resource planning techniques to optimize production processes and operations.	**BT 3**
CO 4	Analyze the impact of quality, cost, and time management tools on market competitiveness	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Project Management**	Scope of production management. Production system and resources (machines, tooling, etc.); Types of production (batch, flow and unit), Roles of line supervisors and production managers Project life cycle: concept phase (RFQ, Quotations, Proposals), Project initiations, DPR preparation (project value, business case development and feasibility study); Project planning (obtaining resources, acquiring financing and procuring required materials); Project team, producing quality outputs, handling risk, acceptance criteria; Project execution (allocation of resources, scheduling, building deliverables); Project Monitoring and control: Project networks, progress review	**10**

		(physical and financial), CPM and PERT, critical path, re-scheduling; Project closure: acceptance of project deliverable; Analytics: Performance, capability aggregation, cost benefit analysis, variability analysis, Output-outcome analysis, project documentation, best practices, and depository.	
II.	**Production Planning and Control**	Production planning, Process planning, Resource planning, demand-utility mapping (production capability index, forecasting models, aggregate production planning, materials requirement planning); Inventory Management: Economic order Quantity, discount models, stochastic inventory models, practical inventory control models, JIT; Supply chain and management.	**10**
III.	**Factory Management**	Factory layout: line balancing, material flow and handling, Lean and green manufacturing, Human resource management, Training need analysis, Advantage and opportunities for Digitalization, Advanced factory systems: TQM; Important acts, regularities and safety norms, Reliability assessment of processes, Block chain, Energy management, Efficiency & throughput, Overall equipment effectiveness. Process capability, lean manufacturing..	**10**
IV.	**Operation Management**	Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment; Simple queuing theory models; Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model..	**10**
TOTAL			**40**

Text Books:

1. L.J. Krajewski and L.P Ritzmen, Operations Management: Strategy and Analysis, Pearson, 2010.
2. R.B. Chase, F.R. Jacobs and N.J. Aquilano, Operations Management for Competitive Advantage, Tata McGraw Hill, 2011.
3. W. J. Hopp and M. L. Spearman, Factory Physics: Foundations of Manufacturing Management, McGraw Hill International Edition, 2008

Reference Books:

1. Mahadevan. B., Operations Management: Theory and Practice, Pearson, 2015.
2. Taha H. A., Operations Research, 6th Edition, PHI India, 2003.
3. M.P. Poonia, Total Quality Management, Khanna Publishing House, 2022

Online Resources:

1 https://onlinecourses.nptel.ac.in/noc20_mg06/preview

Paper VII / Subject Name: Engineering Project-1 (Seminar)		Code: MEE022C617
L-T-P-C –0-0-4-2	Credit Units: 2	Scheme of Evaluation: P

Objectives:

1. This course is aimed to provide more weightage for project work.
2. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college.
3. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course

DETAILED SYLLABUS OF 7th SEMESTER

Paper I / Subject Name: Product Innovation & Entrepreneurship		**Code: MEE022C701**
L-T-P-C –3-0-0-3	**Credit Units: 3**	**Scheme of Evaluation: T**

Objectives:

To expose aspiring student entrepreneurs to various elements of a technology venture starting from market need identification to innovative solution development and its commercialization through business planning and start-up company incubation.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Identify and describe unmet customer needs through structured market research methods	**BT 1**
CO 2	Develop and validate innovative solutions based on problem-solution fit and customer feedback.	**BT 3**
CO 3	Analyze and plan business strategies, including marketing, fund-raising, and incubation for a new venture.	**BT 4**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I.	**Entrepreneurship**	Role of entrepreneurship in economic development; Entrepreneurial mindset, motivation and competencies; Market pull and technology push factors; New product development lifecycle; Technology readiness levels; Product-market fit validation; Commercialization pathways; Business vision & leadership; Team composition & management..	**10**
II.	**Product Innovation**	Opportunity scanning, market survey, need identification and problem definition; Creative design thinking for concept generation; Detailed design & prototyping; Functionality & manufacturability; Bill of materials & components supply chain; Manufacturing & assembly plan; Product testing & quality assurance; Intellectual property rights management.	**10**

III.	**Marketing & Finance**:	Market segmentation & market sizing; Customer persona & value proposition; Marketing (Go-to-market) strategy; Distribution channels and sales network; Funding requirement (based on stage); Source of funding for startup ventures; Financial projections and accounting; Startup to scale up financing.	**10**
IV.	**Venture Creation**	Sustainable business options & pathways; Business model & business canvas; Startup team & business partners; Startup ecosystem and stakeholders; Technology business incubators & parks; Proposal pitching & agreements; Startup company incorporation; Social impact & responsibility. **Course Project**: Need identification, innovative solution, business plan, go-to-market strategy	**10**
TOTAL			**40**

Text Books:

1. Bill Aulet, "Technology Entrepreneurship", 4th ed., Tata McGraw Hill, 2014.
2. Peter F. Drucker, "Innovation and Entrepreneurship", 1st ed., Harper Business, 2006.
3. Chelat Bhuvanachandran, Innovision, Khanna Book Publishing, 2022.

Reference Books:

4. Byers, Dorf, and Nelson, Technology Ventures: From Ideas to Enterprise, McGraw Hill, 2010
5. Steve Blank, "The Startup Owner's Manual"
6. T.V. Rao, "Entrepreneurship - A South Asian Perspective"

Online Resources:

https://onlinecourses.nptel.ac.in/noc22_ge03/preview

Paper II / Subject Name: Finite Element Method		Code: MEE022D702
L-T-P-C –3-0-0-3	Credit Units: 3	Scheme of Evaluation: T

Objectives

- To provide understanding of the general steps of finite element method.
- To introduce the basic finite element formulation techniques.
- To derive the equations for 1D and 2D problems.
- To formulate and solve basic problems in heat transfer, solid mechanics and fluid mechanics.
- To derive the shape functions in terms of natural coordinates
- To solve any problems by any FE software such as ANSYS or be able to develop a code by their own.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall the basic concepts of stress, strain, and governing differential equations used in FEM	**BT 1**
CO 2	Explain the formulation of shape functions and element matrices for 1D and 2D problems.	**BT 2**
CO 3	Apply the finite element procedure to solve simple structural, thermal, or fluid problems.	**BT 3**
CO 4	Analyze the results of FEM simulations and evaluate the influence of mesh quality and boundary conditions.	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Hours
I.	**Finite Element Discretization,Direct stiffness methods and FE approximation methods** Basic concept of structural modelling, Introduction to FE modelling, Solving Axial rod and bending of beams by direct stiffness method – Pre-processing, solving, Post processing. Extensions to plane truss problems. Variational form – principle potential energy, Galerkin, RITZ, Least square method, collocation method	**10**
II.	**1D & 2D Finite element formulation, Numerical Integration** Finite element formulation-completeness, compatibility, shape functions for c^0 and c^1 element, RITZ method, Galerkin method for axial rod problem, Steady state heat conduction problem, heat conduction in polar coordinates and fluid	**12**

	problems. Introduction to types of 2D element, triangular element, tetrahedral element, brick element and rectangular element, pascal's triangle, CST element- 3 node , 6 node and 10 node. Fluid flow problem. Introduction to quadrature, One Dimensional Integration Formulae - Gauss Quadrature 2 point and 3 point.	
III.	**2D FEM : Detailed Discussion** Introduction- Natural Coordinates and Iso-Parametric, Sub-Parametric and Super-Parametric Elements, Four-Noded Quadrilateral Elements, Serendipity Elements, Eight-Noded Curvilinear Elements.	**8**
IV.	**Finite Element Formulations:** Finite element formulation for plane stress and plane strain problems, vibrations of a rod, vibrations of a beam, Thin plate formulation, Thick-plate formulation. Time history problems. Solving FEM Problems on a Computer: FEM Package – ANSYS, MATLAB.	**10**
Total		**40**

Text Books:

1. U.S Dixit, "Finite Element Methods for Engineers". Cengage Learning; 1st edition, 2009
2. R.D. Cook, D.S. Malkus and M.E. Plesha, "Concepts and Applications of Finite Element Analysis", Wiley; Fourth edition (2007)

Reference Books:

1. T.R. Chandrupatla and A.D. Belegundu, "Introduction to Finite Elements in Engineering:, Prentice Hall of India.
2. J.N. Reddy, "An Introduction to the Finite Element Method", McGraw-Hill.
3. S. S. Rao, "Finite Element Analysis", Elsevier Butterworth-Heinemann

Paper III / Subject Name: Renewable Energy Engineering		Code: MEE022D703
L-T-P-C –3-0-0-3	Credit Units: 3	Scheme of Evaluation: T

Objectives:

- To acquire knowledge of technical competency combined with research to generate innovative solutions in Energy engineering.
- To be acquainted with a variety of options in energy sources.
- To prepare the students to exhibit a high level of professionalism, integrity, environmental and social responsibility, and life-long independent learning ability with environment in mind.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall and explain fundamental concepts and terminologies in energy engineering and energy management	**BT 1**
CO 2	Describe different energy systems, energy audit practices, and relevant management strategies.	**BT 2**
CO 3	Apply scientific and engineering principles to evaluate the performance of various energy systems.	**BT 3**
CO 4	Analyze energy consumption patterns and propose management solutions for improving energy efficiency in systems.	**BT 4**

Detailed Syllabus :

Modules	Topics	Course content	Hours
I.	**Introduction**: **Solar Energy**	Basic concepts of energy; Introduction to Renewable Energy Technologies; Energy and Environment – global warming, acid rains, depletion of ozone layer; Global and Indian Scenario of renewable energy sources; Energy storage - necessity and energy storage methods Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems. Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems	**20**

II.	**Wind Energy**	Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems. **Fuel cells**: Overview; Classification of fuel cells; Operating principles; Fuel cell thermodynamics	**10**
III.	**Biomass Energy**	Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.	**5**
IV.	**Other forms of Energy**:	Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles.	**5**
Total			**40**

Text /Reference Books:

1. O.P. Gupta, "Energy Technology", Khanna Book Publishing, New Delhi.
2. V.V.N. Kishore, "Renewable Energy Engineering and Technology: Principles and Practice," Routledge, 1st Edition, 2019.
3. N. Jenkins and J. Ekanayake, "Renewable Energy Engineering," Cambridge University Press, 1st Edition, 2017.
4. G. Boyle, "Renewable Energy," OUP Oxford, 2nd Edition, 2009

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ph44/preview
2. https://onlinecourses.swayam2.ac.in/nou22_ge71/preview

Paper IV / Subject Name: Additive Manufacturing		Code: MEE022O704
L-T-P-C –3-0-0-3	Credit Units: 3	Scheme of Evaluation: T

Objectives:

To provide an overview of Additive Manufacturing proceses, systems and applications.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall and describe the fundamental principles, technologies, and processes involved in additive manufacturing	**BT 1**
CO 2	Explain and compare various additive manufacturing techniques with respect to materials, capabilities, and applications.	**BT 2**
CO 3	Select suitable additive manufacturing methods for different product design and end-use requirements.	**BT 3**
CO 4	Analyze and plan the complete workflow for fabricating a part using additive manufacturing processes.	**BT 4**

Detailed Syllabus :

Modules	Topics	Course Contents	Hours
I.	**Introduction to Additive Manufacturing (AM)**	Evolution of AM/3D printing; Comparison with subtractive and forming processes; Advantages of AM; Classification of AM processes; Key steps in AM.	**10**
II.	**Liquid State-based AM Processes**	Stereo lithography – Process and working principle; Photopolymers; Photo polymerization, layering technology, Laser and Laser scanning; Micro-stereolithography; Equipment and specifications; Applications, advantages, disadvantages, examples; Solid ground curing: Process, Working principle; Equipment and specifications; Applications, advantages, disadvantages, examples.	**10**
III.	**Solid State-based AM Processes**	Fused Deposition Modeling – Process, working principle and materials; Equipment and specifications; Laminated object manufacturing – Process and working principle; Equipment and specifications; Applications, advantages, disadvantages, examples; Other solid-state processes – Ultrasonic consolidation, Gluing, Thermal bonding; Demonstration of equipment.	**10**

IV.	**Powder Based AM Processes**	Powder Bed Fusion Processes – Working principle and materials; Powder fusion mechanism and powder handling; Various LBF processes (principle, materials, applications and examples) – Selective laser Sintering, Electron Beam Melting, Laser Engineered Net Shaping, Binder Jetting and Direct Metal Deposition; Comparison between LBF processes; Materials-process-structure-property relationships; relative advantages and limitations. Product development lifecycle applications – Rapid prototyping, concept models, visualization aids, replacement parts, tooling, jigs and fixtures, moulds and casting; Application sectors – aerospace, automobile, medical, jewelry, sports, electronics, food, architecture, construction and others.	**10**
		Total	**40**

Text Books:

1. Sabrie Soloman, 3D Printing & Design, Khanna Book Publishing Company, New Delhi, 2020.
2. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing", Springer, 2015

Reference Books:

1. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications," World Scientific, 2015.
2. C.P Paul, A.N Junoop, "Additive Manufacturing: Principles, Technologies and Applications," McGrawHill, 2021

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_me115/preview
2. https://onlinecourses.nptel.ac.in/noc20_mg70/preview

Paper V / Subject Name: Composite Materials		Code: MEE022O705
L-T-P-C –3-0-0-3	Credit Units: 3	Scheme of Evaluation: T

Objectives:

- To make the students understand different processing methods, issues, properties and testing methods of different composite materials

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall the types, structures, and properties of different materials used in composite design.	**BT 1**
CO 2	Explain the role of reinforcement and matrix materials in composite behavior and selection.	**BT 2**
CO 3	Apply appropriate manufacturing techniques for different composite materials based on their type and application..	**BT 3**
CO 4	Analyze the limitations and suitability of various composite processing methods for specific design and performance goals.	**BT 4**

Detailed Syllabus:

Modules	Topics	Topics / Course content	Hours
I.	**INTRODUCTION TO COMPOSITES**	Fundamentals of Composites – Need for Composites – Enhancement of Properties – Classification of Composites – Matrix-Polymer Matrix Composites (PMC), Metal Matrix Composites (MMC), Ceramic Matrix Composites (CMC) – Reinforcement – Particle Reinforced Composites, Fibre Reinforced Composites. Applications of Various Types of Composites. Fiber Production Techniques for Glass, Carbon and Ceramic Fibers	**10**

II.	**POLYMER MATRIX COMPOSITES**	Polymer Resins – Thermosetting Resins, Thermoplastic Resins – Reinforcement Fibres – Rovings – Woven Fabrics – Non-Woven Random Mats – Various Types of Fibres. PMC Processes – Hand Lay Up Processes – Spray Up Processes – Compression Moulding – Reinforced Reaction Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament Winding – Injection Moulding. Fibre Reinforced Plastics (FRP), Glass Fibre Reinforced Plastics (GFRP). Laminates-Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. -Applications Of PMC In Aerospace, Automotive Industries	**10**
III.	**METAL MATRIX COMPOSITES**	Characteristics Of MMC, Various Types of Metal Matrix Composites Alloy Vs. MMC, Advantages Of MMC, Limitations Of MMC, Reinforcements – Particles – Fibres. Effect of Reinforcement – Volume Fraction – Rule Of Mixtures. Processing of MMC – Powder Metallurgy Process – Diffusion Bonding – Stir Casting – Squeeze Casting, A Spray Process, Liquid Infiltration In-Situ Reactions-Interface-Measurement Of Interface Properties-Applications Of MMC In Aerospace, Automotive Industries	**10**
IV.	**CERAMIC MATRIX COMPOSITES AND SPECIAL COMPOSITES**	Engineering Ceramic Materials – Properties – Advantages – Limitations – Monolithic Ceramics – Need for CMC – Ceramic Matrix – Various Types of Ceramic Matrix Composites- Oxide Ceramics – Non-Oxide Ceramics – Aluminium Oxide – Silicon Nitride – Reinforcements – Particles- Fibres-Whiskers. Sintering – Hot Pressing – Cold Isostatic Pressing (CIPing) – Hot Isostatic Pressing (HIPing). Applications of CMC In Aerospace, Automotive Industries- Carbon /Carbon Composites – Advantages of Carbon Matrix – Limitations of Carbon Matrix Carbon Fibre – Chemical Vapour Deposition of Carbon on Carbon Fibre Perform. Sol-Gel Technique- Processing of Ceramic Matrix Composites	**10**
Total			**40**

Text Books:

1. Mathews F. L. And Rawlings R. D., "Composite Materials: Engineering and Science", 1st Edition, Chapman and Hall, London, England, 1994.
2. Chawla K. K., "Composite Materials", Second Edition, Springer – Verlag, 1998.

Reference Books:

1. Clyne, T. W. And Withers, P. J., "Introduction to Metal Matrix Composites", Cambridge University Press, 1993.
2. Strong, A.B., "Fundamentals of Composite Manufacturing", SME, 1989.
3. Sharma, S.C., "Composite Materials", Narosa Publications, 2000.
4. Broutman, L.J. And Krock,R.M., " Modern Composite Materials", Addison-Wesley, 1967.
5. ASM Hand Book, "Composites", Vol.21, ASM International, 2001.

Paper VI / Subject Name: Internship Evaluation (Seminar) **Subject Code: MEE022C706**

L-T-P-C – 0-0-0-5 **Credit Units: 05** **Scheme of Evaluation: P**

Objective

- To acquire industrial experience.

Course Outcomes:

On successful completion the student will be able to:

- Acquire and apply fundamental principles of engineering.
- Update with all the latest changes in technological world.
- Identify, formulate and model problems and find engineering solution based on a systems approach

The students need undertake minimum 3 weeks summer training in research institute/organization or industries at the end of the 6th semester. A report needs to be submitted in the start of 7th semester. The students will have to give a presentation on the summer training undertaken during the 6th semester.

Paper VII / Subject Name: Engineering Project-2 (Design & Analysis)		Code: MEE022C717
L-T-P-C –0-0-0-5	Credit Units: 5	Scheme of Evaluation: P

Objectives:

- This course is aimed to provide more weightage for project work.
- The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college.
- Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

DETAILED SYLLABUS OF 8th SEMESTER

Paper I/ PE 3		**Subject Code: MEE022D801**
Subject Name: Computational Fluid Dynamics (CFD)		
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objectives:

- To provide students with the ability to simulate fluid flow, heat, and mass transfer phenomena in a wide range of engineering and natural systems.
- To highlight the necessity of accurate flow prediction for the design and optimization of thermal and fluid-based devices.
- To develop an understanding of the fundamental principles and numerical methods of CFD, with an emphasis on practical applications and design optimization in modern engineering systems.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall and explain the fundamentals of aerodynamic flow and the mathematical form of Navier–Stokes equations.	**BT 1**
CO 2	Describe and set up a CFD problem with appropriate geometry, meshing, and boundary conditions using commercial tools,	**BT 2**
CO 3	Apply CFD software to solve simplified flow problems and simulate engineering systems with appropriate physical parameters	**BT3**
CO 4	Analyze CFD results, validate them against available data, and interpret the findings in the context of engineering applications.	**BT 4**

Detailed Syllabus:

Modules	**Topics**	**Topics / Course content**	**Hours**
I.	**The Equations of Fluid Dynamics**	General form of a Conservation law: equation of mass conservation, conservation law of momentum, conservation equation of energy. The Navier-Stoke's equation, Reynold's Averaged NS equation, Boundary Layer Approximations, The distributed loss model, The inviscid flow model, Euler equations, steady inviscid rotational flow, The potential flow model. Non-dimensionalization of Continuity, NS and Energy equations and its applications	**10**

II.	**Basic discretization techniques:**	Types of Partial Differential Equations and its applications, Truncation Error analysis, Consistency, Stability, Convergence. The finite difference method: Conversion of PDE to FDE using Taylors Series and 3-Point Method. The finite volume method and conservative discretization: Integral Method - Meshing and Grid Generation	**10**
III.	**Solutions of Poisson's and Laplace equation**	FTCS method- FTFS method etc. Solution of 1D Heat conduction equation – Simple explicit method – ADI method – DuFort-Frankel method – Crank Nicolson method etc.	**10**
IV.	**Solution of Berger's equation for Inviscid and Viscous flow using implicit and explicit methods**	Solution of Berger's equation for Inviscid and Viscous flow using implicit and explicit methods. Solution of Wave equation – Euler explicit method – Lax method – Upwind method – MacCormack method – Leap Frog method etc	**10**
Total			**40**

Text Books:

1. Johan D Anderson, JR., "Computational Fluid Dynamics" McGraw-Hill Education Private Ltd, New Delhi.

Reference Books:

1. Johan D Anderson, JR., "Computational Mechanics and Heat Transfer" Taylor & Francis.
2. T. J. Chung, "Computational Fluid Dynamics" Cambridge University Press.
3. Verlag., "Computational techniques for Fluid Dynamics" Fletcher and Springer.
4. Charlse and Hirch., "Numerical Computation of Internal and External flows" John-Wiley
5. John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, "Computational Fluid Mechanics and Heat Transfer" Taylor &Francis.

Paper II/ Subject Name: Refrigeration and Air Conditioning		Subject Code: MEE022C802
L-T-P-C – 3-0-0-3	**Credit Units: 03**	**Scheme of Evaluation: T**

Objectives:

1. To familiarize with the terminology associated with refrigeration systems and air conditioning 2. To understand basic refrigeration processes
2. To understand the basics of psychrometry and practice of applied psychrometrics
3. To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall the fundamental principles, terminologies, and components involved in refrigeration and air conditioning systems.	**BT1**
CO 2	Explain the working of various refrigeration cycles (e.g., vapor compression, absorption) and psychrometric processes.	**BT2**
CO 3	Apply thermodynamic principles to design and analyze basic refrigeration and air conditioning systems.	**BT3**
CO 4	Analyze system performance using COP, refrigeration effect, and psychrometric charts under varying operating conditions.	**BT4**

Detailed Syllabus:

Modules	**Topics**	**Course Contents**	**Hours**
I.	**Introduction To Refrigeration And Air-Conditioning**	Basic Definitions of Refrigeration and Air-Conditioning; History of Refrigeration; Natural and Artificial Refrigeration Methods; Techniques to produce low temperatures; Applications of Refrigeration; Refrigerants- Classification, Nomenclature, Desirable Properties, Selection. Air Refrigeration Cycles - reversed Carnot cycle; Bell-Coleman cycle analysis; various methods of Aircraft Refrigeration: Analysis, Merits and demerits.	**10**
II.	**Vapor Compression Refrigeration System**	Ideal VCR cycle (Working, Analysis and Limitations); Standard VCRS (Working and Analysis); Methods to improve performance of VCR; Multi-Stage VCRS; Cascade Refrigeration. **Components of Refrigeration Systems:** Compressors: Positive Displacement (Reciprocating and Rotary); Dynamic (Centrifugal and Axial) Compressors; Condensers and Evaporators (Both Natural and Forced	**10**

		Convection type); Expansion Devices and other components of the system	
III.	**Vapor Absorption Systems** **Psychrometry:**	Working and Analysis; Absorbent - Refrigerant combinations; Water-Ammonia Systems; Water-Lithium Bromide System; Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly. Brief Discussion on (i) Steam-Jet refrigeration system; (ii) Vortex tube refrigeration; (iii) Thermoelectric refrigeration system; and (iv) Magnetic refrigeration **Psychrometry:** Classification of Air-Conditioning Systems; ASHRAE Nomenclature; Applications of Air-Conditioning; Psychrometry - Air-water vapor mixtures; Psychrometric Properties; Psychrometric or Air-Conditioning processes; Psychrometric Chart.	**10**
IV.	**Air-Conditioning Systems**	Classification of Air-Conditioning Systems; Psychrometry of Air-Conditioning Systems; Thermal Comfort (Definition and Psychrometric Properties for Thermal Comfort); Mathematical Analysis of Air-Conditioning Systems; Cooling and Heating Load Estimation; a brief discussion on Ventilation.	**10**
TOTAL			**40**

Text Books:

1. Singh, Sadhu., Refrigeration and Air conditioning, Khanna Book Publishing Edition, 2021.
2. Domkundwar, Refrigeration and Air conditioning, Dhanpat Rai.
3. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.

Reference Books:

1. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986.
2. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
3. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.

Online Resources:

https://onlinecourses.nptel.ac.in/noc22_me135/preview

Paper III / Subject Name: Automobile Engineering (OE3)		Code: MEE022O803
L-T-P-C –3-0-0-3	Credit Units: 3	Scheme of Evaluation: T

Objectives :

To understand the construction and working principle of various parts of an automobile.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Recall the fundamental components and subsystems of automobiles including engine, transmission, suspension, and brakes.	**BT 1**
CO 2	Explain the working principles of vehicle systems such as steering, powertrain, and braking under different conditions.	**BT 2**
CO 3	Apply engineering principles to identify and solve problems related to vehicle performance and system integration.	**BT 3**
CO 4	Analyze different automotive technologies and evaluate their impact on safety, efficiency, and environmental compliance.	**BT 4**

Detailed Syllabus:

Modules	Topics	Course Contents	Hours
I.	**Introduction to History of automobiles**	History of automobiles; Classification of automobiles; Power plant classification; Engine terminology; Types of cycles; Working principle of an IC engine; Advanced classification of engines and multi cylinder engines; Engine balance and firing order. *Spark Ignition engines* – fuel tank, fuel filter, fuel pump, air filter, carburetor, direct injection of petrol engines; *Compression Ignition engines* – fuel injection (air and solid), pressure charging, super charging and turbo charging; *Ignition systems* – components, battery ignition, magneto ignition, electronic ignition and ignition timing; *Main electrical circuits* – generating & starting circuit, lighting, indicating devices	**10**
II.	**Lubricating System and Cooling System**	Functions & properties of lubricants, methods of lubrication; Oil filters, oil pumps, oil coolers; Characteristics of an effective cooling system; types of cooling systems; Radiator, thermostat, air cooling & water cooling.	**10**
III.	**Chassis & Transmission**	**Chassis & Transmission**: Parts of automobile body; *Automobile frames* – functions, constructions, sub frames, materials and defects; *Transmission* – axles, clutches, propeller shafts, differential, gear boxes, automatic transmission, electronic transmission control, functions and types of front and rear axles, types and functions of clutches, Hotchkiss drive torque tube drive, traction control **Steering, Braking and Suspension**: Steering	**10**

		mechanism, steering gear box types, wheel geometry; Brakes – principle, functions, types, construction, operation and parking brake; *Suspension* - types of spring shock absorbers, objectives and types of suspension system, rear axle suspension, electronic control and proactive suspension system	
IV.	**Recent Trends**:	Ventilation, heating, air condition, refrigerant, compressor and evaporator. **Wheels and Tyres:** Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications. E-vehicles; Satellite-based navigation; Automated steering; Environment effect and mitigation.	**10**
TOTAL			**40**

Text /Reference Books:

1. A.K. Babu, S.C. Sharma, Automobile Mechanics, Khanna Book Publishing, 2019.
2. A.K. Babu, S.C. Sharma, Automobile Engines, Khanna Book Publishing, 2019.
3. Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 1997.
4. Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2002.
5. Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
6. Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

Online Resources:

1. https://archive.nptel.ac.in/courses/107/106/107106088/

Paper IV / Subject Name: Engineering Project-3 (Prototype& Testing)		Code: MEE022C804
L-T-P-C –0-0-0-8	Credit Units: 8	Scheme of Evaluation: P

Objectives:

- It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.
- During VIIIth semester, each student is required to complete the project as per the plan made in the preliminary report submitted during the VIIth semester. At the middle of the VIIIth semester an Interim Evaluation will be carried out by the evaluation committee constituted in the previous semester. At the end of the semester, each student should also appear for Final Evaluation.
- Interim Evaluation of the project should be done at the middle of the eighth semester by the committee. Each student should submit a copy of the Interim Report of the Project before the committee. Also, copies of the Approval of Project and Preliminary Report shall be submitted to the evaluation committee. The committee will award marks based on the student-wise performance. The respective guide will award the individual internal marks