

NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH



RULES AND REGULATIONS SCHEME OF INSTRUCTION AND SYLLABI B.TECH. – MECHANICAL ENGINEERING Effective from 2024-25



NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

VISION

To nurture and produce highly competent engineers, scientists, and entrepreneurs committed to catering to futuristic societal challenges through holistic education synergetic with innovations and a vibrant research ecosystem.

MISSION

- To implement best practices in teaching-learning methodologies for establishing a dynamic knowledge-connected society.
- To create a conducive environment for carrying out research in multi-disciplinary areas and there by nurturing novel thinking capabilities.
- To strengthen the industry-institute interface to inculcate entrepreneurship abilities.
- To address all technological needs of the Nation for self-sustenance.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To impart professional education in mechanical engineering to become successful entrepreneurs capable of developing innovative, interdisciplinary, and sustainable globally competitive technologies and nurture the students as responsible citizens service to the society.

MISSION

- To impart mechanical engineering education with the latest teaching-learning processes.
- To equip the students with the advanced tools to make them suitable for global employment and societal requirements.
- To train the students to solve engineering problems in multi-disciplinary areas.
- To inculcate professional ethics and human values.



Department of Mechanical Engineering:

The Department of Mechanical Engineering at NIT Andhra Pradesh offers a B.Tech. undergraduate programme in Mechanical Engineering, M.Tech. in Manufacturing Engineering and Thermal Engineering, M.S. (by research), and Ph.D. programmes. The department was incepted in the year 2015 with a current sanctioned intake of 120 students for the B.Tech. programme.

The B.Tech. curriculum offered by the department comprises core courses that provide a sound theoretical foundation which is supplemented through industry-relevant elective courses and a project component. The department hosts M.Tech. programmes in Manufacturing Engineering and Thermal Engineering each with an intake of 15 students, from the Academic Year 2020-21 onwards. The M.Tech. curriculum is designed in such a way as to provide a sound theoretical and practical foundation for conducting high-quality research in the thrust sub-domains of the respective specializations.

Regular faculty in the department are experienced and possess degrees from reputed institutions. Faculty members in the department work on research domains including but not limited to IC engine combustion, Biodiesel and other biofuels, Regulated and unregulated emissions, Refrigeration and Air Conditioning, Energy Efficient Thermal Systems, Computational Fluid Dynamics, Cavitation, Heat Transfer in Space Applications, Micro-scale flows and Biological application of Ultrasound, Material Science and Metallurgy, Composite Materials, Manufacturing Technology, Artificial Neural Networks, Additive Manufacturing - Artificial Intelligence Applications in Manufacturing - Weld and Laser-Based Depositions - FEA of metal-deposition Processes - Metal Matrix Composite Materials - CNC Machining, Optimization of Scheduling and Inventory Problems, Soft Computing Techniques, Manufacturing Processes.

The department has vibrant and dynamic professional societies that nurture the technical/soft skills of students. The effectiveness of the strong curriculum and faculty in the Department is attested by the student achievements including but not limited to the number of students placed in core companies and the number of students enrolling for higher studies in institutions of national and international repute.



Within a short span of its inception, the Department boasts of around 150 plus publications in extremely high-impact journals and conferences. Faculty in the department are very active in authoring Books and Book chapters and in disseminating best practices in research through Faculty Development Programmes.

The Department has conducted eleven faculty development programs within the past three academic years and has conducted four Faculty Development Programs (FDP) sponsored by AICTE, Govt. of India. The Department is currently handling 50 Lakhs worth of research projects sponsored by DST.

The Department of Mechanical Engineering has the following five laboratories with the relevant Manufacturing and thermal Engineering Laboratories to support the undergraduate, postgraduate laboratories and research work of the doctoral students. The Department currently hosts 8 full-time and 35 part-time research scholars working towards solving open contemporary research problems in mechanical engineering domains.

**B.Tech. MECHANICAL ENGINEERING****Program Outcomes (POs)**

At the end of the program, the student will be able to:

PO1	Engineering knowledge: Apply knowledge of mathematics, science and engineering to analyze, design and evaluate mechanical components & systems using state -of-the-art IT tools.
PO2	Problem analysis: Analyze problems of mechanical engineering including thermal, manufacturing and industrial systems to formulate design requirements.
PO3	Design/Development of solutions: Design, implement, and evaluate mechanical systems and processes considering public health, safety, cultural, societal and environmental issues.
PO4	Conduct investigations of complex problems: Design and conduct experiments using domain knowledge and analyze data to arrive at valid conclusions.
PO5	Modern tool usage: Apply current techniques, skills, knowledge and computer based methods & tools to develop mechanical systems
PO6	The engineer and society: Analyze the local and global impact of modern technologies on individual organizations, society and culture
PO7	Environment and sustainability: Apply knowledge of contemporary issues to investigate and solve problems with a concern for sustainability and eco friendly environment.
PO8	Ethics: Exhibit responsibility in professional, ethical, legal, security and social issues
PO9	Individual and team work: Function effectively in teams, in diverse and multidisciplinary areas to accomplish common goals.
PO10	Communication: Communicate effectively in diverse groups and exhibit leadership qualities.
PO11	Project management and Finance: Apply management principles to manage projects in multidisciplinary environment.
PO12	Life-long learning: Pursue life-long learning as a means to enhance knowledge and skills.

Program Specific Outcomes (PSOs)

PSO1	Apply mechanical engineering and interdisciplinary knowledge for analyzing, designing and manufacturing products to address the needs of the society.
PSO2	Apply state of the art tools and techniques to conceptualize, design and introduce new products, processes, systems and services.
PSO3	Apply research-based methods to innovate, improve, and validate theoretical understandings for addressing the needs of industries and the society.

**SCHEME OF INSTRUCTION****B.Tech. (Mechanical Engineering) Course Structure****Note:**

1. All BSC Courses must be offered within V Semester (Including).
2. All ESC Courses must be offered within VI Semester (Including).
3. For all courses in the HSC basket, slots are reserved in the template.
4. Open electives/DAC approved Free Electives (MOOCS/NPTEL etc.) shall be offered from IV semester.
5. Department electives shall be offered from IV semester.
6. VIII semester is reserved for a semester-long internship or an additional courses/project at the institute.

I – Year: I – Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.		English Communication	2	0	0	2	HSC
2.	MA1071	Differential and Integral Calculus	3	0	0	3	BSC
3.	PH1011	Engineering Physics	2	0	0	2	BSC
4.	CY1011	Engineering Chemistry	2	0	0	2	BSC
5.	ME1013	Engineering Drawing with CAD	2	0	2	3	ESC
6.	ME1021	Basics of Mechanical Engineering	2	0	0	2	ESC
7.	PH1012	Physics Laboratory	0	1	2	1	BSC
8.	CY1042	Chemistry Laboratory	0	1	2	1	BSC
9.	PE1012	Physical Education - I	0	0	2	1	HSC
Total						17	

I – Year: II – Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	MA1081	Fundamentals of Matrices and Differential Equations	3	0	0	3	BSC
2.	EE1621	Introduction to Electrical & Electronics Engineering	2	0	0	2	ESC
3.	ME1031	Engineering Mechanics	2	1	0	3	PCC
4.	CS1031	Problem Solving Through Computer Programming	3	0	0	3	ESC
5.	ME1041	Introduction to Automation	2	0	0	2	PCC
6.	ME1051	Engineering Thermodynamics	2	0	0	2	PCC
7.	CS1032	Problem Solving Through Computer Programming Laboratory	0	1	2	2	ESC
8.	ME1062	Fabrication Laboratory	0	0	2	1	ESC
9.	PE1022	Physical Education - II	0	0	2	1	HSC
Total						19	



Note:

BSC: Basic Science Courses

ESC: Engineering Science Courses

PCC: Professional Major Core Courses

DEC: Professional Major Elective Courses

OEC: Open Elective Courses

HSC: Humanities and Social Science Courses

PRC: Professional Major Work

SLI: Semester Long Internship

SCHEME OF INSTRUCTION
B.Tech. (Mechanical Engineering) Course Structure

II – Year: I – Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	MA2061	Probability and Transformation Techniques	2	1	0	3	BSC
2.	MM	Materials Science and Metallurgy	2	0	0	2	ESC
3.	ME2071	Manufacturing Science-I	2	0	0	2	PCC
4.	ME2081	Fluid Mechanics	2	0	0	2	PCC
5.	ME2091	Applied Thermal Engineering	2	0	0	2	PCC
6.	ME2101	Mechanics of Solids	2	1	0	3	PCC
7.	ME2111	Geometric Modelling for CAD	2	0	0	2	PCC
8.	ME2122	Manufacturing Science - I Laboratory	0	1	2	2	PCC
9.	ME2132	Fluid Mechanics Laboratory	0	0	2	1	PCC
10.	ME2142	Materials Testing Laboratory	0	0	2	1	PCC
11.	HS2011	Personality Development / Life Skills	1	0	0	1	HSC
12.	PE2012	Yoga	0	0	2	1	HSC
Total						22	

II – Year: II – Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.		Open Elective /DAC approved Free Electives (NPTEL, MOOCs, etc.)	3	0	0	3	OEC
2.	ME2151	Theory of Machines	2	1	0	3	PCC
3.	ME2161	Manufacturing Science-II	2	0	0	2	PCC
4.	ME2173	Machine Drawing and Solid Modelling	2	0	2	3	PCC
5.	ME2181	IC Engines and Gas Turbines	2	0	0	2	PCC
6.		DE-1	3	0	0	3	DEC
7.	ME2192	IC Engines Laboratory	0	1	2	2	PCC
8.	ME2202	Manufacturing Science – II Laboratory	0	0	2	1	PCC
9.	ME2212	Theory of Machines Laboratory	0	1	2	2	PCC
10.	HS2052	National Service Scheme (NSS)	0	0	2	1	HSC
Total						22	

**SCHEME OF INSTRUCTION****B.Tech. (Mechanical Engineering) Course Structure****III – Year: I – Semester**

S.No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.		Open Elective /DAC approved Free Electives (NPTEL, MOOCs, etc.)	3	0	0	3	OEC
2.	ME3221	Design of Machine Members	2	1	0	3	PCC
3.	ME3231	Industrial Engineering and Management	3	0	0	3	PCC
4.	ME3241	Measurements and Instrumentation	3	0	0	3	PCC
5.	ME3251	Heat Transfer	2	0	0	2	PCC
6.		DE-2	3	0	0	3	DEC
7.		DE-3	3	0	0	3	DEC
8.	ME3262	Heat Transfer Laboratory	0	0	2	1	PCC
9.	ME3272	Measurements and Instrumentation Laboratory	0	0	2	1	PCC
10.	SM3011	Introduction to Entrepreneurship	1	0	0	1	HSC
Total			17	1	5	23	

III – Year: II – Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.		Open Elective /DAC approved Free Electives (NPTEL, MOOCs, etc.)	3	0	0	3	OEC
2.	ME3281	Smart Manufacturing	2	0	0	2	PCC
3.	ME3291	Finite Element Method	2	0	0	2	PCC
4.		DE-4	3	0	0	3	DEC
5.		DE-5	3	0	0	3	DEC
6.	ME3301	Operations Research	2	0	0	2	PCC
7.	ME3312	Smart Manufacturing Laboratory	0	0	2	1	PCC
8.	ME3322	CAE Laboratory	0	0	2	1	PCC
9.	HS3011	English for Engineers II	2	0	2	3	HSC
10.	SM3021	Introduction to Design Thinking	1	0	0	1	HSC
Total						21	

**SCHEME OF INSTRUCTION****B.Tech. (Mechanical Engineering) Course Structure****IV – Year: I – Semester**

S.No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.		Open Elective /DAC approved Free Electives (NPTEL, MOOCs, etc.)	3	0	0	3	OEC
2.		Open Elective /DAC approved Free Electives (NPTEL, MOOCs, etc.)	3	0	0	3	OEC
3.	ME4334	Professional Major Work	0	0	6	6	PRC
4.		DE-6	3	0	0	3	DEC
5.	ME4343	Mechatronics	1	0	2	2	PCC
6.		Liberal Arts/Creative Arts Courses – II				3	HSC
Total						20	

IV – Year: II – Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	ME4354	Semester-Long Internship (SLI) /Additional Project at the institute/Additional department elective courses for 6 credits	0	0	6	6	SLI/ PCC/ DEC
Total			0	0	6	6	

Basket – 1 (DE-1): Departmental Elective Courses:

S.No.	Course Code	Credits	Course Title
1.	ME2361	3	Advanced Casting and Forming Technologies
2.	ME2371	3	Non-destructive Technologies and Evaluation
3.	ME2381	3	Micro and Nano Manufacturing
4.	ME2391	3	Design for Sustainability
5.	ME2401	3	Design Optimization Methods
6.	ME2411	3	Robotics
7.	ME2421	3	Advanced Thermodynamics
8.	ME2431	3	Energy Engineering
9.	ME2441	3	Experimental Methods in Thermal Engineering

**Basket – 2 (DE-2): Departmental Elective Courses:**

S.No.	Course Code	Credits	Course Title
1.	ME3451	3	Laser Processing of Materials
2.	ME3461	3	Industrial Automation
3.	ME3471	3	Sustainable Manufacturing
4.	ME3481	3	Engineering Fracture Mechanics
5.	ME3491	3	Design and Analysis of Advanced Mechanisms
6.	ME3501	3	Industrial Tribology
7.	ME3511	3	Alternative Fuels and Energy Systems
8.	ME3521	3	Environmental Pollution and Control Systems
9.	ME3531	3	Automobile Engineering

Basket – 3 (DE-3): Departmental Elective Courses:

S.No.	Course Code	Credits	Course Title
1.	ME3541	3	Advanced Welding Technology
2.	ME3551	3	Total Quality Management
3.	ME3561	3	Design for Manufacturing and Assembly
4.	ME3571	3	Mechanics of Composite Materials
5.	ME3581	3	Dynamics of Ground Vehicles
6.	ME3591	3	Micro-electro Mechanical Systems
7.	ME3601	3	Power Plant Engineering
8.	ME3611	3	Design of Pumps and Turbines
9.	ME3621	3	Nano Fluids



Basket – 4 (DE-4): Departmental Elective Courses:

S.No.	Course Code	Credits	Course Title
1.	ME3631	3	Processing of Composite Materials
2.	ME3641	3	Artificial Intelligence in Mechanical Engineering
3.	ME3651	3	Smart Materials for Mechatronics Applications
4.	ME3661	3	Control Systems
5.	ME3671	3	Product Design and Development
6.	ME3681	3	Mechanical Vibrations
7.	ME3691	3	Computational Fluid Dynamics
8.	ME3701	3	Refrigeration and Air-Conditioning
9.	ME3711	3	Bio-Fluid Mechanics

Basket – 5 (DE-5): Departmental Elective Courses:

S.No.	Course Code	Credits	Course Title
1.	ME3721	3	Reverse Engineering
2.	ME3731	3	Additive Manufacturing
3.	ME3741	3	Modeling and Simulation of Manufacturing Systems
4.	ME3751	3	Condition Monitoring
5.	ME3761	3	Theory of Plasticity
6.	ME3771	3	Design of Transmission Elements
7.	ME3781	3	Introduction to CFD Tools.
8.	ME3791	3	Fuels and Combustion
9.	ME3801	3	Energy Conservation and Management

**Basket – 6 (DE-6): Departmental Elective Courses:**

S.No.	Course Code	Credits	Course Title
1.	ME4811	3	Materials Characterization
2.	ME4821	3	Precision Manufacturing
3.	ME4831	3	Advances in Robotics and Artificial Intelligence
4.	ME4841	3	Data Modelling and Visualization
5.	ME4851	3	AI and ML for Mechanical Systems
6.	ME4861	3	Rotor Dynamics
7.	ME4871	3	Jet Propulsion and Rocketry
8.	ME4881	3	Heating, Ventilation & Air-Conditioning
9.	ME4891	3	Engineering Acoustics

Basket – 1: Open Elective Courses (offered to other departments):

S.No.	Course Code	Credits	Course Title
1.	ME2901	3	IC Engines & Hybrid Vehicles
2.	ME3911	3	Alternative Sources of Energy
3.	ME3921	3	Machine Learning for Robotics
4.	ME4931	3	Simulation of Mechanical Systems

ME3941: Fundamentals of Artificial Intelligence is offered in the Minor Program Course Distribution (Artificial Intelligence and Robotics).

**Special Notes/Instructions:****Minor/Double Major programs**

- Each engineering department should identify the list of courses for the minor & Double Major degree programmes. These identified courses will be offered to the Minor/Double Major degree students in every branch.
- To get Minor degree in any engineering branch, a student has to earn 12 Credits (6 Core credits + 6 Elective Credits) prescribed for the programme.
- To get Double Major degree in any engineering branch, a student has to earn 24 Credits (12 Core credits + 12 Elective Credits) prescribed for the programme.
- The Minor & Double Major choices start from the robotics beginning of 3rd Semester.
- The students of Minor & Double Major courses will sit with regular students in the class.
- There will a separate time table slots for Minor & Double Major courses identified by each department to enable the students to register for these courses. Courses other than Minor & Double Major courses will not be offered during these slots.
- A student is permitted to do one Minor and one Double Major at max.
- Each department will choose a CGPA cut off (based on II Sem CGPA) such that the total of Minor and Double Major students in any branch do not cross maximum of 30 seats.

Minor program Course Distribution (Artificial Intelligence and Robotics)

S. No.	Course Code	Course Title	Credits	Offered Sem
1.	ME3941	Slot – I: Fundamentals of Artificial Intelligence	03	III
2.	ME2411	Slot – II: Robotics	03	IV
3.	ME3461	Slot – III: Industrial Automation	03	V
4.	ME3281	Slot – IV: Smart Manufacturing	03	VI
TOTAL (6 Core credits + 6 Elective Credits)			12	

Double Major Program Course Distribution

S. No.	Course Code	Course Title	Credits	Offered Sem
1.		Slot – I:	06	III
	ME2071	Manufacturing Science - I		
	ME2081	Fluid Mechanics		
	ME2091	Applied Thermal Engineering		
2.		Slot – II:	06	IV
	ME2151	Theory of Machines		
	ME2411	Robotics (DE-1)		
3.		Slot – III:	06	V
	ME3221	Design of Machine Members		
	ME3531	Automobile Engineering (DE-2)		
4.		Slot – IV:	06	VI
	ME3641	Artificial Intelligence in Mechanical Engineering (DE-4)		
	ME3761	Theory of Plasticity (DE-5)		
TOTAL (12 Core credits + 12 Elective Credits)			24	



DETAILED SYLLABUS

Course Code: MA1071	Differential and Integral Calculus	3-0-0	Credits 03
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Pre-requisites: None

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

CO1	Understand the concepts of limit, continuity, and differentiability.
CO2	Understand the concepts of partial derivative, chain rule, and total differentiation.
CO3	Find the maxima and minima of multivariable functions.
CO4	Evaluate multiple integrals in various coordinate systems
CO5	Apply the concepts of gradient, divergence, and curl to formulate engineering problems.
CO6	Convert line integrals into area integrals and surface integrals into volume integrals.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														
CO6														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Differential Calculus of functions of several variables: Review of Limit, continuity (sequential verification) and differentiability, Partial differentiation; Total differentiation; Euler’s theorem and generalization; Change of variables- Jacobians; Maxima and minima of functions of several variables (2 and 3 variables); Lagrange’s method of multipliers.

(14)

Integral Calculus: Beta and Gamma integrals (including convergence); Differentiation under integral sign; Double and Triple integrals - computation of surface areas and volumes; change of variables in double and triple integrals.

(14)

Vector Calculus: Scalar and vector fields; vector differentiation; level surfaces; directional derivative; gradient of a scalar field; divergence and curl of a vector field; Laplacian; Line and Surface integrals; Green’s theorem in a plane; Stokes’ theorem; Gauss Divergence theorem.

(14)



Text Books:

1. Joel R. Hass, Maurice D. Weir, George B. Thomas, Thomas' Calculus, 12th edition, Pearson, 2010.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley and Sons, 2015.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.
4. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", 5th Edition, Narosa Publishing House, 2016.

Reference Books:

1. T. M. Apostol, Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.



Course Code: PH1011	Engineering Physics	2-0-0	Credits 02
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Pre-requisites: Nil

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

CO1	Solve engineering problems using the concepts of wave and particle nature of radiant energy
CO2	Understand the use of lasers as light sources for low and high energy applications
CO3	Construct quantum mechanical model to explain the behaviour of a system at microscopic level
CO4	Apply the concepts of energy harvesting and understand the mechanisms of photo-voltaic cells
CO5	Understand the nature and characterization of magnetic and nano-materials for applications

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

UNIT- I WAVE OPTICS (7)

Interference: Superposition principle, coherence of light, methods to produce coherent light: division of amplitude and wavefront, Young’s double slit and Newton’s rings experiment: concept, working principle, and applications.

Diffraction: Introduction to Fresnel and Fraunhofer diffraction, Fraunhofer’s single-slit diffraction, double-slit diffraction and diffraction grating (quantitative), and resolving power of a grating.

Polarization: Introduction to polarization, Types of polarization, Methods to produce polarization: Reflection, refraction, scattering, selective absorption and double refraction.

UNIT - II LASERS (5)

Basic theory of LASER, Einstein’s coefficients and their relations, concept of population inversion, components of lasers, three and four level lasing systems, construction and working principle of various types of lasers: Nd-YAG, Helium-Neon and semiconductor lasers and their applications.

UNIT - III QUANTUM PHYSICS (7)



Origin of quantum theory and related experiments: Black-Body radiation and photo-electric effect. Heisenberg's uncertainty principle, de- Broglie's wave concept, wave function, and its properties, operators, Schrödinger's time-dependent and time-independent equations (Quantitative), particle in one-dimensional, infinite potential well, quantum tunneling phenomena and their applications in alpha decay, and scanning tunnelling microscopy (STM). Introduction to Quantum Technology (Q-switching, interaction of radiation with matter).

UNIT - IV PHOTOVOLTAICS (4)

Introduction to semiconductors, Solar spectrum, photovoltaic (PV) effect, materials, structure and working principle, I-V characteristics, power conversion efficiency, quantum efficiency, emerging PV technologies, and applications.

UNIT - V MAGNETIC AND NANO MATERIALS (5)

Magnetic Materials: Introduction to Weiss theory of ferromagnetism, concepts of magnetic domains, spontaneous magnetization, Curie transition, hard and soft magnetic materials and their applications.

Nanomaterials: Introduction, classification, and properties of nanomaterials, various methods of synthesizing nanomaterials: top-down (ball milling) and bottom-up (sol-gel) approaches.

Text Books:

1. A Textbook of Engineering Physics, Revised Edition, M. N. Avadhanulu, P. G. Kshirsagar, S. Chand and Company (2014).
2. Concepts of Modern Physics, 7th Edition, Beiser A., Mc. Graw Hill Publishers (2017).
3. Optics, Ajoy Ghatak, 7th Edition, Tata Mc Graw Hill (2020).
4. Lasers- Fundamentals and Applications, Ajoy Ghatak and K. Thyagarajan, 2nd Edition, Laxmi Publications (2019).

Reference Books:

1. Materials Science and Engineering: An Introduction (Tenth edition), William D. Callister, John Wiley & Sons (2018).
2. Introduction to Solid State Physics, 8th Edition, Charles Kittel, Wiley Publishers (2012).



Course Code: CY1011	Engineering Chemistry	2-0-0	Credits 02
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Pre-requisites: Nil

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

CO1	Gain foundational knowledge on how chemical principles influence the electrochemical properties of matter.
CO2	Understand how basic chemical principles relate to everyday materials.
CO3	Understand the electronic, and vibrational properties of materials
CO4	Analyze and solve problems associated with hardness of water and address the societal issues related to the quality of water

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Chapter-I: Electrochemistry (8 hours)

Redox reactions; Electrode potential; Electrochemical cells; Electromotive force (EMF); Nernst equation; Batteries, Primary batteries: Daniel and Leclanche cell; Rechargeable batteries: lead-acid, nickel-cadmium and lithium-ion; Fuel Cells: hydrogen-oxygen and methanol-oxygen; Corrosion: dry & wet corrosion, corrosion controlling methods.

Chapter-II: Polymer Chemistry and Engineering Materials (6 hours)

Polymers: degree of polymerization, functionality, tacticity, classification, types of polymerization & their mechanism, molecular weight of polymers, polydispersity index, Recycling of Polymers, conducting polymers and their classification; Engineering materials: organic light-emitting diode (OLED).

Chapter-III: Spectroscopy (8 hours)

Origin of spectroscopy; Electromagnetic radiation; Quantized energy levels of matter; UV-Vis spectroscopy: electronic transitions, Beer-Lambert's law, instrumentation, Woodward-Fieser rules and applications; Infrared (IR) spectroscopy: vibrational transitions, principle, influencing factors, instrumentation and applications.

Chapter-IV: Water Technology (6 hours)

Soft and hard water; Estimation of hardness by EDTA method and numerical problems; Boiler troubles; Softening of water: lime-soda process, ion-exchange process, reverse osmosis; Internal treatment of water: carbonate conditioning, phosphate conditioning, colloidal conditioning, calgon conditioning.



Text Books:

1. Engineering Chemistry by Jain and Jain, Dhanpat Rai Publishing Company.
2. Introduction to Spectroscopy by Donald L. Pavia, 5th edition, Cengage Learning India Private Limited, 2015.
3. Polymer Science and Technology by Premamoy Ghosh, 3rd edition, McGraw-Hill, 2010.

Reference Books:

1. Elements of Physical Chemistry by P. W. Atkins, Oxford University Press, 2007.
2. A textbook of Polymer Chemistry by M. S. Bhatnagar, S. Chand, ISBN-13:978-8121932301.
3. Organic Spectroscopy by William Kemp, 2nd edition, Macmillan publishers, 2019.



Course Code: ME1013	Engineering Drawing with CAD	2-0-2	Credits 03
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Pre-requisites: Nil

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

CO1	Apply BIS standards and conventions while drawing Lines, printing Letters and showing Dimensions.
CO2	Classify the systems of projection with respect to the observer, object, and reference planes.
CO3	Construct orthographic views of an object when its position with respect to the reference planes is defined.
CO4	Analyze the internal details of an object through sectional views.
CO5	Analyze the details of an object through the development of surfaces and the intersection of surfaces.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Significance of engineering drawing, BIS conventions of engineering drawing, selection of drawing sheet size and scale, types of lines, lettering, dimensioning, geometrical construction of polygons, and scales. Coordinate systems and reference planes.

Introduction to Orthographic projections: Principles of Orthographic projection, Orthographic projections of points in 1st and 3rd quadrants, Orthographic projections of lines, Orthographic projections of planes viz. triangle, square, rectangle, pentagon, hexagon, and circular laminae.

Orthographic Projection of Solids: Orthographic projection of right regular solids: Prisms, Pyramids, Cylinders, Cones, Cubes, and Tetrahedron.

Sections of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.

Isometric Projections: Isometric scale, Isometric projection of hexahedron, right regular prisms, pyramids, cylinders, cones and spheres. Isometric projection of combination of two simple solids.

Development of Surfaces of Solids: Development of lateral surfaces of right regular prisms, cylinders, pyramids and cones resting with base on HP only. Development of lateral



surfaces of their frustums and truncations. Problems related to applications of development of lateral surfaces like funnels and trays.

Introduction to Computer Aided Drafting software (AutoCAD): Draw entities, complex entities and edit entities, coordinate systems, and reference lines and planes.

Text Books:

1. Engineering Graphics, N.D. Bhatt and V.M. Panchal, Charotar Publishers, 2013.
2. AutoCAD 2017 for Engineers & Designers, Sham Tickoo, Dreamtech Press, 2016, 23rd Edition.



Course Code: ME1021	Basics of Mechanical Engineering	2-0-0	Credits 02
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Pre-requisites: Nil

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

CO1	Identify Materials for Engineering Applications
CO2	Comprehend the functioning of mechanisms and power transmission systems for a given application.
CO3	Understand the fundamental concepts of thermodynamics, fluid mechanics, heat transfer and their applications to thermal machines
CO4	Understand manufacturing processes and the principles of operation of machine tools
CO5	Understand the principles of work study, CPM, PERT and Operations Research

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Engineering Materials: Evolution during Industrial Revolutions, Introduction to Engineering Materials, Classification and Properties.

Design Engineering: Evolution during industrial revolutions, Simple to complex mechanisms - kinematics, dynamics, the evolution of Automobile Engineering, Power Transmission, Fasteners, and Bearings, introduction to - design of machine elements, CAD.

Thermal Engineering: Evolution during Industrial Revolutions, Fundamentals of Thermodynamics, fluid mechanics and heat transfer, Energy sources, Energy generation and conversion, Prime movers - Steam power, IC Engines, Introduction to - High altitude propulsion, Refrigeration and Air-Conditioning.

Production Engineering: Evolution during Industrial Revolutions, Manufacturing Processes – subtractive, confirmative, and additive, Machine Tools – classification, working principle, surface finishing processes, introduction to CAM.

Industrial Engineering: Evolution during industrial revolutions, Scientific management, introduction to – work study, CPM, PERT, and Operations Research.

Future of Mechanical Engineering: Industry 4.0-principles and concepts, Introduction to – Robotics, Autonomous Vehicles - Artificial Intelligence and Machine Learning.



Text Books:

1. History of Mechanical Engineering, Ce Zhang, Jianming Yang, Springer, 2020, 1st Edition.
2. A Brief History of Mechanical Engineering, Dixit, U., Hazarika, M. and Davim, J., Springer International Publishing, 2017, 1st Edition.

Reference Books:

1. Basic Mechanical Engineering, Praveen Kumar, Pearson Education, 2018, 2nd Edition.
2. Exploring Engineering: An introduction to Engineering and Design, Philip Kosky, Rober Balmer, William Keat, George Wise, Academic Press, 2015, 4th Edition.
3. Saeed Movaveni, Engineering Fundamentals: An Introduction to Engineering, Cengage Learning India Pvt. Ltd., 2011, 4th Edition.

Online Resources:

1. <https://www.bbc.co.uk/programmes/p00kjq6d>
2. <https://www.natgeotv.com/in/super-factories/videos>
3. <https://www.discoveryuk.com/series/how-do-they-do-it/>
4. <https://www.historyindia.com/show/how-trains-changed-the-world>



Course Code: PH1012	Engineering Physics Laboratory	0-1-2	Credits 01
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Pre-requisites: Nil

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

CO1	Understand the basic properties of light by performing experiments on interference, diffraction and polarization.
CO2	Acquire the experimental knowledge by performing the experiment using light-emitting diode (LED) for energy conversion applications.
CO3	Understand the nature and characteristics of ferromagnetic and dielectric materials for memory device and sensor applications.
CO4	Apply the knowledge of Solar/ PV cells for choice of materials in efficient alternate energy generation.
CO5	Apply the concepts of wave propagation through optical fibres and communication systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

List of experiments (any six experiments from the following list):

1. Determination of radius of curvature of plano-convex lens using Newton's ring experiment.
2. Determination of the width of narrow-slit by diffraction method
3. Determination of wavelength of spectral lines of Mercury light by normal incidence method using diffraction grating
4. Determination of Planck's constant using light emitting diode
5. Study the B-H loop hysteresis and find the coercivity and retentivity of magnetic materials
6. Studying current-voltage characteristics of a photovoltaic material using solar cell
7. Determination of wavelength of diode laser using diffraction by metal scale
8. Determination of dielectric constant of various dielectric materials
9. Determination of numerical aperture of an optical fibre



10. Determination of specific rotation of an optically active material-using Laurent's half-shade polarimeter.

Exposure to Virtual Lab (any two of the following):

1. B-H Loop tracer
2. Planck's Constant
3. Numerical aperture of Optical Fibre
4. Newton's ring

Text Books:

1. Physics Laboratory Manual, 2024, Department of Physics, School of Sciences, National Institute of Technology Andhra Pradesh, Tadepalligudem.
2. Shukla R K, Srivastava A, 2011, Practical Physics, New Age International Pvt. Ltd., New Delhi.
3. Arora, CL, 2012, B.Sc. Practical Physics, S Chand and Company Ltd., New Delhi.
4. A Textbook of Engineering Physics, M. N. Avadhanulu, P. G. Kshirsagar, S. Chand and Company (2015).
5. A Course of Experiments with He-Ne Lasers by R.S. Sirohi, New Age International (P) Ltd. (2009)



Course Code: CY1042	Chemistry Laboratory	0-1-2	Credits 01
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Pre-requisites: Nil

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

CO1	Select a suitable methodology and compare the strategies involved in the estimation of hardness of water for various applications.
CO2	Apply a selective instrumental method to alternate tedious and complex titration processes for repeated and regulated analysis of acids, bases, etc.
CO3	Work independently and in teams to solve problems with effective communication.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

List of experiments:

1. Standardization of potassium permanganate solution
2. Determination of hardness of water
3. Determination of the concentration of a coloured solution using the colorimetric method
4. Synthesis of Bakelite
5. Conductometric titration of a strong acid vs a strong base
6. pH-metric titration of a strong acid vs a strong base

Text Books:

1. Vogel's Textbook of Quantitative Chemical Analysis (Latest ed.), Revised by G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denney.
2. David Collins, Investigating Chemistry: Laboratory Manual, Freeman & Co., 1st Edition, 2006.



Course Code: PE1012	Physical Education - I	0-0-2	Credits 01
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Pre-requisites: None

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

CO1	Understand the fundamental concepts and importance of health and personal hygiene practices.
CO2	Identify the components of a balanced diet and apply principles of weight management.
CO3	Assess and improve their physical fitness through appropriate activities and exercises.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

I. Introduction to Physical Education: Meaning & Definitions of Physical Education, Aim & Objectives of Physical Education in Higher Education, Importance of Physical Education in the present era, Role of Physical Education in General & Professional Education, Line Formations and Marching.

II. Health Education & Personal Hygiene: Meaning and Definitions of Health Education, Meaning and Definitions of Health, Factors Affecting of Health and Need for and Importance of Health in Present Era, Meaning and Definitions of Personal Hygiene, Need for and Importance of Personal Hygiene, Personal Cleanliness & Hygiene (Teeth, Ears, Eyes, Nose, Throat, Nails &Fingers, Skin, Cloths &Hair).

III. Nutrition: Meaning and Definitions of Nutrition and Basic Guideline of Nutrition, Components of Balanced Diet and Design Balance Diet Plan Healthy Lifestyle, Nutrition Daily Caloric Requirement and Expenditure, Weight Management in Modern Era and Factor Affecting Weight Management, Dieting Versus Exercise for Weight Control, Values of Weight Management, Common Myths About Weight Loss, Design Diet Plan and Exercise Schedule for Weight Gain and Loss and Ideal Weight.

Obesity Meaning and Definitions and Types of Obesity, Health Risks Associated with Obesity, Obesity Causes and Solutions for Overcoming Obesity.

IV. Components of Physical Fitness: Meaning and Definitions of Physical Fitness, Need for and Importance of Physical Fitness, Warming Up and Limbering Down Exercises, Strength and Training of Strength Development,



Speed and Training of Speed Development, Endurance and Training of Endurance Development, Flexibility and Training of Flexibility Development, Coordination and Training of Coordination Development.

V. Sports/ Games: Select any Game/Sport of choice of student out of: Athletics, Badminton, Basketball, Cricket, Chess, Football, Handball, Kabaddi, Kho-Kho, Tennis, Table Tennis, Volleyball, Weight and Power Lifting, and Yoga. etc.

Teaching of the Game/Sport, Latest General Rules of the Game/Sport, Training & Coaching of the Game /Sport of Techniques, Skills, Tactics, and Strategies, Specifications of Playgrounds and Related Sports Equipment.

Text Books:

1. Bucher, C. A. (n.d.) Foundation of physical education. St. Louis: The C.V. Mosby Co.
2. Deshpande, S. H. (2014). Physical Education in Ancient India. Amravati: Degree college of Physical education.
3. Plimmar, R. (2006). Food, Health and Vitamins. New Delhi: Sports Publication.
4. Muller, J. (2007). Health, Exercise and Fitness. New Delhi: Sports Publication.
5. S.N. Ghosh. (1989). Hygiene and Public health. Calcutta: Scientific Publishing Company.
6. Srivastava, V. (2009). Nutrition and diet for sportsmen. New Delhi: Bhagwati Publishers.
7. Bunn, J. W. (1972). Scientific principles of coaching. Englewood Cliffs, NJ: Prentice Hall.
8. Matvyew, L.P. (1981). Fundamental of sports training. Moscow: Progress Publishers.
9. Sharkey, B. J. (1990). Physiology of fitness, Human Kinetics Book.
10. Bunn, J. W. (1968). The art of officiating sports. Englewood cliffs N.J. Prentice Hall.
11. Bunn, J. W. (1972). Scientific principles of coaching. Englewood cliffs N. J. Prentice Hall.



Course Code: MA1081	Fundamentals of Matrices and Differential Equations	3-0-0	Credits 03
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Pre-requisites: Differential and Integral Calculus (MA1071)

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

CO1	Solve the consistent system of linear equations
CO2	Apply orthogonal transformations to a quadratic form
CO3	Solve higher-order linear differential equations with constant coefficients
CO4	Apply the concepts in solving physical problems arising in engineering
CO5	Apply Laplace transforms to solve initial value problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Matrix Theory: Linear dependence and independence of vectors; Rank of a matrix; Consistency of the system of linear equations; Eigenvalues and eigenvectors of a matrix; Caley-Hamilton theorem and its applications; Reduction to diagonal form; Reduction of a quadratic form to canonical form - orthogonal transformation; Properties of complex matrices - Hermitian, Skew-Hermitian and Unitary matrices. (14)

Ordinary Differential Equations of Higher Order: Review of First-order Ordinary Differential Equations, applications of first-order order linear differential equations, Higher order linear differential equations with constant coefficients - homogeneous and non-homogeneous; Euler and Cauchy's differential equations; Method of variation of parameters; System of linear differential equations, applications in physical problems - forced oscillations. (14)

Laplace Transforms: Laplace transforms; inverse Laplace transforms; Properties of Laplace transforms; Laplace transforms of unit step function, impulse function, periodic function; Convolution theorem, solving certain initial value problems, Solving system of linear differential equations, applications (branch-specific). (14)

Text Books:

1. E. Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley and Sons, 2015.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.
3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5th Edition, Narosa Publishing House, 2016.



Reference Books:

1. G. Strang, Linear Algebra and Its Applications, 4th Edition, Brooks/Cole India, 2006.
2. T. M. Apostol, Calculus, Volume 2 (2nd Edition), Wiley Eastern, 1980.
3. G. F. Simmons, Differential equations with applications and historical notes. CRC Press, 2016.



Course Code: EE1621	Introduction to Electrical & Electronics Engineering	2-0-0	Credits 02
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Pre-requisites: None

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

CO1	Analyze DC & AC circuits and determine power & power factor.
CO2	Understand the principle and operation of transformers
CO3	Identify the type of DC electrical machines for a given application
CO4	Identify the type of AC machines for a given application
CO5	Analyze basic electronic circuits.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Electrical Circuits: Kirchoff's voltage and current laws, superposition theorem, star delta transformations. Complex representation of impedance, phasor diagrams, power & power factor, solution of 1-phase series & parallel circuits.

Single Phase Transformers: Principle of operation of a single-phase transformer, emf equation, phasor diagram, equivalent circuit of a 1-phase transformer, voltage regulation & efficiency.

DC Machines: Principle of operation, classification, emf and torque equations, characteristics of generators and motors.

AC Machines: 3-Phase induction motor- principle of operation, torque – speed characteristics of 3-phase induction motor & applications. Single phase induction motor - equivalent circuit - starting methods of single-phase induction motors - applications.

Electronic Devices & Circuits: P-N junction diode, I-V characteristics, bipolar junction transistor operation and characteristics.

Text Books:

1. Engineering Circuit Analysis, William H. Hayt Jr., Jack E. Kemmerly, Steven M. Durbin, Tata McGraw Hill, 2020, 9th Edition.
2. Fundamentals of Electrical Circuits by Charles k. Alexander, Matthew N.O. Sadiku, Tata McGraw Hill, 2022, 7th Edition.
3. V.N.Mittle, Basic Electrical Engineering, 2nd edition, MC Graw Hill Education, 1 July 2017



4. Ravish R Singh, Basic Electrical Engineering, MC Graw Hill Education, 3rd edition, 2018.
5. R. Boylested and L. Nashelsky, "Electronics Devices and Circuits", Prentice Hall India, 2009.

Reference Books:

1. J. A. Edminister, Electric Circuit Theory, Schaum's Outline series: 5th edition, McGraw Hill, 2017.
2. D. P. Kothari & I.J. Nagrath, Basic Electrical Engineering, 4th edition, MC Graw Hill Education, 2019.



Course Code: ME1031	Engineering Mechanics	2-1-0	Credits 03
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Pre-requisites: Nil

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

CO1	Determine the resultant force and moment for a given system of forces.
CO2	Analyse planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction.
CO3	Calculate the motion characteristics of a body subjected to a given force system.
CO4	Determine the deformation of a shaft and understand the relationship between different material constants.
CO5	Determine the centroid and second moment of area.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Specification of the force vector, Formation of Force Vectors, Moment of Force – Cross product - Problems, Resultant of a general force system in space, Degrees of freedom – Equilibrium Equations, Kinematics - Kinetics - De' Alemberts principle, Degree of Constraints - Freebody diagrams.

Spatial Force systems: Concurrent force systems - Equilibrium equations (Vector approach) – Tension Coefficient method (Tension Coefficient method), Parallel force systems - problems, Center of Parallel force system.

Coplanar Force System: Introduction - Equilibrium equations - All systems, Problems on Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system - Point of action, Method of joints, Method of sections, Method of sections, Method of members, Friction - Coulomb's laws of dry friction - Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Mechanics of Deformable Bodies: Stress & Strain at a point- Normal and shear stresses, Axial deformations - Problems on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Stepped shaft due to axial loading, Poisson's Ratio - Bulk Modulus - Problems, change in dimensions and volume.

Centroid and Moment of Inertia: Centroid and M.I. - Arial - Radius of Gyration, Parallel axis Perpendicular axis theorem - Simple Problems.



Dynamics of Particles: Rectilinear Motion - Kinematics Problems, Kinetics - Problems, Work & Energy - Impulse Moment, Curvilinear Motion - Normal and tangential components.

Text Books:

1. Engineering Mechanics, J.L. Meriam, L.G. Kraige, John Wiley & Sons, 2012, 7th Edition.
2. Engineering Mechanics, Timoshenko, Young, McGraw Hill Publishers, 2006, 3rd Edition.
3. Mechanics of Materials, Gere, Timoshenko, CBS Publishers, 2011, 2nd Edition.

Reference Books:

1. Engineering Mechanics- Statics- Volume 1, Dynamics- Volume 2, Meriam J.L. and Kraige L.G., John Wiley & Sons, 1993, 3rd Edition.
2. Engineering Mechanics– Statics and Dynamics, Irving H. Shames and Krishna Mohana Rao. G., Pearson Education, 2006. 4th Edition.

Online Resources:

1. <https://archive.nptel.ac.in/courses/112/103/112103108/>



Course Code: CS1031	Problem Solving Through Computer Programming	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Apply problem-solving strategies such as top-down and bottom-up approaches to design simple algorithms and flowcharts for computational problems.
CO2	Construct algorithms for solving problems that requires solutions involving searching, sorting, selection and / or a numerical method as a sub-routine.
CO3	Analyze the suitability of different algorithmic design paradigms for solving problems with an understanding of the time and space complexities incurred.
CO4	Construct efficient modular programs for implementing algorithms by leveraging suitable control structures.
CO5	Construct efficient programs by selecting and using suitable in-built Data Structures and programming language features available.

Course Articulation Matrix:

CO \ PO	PO											
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012
CO1	S	M	L									L
CO2	S	M	L									L
CO3	S	M	L									L
CO4	S	M	L									L
CO5	S	M	L									L

S: Strong correlation, M: Medium correlation, L: Low correlation

Syllabus:

Fundamentals of Computers, Historical perspective, Early computers, Modern Computers, Hardware Components of a Computer, Data Representation in Computers, Introduction to Operating Systems, Software and Firmware, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs.

Problem solving techniques – Algorithmic approach, characteristics of algorithms, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms, Algorithm Analysis.

Basic Syntax in Python, Data Types, Variables, Assignments, immutable variables, Types of Operators, Expressions, Comments, Boolean Logic, Logical Operators in Python. Conditional statements - If-else, Loops - while, for, Lazy Evaluation Inbuilt Data Structures and their operations in Python: List, Tuples and Dictionaries.



Fundamental Algorithms: Swapping variables, Problems involving summation of a series, Sine function computation, Base Conversion, generation of sequences like Fibonacci, Reversing the digits of an integer, Character to number conversion.

Factoring Methods: Finding the square root, Finding the smallest divisor of an integer, finding the greatest common divisor using Euclid's algorithm, Computing the prime factors of an integer, generating prime numbers, Raising a number to a large power, Computation of the nth Fibonacci number.

Functions – Modular programming and benefits, user defined functions, library functions, parameter passing, Formal and Actual arguments, named arguments return values, Recursion.

Sorting algorithms: Bubble, Selection and Insertion sorts, Search algorithms: Linear and binary search

String processing: Algorithms for implementing String functions like Strlen, Strcpy, StrRev, Strcmp, Searching for a keyword or pattern in a text.

File and Directory Handling: Reading and Writing to/from a file, Formatted File creation and operations.

Text Books:

1. Kenneth Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2019
2. R.G. Dromey, how to solve it by Computer, Pearson, 2008.
3. Brian W.Kernighan, Dennis Ritchie, "The C Programming Language", 2nd edition, Person Education India, 2015

Reference Books:

1. Hanly J R & Koffman E.B, "Problem Solving and Programm design in C", 7th edition, Pearson Education
2. Randal E. Bryant, David R. O'Hallaron, "Computer Systems. A Programmer's Perspective", 2nd Edition, Prentice Hall



Course Code: ME1041	Introduction to Automation	2-0-0	Credits 02
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Pre-requisites: Nil

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

CO1	Gain Knowledge of key Industrial Automation concepts including latest technologies, architectures.
CO2	Identify sensors, localization, wireless protocols, data storage and security.
CO3	Understand how to develop and implement own automation technologies, solutions, applications and regulations.
CO4	Learn to design and implement sequential logic and data shifting mechanisms to control and monitor processes effectively.
CO5	Learn to navigate and utilize Windows properties and settings to customize and optimize SCADA software environments.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: What is Automation, Brief history of Automation, Automation Uses, Automation - PLC Basics, Mechanical relays versus PLC, PLC Architecture, Functions of various blocks, and working principle of PLC?

PLC Hardware & Programming: Types of Programming, construction of PLC ladder diagrams, Controlling Program Flow in a Ladder Logic Program. Various Types of Addressing Used within a PLC, PLC Programming input instructions.

Timers and Counters: What are timers & Counters, Use of timers and counters within a ladder logic program, Basic concepts of function blocks.

Different operational blocks: Math block, Logical block, Compare block, Sequential & Shift, Program block, Control block.

Introduction to SCADA: Introduction and SCADA Basics. Importance of SCADA in Industrial Automation.

Basic operation of SCADA: Basic operations related to SCADA. How to work on windows property.

Advance operation of SCADA: Advance operations related to SCADA. Alarms, Trends, Data base connectivity, report generation, recipe management, security, scripts, networking.



Text Books:

1. Introduction to Industrial Automation, D. B. Spence.
2. Programmable Logic Controllers: An Introduction, Gary A. Dunning.
3. Programmable Logic Controllers: Hardware and Programming, William Bolton.
4. Industrial Automation and Process Control, Jon Stenerson.

Reference Books:

1. PLC Programming Using RSLogix 500: With Troubleshooting and Maintenance Techniques, John R. Hackworth, Frederick D. Hackworth.
2. SCADA Systems for Technicians, Mark J. T. W. White.
3. Advanced SCADA Systems for Industrial Automation, Philip H. McKinnon.



Course Code: ME1051	Engineering Thermodynamics	2-0-0	Credits 02
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Pre-requisites: Nil

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

CO1	Understand the concepts of continuum, system, control volume, thermodynamic properties, thermodynamic equilibrium, work and heat.
CO2	Understand the laws of thermodynamics and Internal energy, enthalpy, and specific heats.
CO3	Evaluate the Reversibility and irreversibility and the concept of available energy.
CO4	Evaluate Thermodynamic Relations and properties of pure substances.
CO5	Analyse Gas Mixtures and Psychrometrics.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Thermodynamics, Definition and scope of thermodynamics, Concepts of system, surroundings, and universe, Types of systems: Open, closed, and isolated Properties of systems: Intensive and extensive, State, path, process, and cycle. Thermodynamic equilibrium, Quasi-static process.

First Law of Thermodynamics: Energy and the First Law, Concepts of work and heat, First law of Thermodynamics for closed and open systems, Internal energy, enthalpy, and specific heats. Energy balance for steady-flow processes.

Second Law of Thermodynamics and Entropy: Second Law of Thermodynamics, Statements of the second law (Kelvin-Planck and Clausius statements). Reversibility and irreversibility. Carnot cycle and Carnot theorem, Concept of entropy. T-s and h-s diagrams/ Entropy change for various processes, Available energy, Availability, and Irreversibility.

Thermodynamic Relations and Properties of Pure Substances: Thermodynamic Relations, Maxwell relations, Clapeyron equation, Joule-Thomson coefficient, Inversion curve. P-V-T behavior of pure substances. Phase diagram and critical point. Use of steam tables and Mollier diagram.

Gas Mixtures and Psychrometrics: Gas Mixtures, Dalton's law of partial pressures. Amagat's law of additive volumes. Analysis of gas mixtures. Reactive Gas Mixtures. Psychrometrics.



Properties of atmospheric air: Use of psychrometric chart Processes involving air-water vapor mixtures (heating, cooling, humidification, dehumidification)

Text Books:

1. Thermodynamics: An Engineering Approach, Yunus A. Çengel and Michael A. Boles, McGraw Hill, 2018 and 9th Edition.
2. Fundamentals of Thermodynamics, Claus Borgnakke, Richard E. Sonntag, Wiley, 2016 and 8th Edition.
3. Engineering Thermodynamics, P.K. Nag, McGraw Hill, 2017 and 6th Edition

Reference Books:

1. Advanced Engineering Thermodynamics, Adrian Bejan J. A. Jones, John Wiley & Sons, 2016 and 4th Edition.
2. Applied Thermodynamics for Engineering Technologists, T.D. Eastop, A. Mcconkey, Pearson Education India, 2002 and 5th Edition.

Online Resources:

1. Thermodynamics by Prof. S.K. Som, IIT Kharagpur, <https://www.nptelvideos.com/course.php?id=773>
2. Concepts of Thermodynamics by Prof. Suman Chakraborty, Prof. Aditya Bandopadhyay, IIT Kharagpur, <https://archive.nptel.ac.in/courses/112/105/112105266/>



Course Code: CS1032	Problem Solving Through Computer Programming Laboratory	0-1-2	Credits 02
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Pre-requisites: Nil

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

CO1	Construct, debug, test and run efficient programs by leveraging suitable flow of control constructs and syntactic units of the programming language.
CO2	Construct efficient programs by constructing and translating algorithms for solving problems using sorting, searching, selection and / or arithmetic computations.
CO3	Implement, refactor, test and debug functional programs in a shell-based run time environment.
CO4	Apply algorithmic thinking to break down complex problems into logical steps and implement efficient solutions through structured programming constructs.

Course Articulation Matrix:

CO \ PO	PO											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L		S				M			L
CO2	S	M	L		S				M			L
CO3	S	M	L		S				M			L
CO4	S	M	L		S				M			L

S: Strong correlation, M: Medium correlation, L: Low correlation

Syllabus:

Familiarization with Python installation, basic syntax and running scripts in the shell, conditional control constructs, iterative constructs. (While, do-while, for), user defined functions and in-built function calls, Recursion, in-built data structures like List, Tuples and Dictionaries, String processing, Files and I/O.

Implementation of Factoring methods, sorting, searching and selection as sub-routines, simple 2D graphics.

Implementation of a capstone application to unify the concepts learnt in the course.

Text Books:

1. Kenneth Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2019
2. R.G. Dromey, how to solve it by Computer, Pearson, 2008.
3. Hanly J R & Koffman E.B, "Problem Solving and Programm design in C", 7th edition, Pearson Education
4. Randal E. Bryant, David R. O'Hallaron, "Computer Systems. A Programmer's Perspective", 2nd Edition, Prentice Hall
5. The Python Tutorial, Available at: <https://docs.python.org/3/tutorial/>



Course Code: ME1062	Fabrication Laboratory	0-0-2	Credits 01
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Pre-requisites: Nil

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

CO1	Identify workshop tools and their operational capabilities
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO4	Apply suitable tools for machining processes including turning, facing, thread
CO5	Practice on fabrication of simple components using PLA.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Demonstration: Safety practices and precautions to be observed in the workshop.

Fitting Trade: Demonstration and practice of fitting tools, Preparation of T-Shape, Dovetail Joint.

Carpentry: Demonstration and practice of carpentry tools, Preparation of Cross Half lap joint and Mortise Tenon Joint.

Plumbing: Demonstration and practice of Plumbing tools, Preparation of Pipe joints with coupling for the same diameter and with reducer for different diameters.

Machine shop: Demonstration and practice on Lathe Machine, Preparation of workpieces involving Facing, Plane Turning, step turning, knurling, and parting operations.

House Wiring: Demonstration and practice on Electrical tools, wiring, and earthing, Exercises on Staircase Wiring & Godown wiring.

Power Tools: Demonstration and practice on Power tools (Bosch Power Tools) and Safety Practices.

Foundry Trade: Demonstration and practice on Moulding tools and processes, Preparation of Green Sand Moulds for given Patterns.

Welding Shop: Demonstration and practice on Arc Welding and Gas welding. Preparation of Lap joint and Butt joint.



Text Books:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published, 2019.
2. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.
3. A Course in Workshop Technology Vol I. & II, B.S. Raghuvanshi, Dhanpath Rai & Co., 2015 & 2017.

Reference Books:

1. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14th Edition.
2. Elements of Workshop Technology, Vol. II by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 12th Edition.
3. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.
4. Technology of machine tools, Steve F. Krar, Arthur R. Gill and Peter Smid, McGraw Hill Education (India) Pt. Ltd., 2013.
5. Engineering Practices Laboratory Manual, Ramesh Babu.V., VRB Publishers Private Limited, Chennai, Revised Edition, 2013 – 2014.
6. Engineering Practices Lab Manual; T.Jeyapooan, Vikas Pub, 2008, 4th Edition.
7. Mechanical Workshop Practice; John K.C., PHI, 2010.
8. Wiring Estimating, Costing and Contracting; Soni P.M. & Upadhyay P.A.; Atul Prakashan, 2021-22.

Online Resources:

1. Different Trade E-Books (Fitting, Plumbing, Welding, Carpentry, Foundryman, Turner and House Wiring etc.) developed by National Instructional Media Institute, Chennai. Directorate General of Training, Ministry of Skill Development & Entrepreneurship, Govt. of India. (<https://bharatskills.gov.in>).



Course Code: PE1022	Physical Education - II	0-0-2	Credits 01
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Pre-requisites: None

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

CO1	Demonstrate an understanding of gym practices and various training exercises.
CO2	Identify components of physical fitness and apply appropriate development methods.
CO3	Assess body efficiency using standardized tests and measurements.
CO4	Recognize postural deformities and apply corrective exercises to improve body posture.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

I. Gym and Weight Training Exercises

Toning the Upper Body with Light Weight - Exercises with Curling Machine, Bench Press, Bicep Curling with Single Rod, Bicep Curling with Dumbbell, Exercises for Triceps, Exercises for Biceps, Shoulders, latissimus dorsi, and Exercises for Forearm.

Toning the Lower Body with Light Weights – Squats, Dead Lift, Exercises for Lower Back, Hamstring, Gastronomical Muscle, Ankles, and Exercises on Leg Curling Machines.

Body Part Split Training Program Schedules - Beginners Training Schedule (Starting One Month), Mediocre Training Schedule (After 1 Month to 6 Months), Advanced Training Schedule (After Six Months).

II. Training Methods in Physical Education

Continuous Training Method (Endurance), Interval Training Method (Speed Endurance), Repetition Training Method (Speed). Fartlek Training (Endurance), Weight (Resistance) Training (Strength), Circuit Training Method (Strength Endurance), Plyometric Training Method (Power), Flexibility Training Methods (Flexibility), High-Intensity Interval Training (HIIT) (Cardiovascular), Cross Country Training Method (Endurance).

III. Test, Measurement and Evaluation

Measurement of Height, Weight, Age, and Calculation of BMI. Norms, Procedure and Conduct of Physical Fitness Tests - 30-Meter Sprint (Speed), Standing Broad Jump (Explosive Strength), Bent Knee Sit-Ups (Abdominal Strength), 12-Minute Run/Walk (Cardiovascular Endurance), Sit and Reach (Flexibility), 6x10 Meters Shuttle Run (Agility).



IV. Posture and Somoto Body Types

Concept and Significance of Good Posture, Postural Deformities, lordosis, kyphosis scoliosis, Scoliosis, Knocked knees, Bow legs, flat foot and their Remedies, Corrective Exercises for Postural illnesses and deformities, Meaning and Definitions of Somatic, BodyKreshemer Classification - Asthetic, Athletic, Pyknic and Dyplastic body types, Sheldon classification - Ectomorph, Mesomorph and Endomorph body types.

V. Sports/Games

Select any Game/Sport of choice of student out of: Athletics, Badminton, Basketball, Cricket, Chess, Football, Handball, Kabaddi, Kho-Kho, Tennis, Table Tennis, Volleyball, Weight and Power Lifting, and Yoga. etc.

Teaching of the Game/Sport, Latest General Rules of the Game/Sport. Training & Coaching of the Game /Sport of Techniques, Skills, Tactics, and Strategies, Specifications of Playgrounds and Related Sports Equipment.

Text Books:

1. Singh, A., Gill, J. S., Bains, J., & Brar, R. S. (2004). Physical education for B.P.E., B.P.Ed., and M.P.Ed. Ludhiana: Kalyani Publishers.
2. Harre, D. (1982). Principles of sports training. Berlin: Sportverlag,
3. Hardayal Singh, "Sports Training: General Theory & Methods" Netaji Subhas National Institute of Sports, 1984.
4. Singh, H. (1984). Sports training, general theory and methods. Patials: NSNIS. Uppal, A.K., (1999). Sports Training. New Delhi: Friends Publication.
5. Bompa, T. O., & Buzzichelli, C. (2019). Periodization Theory and Methodology of Training. Human Kinetics.
6. Barrow, H. M., & McGee, R. (2000). Barrow and McGee's Practical Measurement and Assessment. Lippincott Williams and Wilkins.
7. Clarke, H. D. (1987). Application of Measurement to Physical Education. Englewood Cliffs, Prentic Hall.
8. Kansal, D. (2008). Text Book of Applied Measurement & Evaluation & Sports. New Delhi: Sports & Spiritual Science Publications.
9. Morrow, J. R. (2000). Measurement and Evaluation in Human performance. Human Kinetics.
10. Sivarajan. K "Psychological Foundations of Education" Calicut University, Kerala, India, 2006.
11. Baron. R.A "Psychology" Pearson Education South Asia, New Delhi, 2008.
12. Cox. R.H "Sport Psychology: Concepts and Applications" Mc Graw Hill, New York, USA, 2012.
13. Skinnner, C. E., (1984.). Education psychology. New Delhi: Prentice Hall of India.
14. Singer, R. N. (1972). Coaching, athletic & psychology. New York: M.C. Graw Hill.



Course Code: MA2061	Probability and Transformation Techniques	2-1-0	Credits 03
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Pre-requisites: Differential and Integral Calculus (MA1071) and Fundamentals of Matrices and Differential Equations (MA1081).

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

CO1	Evaluate real integrals using residue theorem
CO2	Transform a region to another region using conformal mapping
CO3	Determine Fourier series expansion of functions
CO4	Determine solutions of PDE for vibrating string and heat conduction

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Fourier Series: Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions (4)

Fourier Transforms: Complex form of Fourier series - Fourier transformation and inverse transforms - sine, cosine transformations and inverse transforms – simple illustrations. (6)

Partial Differential Equations: Classification of Second order linear Partial Differential Equations, D'alembert's solution of wave equation, Solutions of Wave equation, Heat equation and Laplace's equation by the method of separation of variables and their use in problems of vibrating string, one dimensional unsteady heat flow and two dimensional steady state heat flow including polar form. (14)

Probability and Statistics: Random variables, discrete and continuous random variables, Mean and variance of Binomial, Poisson and Normal distributions and applications. Testing of Hypothesis – Null and alternate hypothesis, level of significance and critical region - Z-test for single mean and difference of means, single proportion and difference of proportions - t-test for single mean and difference of means - F-test for comparison of variances, Chisquare test for goodness of fit - Karl Pearson coefficient of correlation, lines of regression and examples. (18)

Text Books:

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, 2016.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2017.



Reference Books:

1. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, S.Chand & Co, 2006.
2. J. E. Freund, and M. Miller, M. John E. Freund's Mathematical Statistics: With Applications. Pearson Education India, (2004).



Course Code: MMxxxx	Material Science and Metallurgy	2-0-0	Credits 02
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Pre-requisites: NIL

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

CO1	Assess the properties and applications of different types of materials in engineering contexts.
CO2	Describe the structure of metals and apply techniques for macro and microscopic examination.
CO3	Apply phase diagrams to interpret phase transformations and resultant microstructures in alloy systems.
CO4	Analyze equilibrium cooling processes and their effects on steel microstructures and properties.
CO5	Design heat treatment processes for different machine components and mechanical equipment based on desired material properties

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Material Science: Basics of Engineering Materials, their Classifications and Application, Basics of Advance Engineering Materials, Engineering requirements of materials, Properties of engineering materials, Criteria for selection of materials for engineering Applications.

Crystallography: Crystal, space lattice, unit cell- SC, BCC, FCC, atomic packing factor and HCP structures - short and long range order - effects of crystalline and amorphous structure on mechanical properties, Miller indices for directions and planes. Atomic packing density in crystals, Crystal imperfections, grain boundary, twin boundary, twist boundary, partial dislocations.

Metallic Materials: Types, properties and applications, Structure of Metals, Fracture, Macro-examination.

Solidification and Theory of Alloys: Solidification of metals and an alloy, Nucleation and Growth during freezing of pure metal and alloy ingot/a casting Resultant macrostructures; Effects of Structure on Mechanical Properties. Systems, phases and phase rule, structural constituents, Gibb's free energy for thermodynamic stability of phases, Gibb's phase rule. Solid solutions and compounds, Hume-Rothery rules; Cooling curves, lever-arm principle.



Phase and Phase equilibrium: Unary and Binary equilibrium phase diagrams, Different reactions like eutectic, eutectoid, peritectic and peritectoid; Non-equilibrium cooling.

Allotropy of Iron, Iron-Iron Carbide equilibrium system: Allotropy of iron; Iron-iron carbide equilibrium diagram: Phases present and their properties, different reactions of the Iron-Iron Carbide equilibrium system; constituents, microstructures and properties of plain carbon steels. Alloy groups (Wrought Irons, Steels and Cast Irons) of Iron-Iron Carbide equilibrium system and their characteristics in general. Equilibrium cooling of eutectoid, hypoeutectoid and hypereutectoid steels, their resultant microstructures and hence correlated properties and applications. IS and ISO Codification, Different specifications and designations of steels.

TTT diagram and Heat Treatment of Steel: Time-Temperature-Transformation Diagram, Isothermal and continuous transformations. Study of heat treatment processes such as annealing, normalizing, spheroidizing, hardening, tempering, carburizing, nitriding, cyaniding, induction hardening, flame hardening and hardenability of steel. Application of above processes to machine components and mechanical equipments such as gears, shaft bearings, turbine blades, crank shafts, pistons etc.

Powder Metallurgy: Applications of powder metallurgy, advantages of powder metallurgy, manufacturing processes, production of powder, compacting, sintering, products of powder metallurgy.

Text Books:

1. Callister's Material Science and Engineering, R. Balasubramaniam, Wiley India.
2. Elements of Material Science and Engineering, Lawrence H. Van Vlack, Pearson Education.
3. The Science and Engineering of Materials Donald R. Askeland and Pradeep P. Phule, Cengage Learning.

Reference Books:

1. Principles of Materials Science and Engineering, W F Smith, McGraw Hill.
2. Materials Science and Metallurgy, K. I. Parashivamurthy, Pearson Education.
3. Physical Metallurgy, Sydney H. Avner, Tata McGraw-Hill.



Course Code: ME2071	Manufacturing Science-I	2-0-0	Credits 02
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Pre-requisites: Nil

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

CO1	Design core, core print and gating system in metal casting processes.
CO2	Develop joints using solid state and fusion joining, brazing and soldering techniques.
CO3	Understand Plastic deformation, recrystallization, grain growth, Strain hardening and Annealing.
CO4	Develop process-maps for metal forming processes using plasticity principles.
CO5	Develop process-maps for manufacturing of Semiconductor.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Manufacturing and its evolution, Net and near-net shape manufacturing;

Metal Casting: Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Molding, different types of cores, Principles of Gating, Risers, casting design considerations. Methods of melting and types of furnaces, Solidification of castings and casting defects- causes and remedies. Basic principles and applications of special casting processes - Centrifugal casting, Die casting, Investment casting and shell molding.

Welding Processes: Classification of welding processes, types of welded joints and their characteristics, gas welding, different types of flames and uses, and oxygen-acetylene gas cutting. Basic principles of Arc welding, power characteristics, Manual metal arc welding, submerged arc welding, TIG & MIG welding. Electro-slag welding. Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering & Brazing. Heat affected zones in welding; pre & post heating, welding defects –causes and remedies.

Metal Forming: Plastic deformation in metals and alloys-recovery, recrystallization, and grain growth. Hot working and Cold Working-Strain hardening and Annealing.

Bulk-forming processes: Forging-Types of Forging, forging defects and remedies. Rolling –fundamentals, types of rolling mills and products, Forces in rolling, and power



requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing, and Tube drawing. Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools.

High energy rate forming processes: Principles of explosive forming, electromagnetic forming, Electro-hydraulic forming, rubber pad forming, advantages, and limitations.

Polymer processing techniques: Extrusion, Injection molding, Blow molding, Rotational molding, Compression molding, Thermoforming, Casting, Solution Casting, Fibre spinning.

Semiconductor manufacturing process: Basic semiconductor fabrication, yield, cleanroom, semiconductor fab, IC chip test, and packaging, Fabrication of semiconductor devices and IC chips, Crystal structure and silicon wafer manufacturing, Thermal processes, including oxidation and diffusion, Photolithography and plasma applications, Ion implantation and etch processes, Chemical vapor deposition (CVD) and dielectric thin-film deposition, Metallization and physical vapor deposition (PVD) processes, Planarization and chemical mechanical polishing (CMP), Process integration and CMOS process flow, Future development of the semiconductor industry.

Text Books:

1. Manufacturing Science. Amitabha Ghosh and Mallick A. K, Affiliated East-West Press Pvt. Ltd. 2010.
2. Fundamentals of Manufacturing Process, G. K. Lal and S. K. Choudhury, 2009, CRC Press.
3. Science and Engineering of Casting Solidification, Doru Michael Stefanescu, Springer, 2009
4. Introduction to Semiconductor Manufacturing Technology, Hong Xiao, 2001, Prentice Hall.

Reference Books:

1. Materials and Processes, in Manufacturing, Paul Degarmo E, Black J.T and Ronald A. Kosher, Eight Edition, Prentice –Hall of India, 1997.
2. Solidification and Casting, Brian Cantor, Keyna O'Reilly, Taylor and Francis, 2002.
3. Formability of Metallic Materials: Plastic Anisotropy, Formability Testing, Forming Limits, Dorel Banabic, Springer, 2010.

Online Resources:

1. <https://www.mooc-list.com/tags/manufacturing>



Course Code: ME2081	Fluid Mechanics	2-0-0	Credits 02
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Pre-requisites: Nil

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

CO1	Apply conservation laws to fluid flow problems in engineering applications
CO2	Understand and analyse the classification of flows, equation of continuity, velocity potential and stream function.
CO3	Design experimental procedure for physical model studies.
CO4	Analyze and design free surface and pipe flows.
CO5	Compute drag and lift coefficients using the theory of boundary layer flows.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Preliminaries, Types of Fluids, Concept of continuum, Properties of Manometers, pressure on plane and curved surfaces, center of pressure, fluid masses subjected to linear acceleration and uniform rotation about an axis. Importance of Fluid Mechanics in Various Engineering Fields.

Fluid Kinematics: Stream line, Streak line and path line, classification of flows, rotational and irrotational flows, equation of continuity for one dimensional and three-dimensional flows, velocity potential function and stream function.

Fluid Dynamics and Dimensional Analysis: Euler's Equation of motion along a streamline, Bernoulli's equation and its applications, Momentum equation and its application to pipe flow. Dimensional Analysis, Buckingham's Pi theorem, important dimensionless numbers and their physical significance, geometric, kinematic, and dynamic similarity, model studies, Hydraulic similitude.

Closed Conduit Flow: Equation of motion for laminar flow through pipes, Stokes law, transition from laminar to turbulent flow, types of turbulent flow, isotropic and homogenous turbulence, Prandtl's mixing length theory, velocity distribution in turbulent flow over smooth and rough surfaces, resistance to flow, minor losses, pipe in series and parallel, power transmission through a pipe, three reservoir problems and pipe network. Equations of motion for laminar flow of a Newtonian fluid – Viscous flow - Navier-Stoke's equations, simple exact solutions for Hydrodynamic lubrication.

Boundary Layer Theory: History of boundary layer, displacement and momentum thickness, boundary layer over a flat plate, Prandtl boundary layer equation, laminar



boundary layer, application of momentum equation, turbulent boundary layer, laminar sub-layer, separation, and its control, drag and lift, drag on a sphere, 2D cylinder and airfoil, Magnus effect.

Text Books:

1. Introduction to Fluid Mechanics, Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, Wiley, 2011 and 8th Edition
2. Fluid Mechanics and Hydraulic Machines, R.K. Bansal, Laxmi Publications, 2018, 10th Edition.
3. Fluid Mechanics: Fundamentals and Applications, Yunus A. Çengel, John M. Cimbala, McGraw Hill, 2020 and 4th Edition.

Reference Books:

1. Fluid Mechanics, Frank M. White, McGraw Hill, 2015 and 8th Edition.

Online Resources:

1. Fluid Mechanics, Prof. Gautam Biswas, Prof. Suman Chakraborty, IIT Kanpur, <https://nptel.ac.in/courses/112104118>
2. Introduction to Fluid Mechanics and Fluid Engineering, Prof. S. Chakraborty, IIT Kharagpur, <https://nptel.ac.in/courses/112105183>



Course Code: ME2091	Applied Thermal Engineering	2-0-0	Credits 02
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Pre-Requisites: ME1051: Engineering Thermodynamics

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

CO1	Apply and analyse thermodynamics concepts to power generating cycles.
CO2	Design components of steam power plants.
CO3	Design and evaluate various compressors.
CO4	Analyse Refrigeration Cycles and properties of refrigerants.
CO5	Evaluate Energy Economics and Environmental Issues of power plants.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Power Cycles: Basic Concepts, Carnot cycle and its limitations. Rankine cycle: Simple Rankine cycle, reheat Rankine cycle, regenerative Rankine cycle. Binary vapor cycle. Brayton cycle: Simple and with regeneration, inter-cooling, and reheating. Gas turbine combustion systems – Introduction.

Steam Nozzles: Steam Nozzles- Introduction, Area- velocity relationship, Mass flow rate, Choking of Nozzles, Performance characteristics of Nozzles.

Steam Turbines: Steam Turbines - Impulse and reaction Turbines, compounding of steam turbines, multistage reaction Turbines, Reheat factor and Efficiency.

Centrifugal Compressors: Centrifugal Compressors- Principle of Operation, T-s diagram, Energy equation, velocity triangles, types of blades. Analysis of Flow, Performance Characteristics.

Axial Flow Compressors: Axial Flow Compressors - Construction, Principle of Operation, T-s diagram, Energy equation, velocity triangles. Analysis of Flow. Work done factor, Stage efficiency, Degree of reaction, Performance characteristics.

Rotary Compressors: Mechanical Details and principal of Working, efficiency considerations.

Refrigeration: Introduction to Refrigeration, Basic Concepts, and Refrigerants. Refrigeration Cycles: Vapour Compression Refrigeration Cycle, Other Refrigeration Cycles.



Energy Economics and Environmental Issues of Power Plants: Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

Text Books:

1. Gas Turbine Theory, H. Cohen, G.F.C. Rogers, Paul Straznicky, H.I.H. Saravanamuttoo, Andrew Nix, Pearson India, 2017 and 7th Edition.
2. Applied Thermodynamics for Engineering, Eastop, Pearsons Publishers.

Reference Books:

1. Power Plant Engineering, P.K. Nag, McGraw Hill, 2017 and 4th Edition.

Online Resources:

1. Steam and Gas Power Systems, Prof. A.K. Jain, IIT Bombay,
<https://nptel.ac.in/courses/112107216>
2. Refrigeration and air-conditioning, Prof. Ravi Kumar, IIT Roorkee,
<https://nptel.ac.in/courses/112107208>
3. Power Plant Engineering, Prof. Ravi Kumar, IIT Roorkee,
<https://nptel.ac.in/courses/112107291>



Course Code: ME2101	Mechanics of Solids	2-1-0	Credits 03
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Pre-requisites: ME1031: Engineering Mechanics

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

CO1	Understand statically determinate and indeterminate problems.
CO2	Determine the resistance and deformation in machine members subjected to axial, flexural and torsional loads
CO3	Evaluate shear force, bending moment, Shear stress and Torsion.
CO4	Analyze and design thin cylinders
CO5	Determine Deflection of beams, Principal Stresses and Strains.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Mechanics of Solids: Basic concepts and definitions, types of stresses and strains, Stress and strain transformations, strain gauges and rosettes, Testing of material properties: Tensile strength, compressive strength, Impact strength, Hardness, Fatigue strength, Creep.

Resistance and Deformation: Concept of Resistance and deformation - Determinate and Indeterminate problems in Tension and Compression - Thermal Stresses - pure shear - young's modulus of elasticity, Poisson's ratio, Modulus of rigidity and Bulk modulus - Relation between elastic constants - Stress-strain diagrams for brittle and ductile materials - working stress - Strain energy in tension and compression - Impact loading.

Shear Force and Bending Moment: Types of supports - Types of beams - Types of loads - articulated beams - Shear Force and Bending Moment diagrams.

Theory of Simple Bending: Assumptions - Bending stresses in beams - Efficiency of various cross sections - Composite beams.

Shear Stress Distribution: Flexural shear stress distribution in different cross sections of beams.

Torsion of Circular cross sections: Theory of pure torsion - transmission of Power in Solid and Hollow circular shafts - Combined bending and torsion.

Thin Cylinders: Thin Cylinders - spherical shells subjected to internal fluid pressure - Wire wound thin cylinders - Compound cylinders - Shrink fit.



Deflection of Beams: Slope and deflection of beams - Double Integration method - Macaulay's method - strain energy method.

Principal Stresses and Strains: Analysis of Biaxial state of stress with and without shear - Mohr's Circle.

Text Books:

1. Statics and Mechanics of Materials, Goodno, Barry J., and James Gere, Cengage Learning, 2018.
2. Introduction to Solid Mechanics, Shames, I. H., & Pitarresi, J. M. 2000.
3. Mechanics of Materials, Timoshenko and Gere, CBS Publishers, 2011.

Reference Text Books:

1. Engineering Mechanics of Solids, E.P.Popov, PHI, 2009.
2. Mechanics of Structures, S. B. Junarkar, Charotar Publishers, 2010.



Course Code: ME2111	Geometric Modelling for CAD	2-0-0	Credits 02
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Pre-Requisites: ME1013: Engineering Drawing with CAD

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

CO1	Apply geometric transformations and projection methods in CAD.
CO2	Develop geometric models to represent curves.
CO3	Design surface models for engineering design.
CO4	Model engineering components using solid modelling techniques for design.
CO5	Apply geometric modelling techniques in design and analysis.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Introduction to CAE, CAD. Role of CAD in Mechanical Engineering, Design process, software tools for CAD, geometric modelling.

Introduction to Geometric Modeling for Design: Introduction to CAGD, CAD input devices, CAD output devices, CAD Software, Display Visualization Aids, and Requirements of Modelling.

Transformations in Geometric Modeling: Introduction, Translation, Scaling, Reflection, Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. Computer-Aided assembly of rigid bodies, applications of transformations in design and analysis of mechanisms, etc. Implementation of the transformations using computer codes.

Projections: Projective geometry, transformation matrices for Perspective, Axonometric projections, Orthographic and Oblique projections. Implementation of the projection formulations using computer codes.

Curves in Geometric Modeling for Design: Differential geometry of curves, Analytic Curves, PC curve, Ferguson's Cubic Curve, Composite Ferguson, Curve Trimming and Blending. Bezier segments, de Castegliau's algorithm, Bernstein polynomials, Bezier-subdivision, Degree elevation, Composite Bezier. B-spline basis functions, Properties of basic functions, Knot Vector generation, NURBS. Conversion of one form of curve to other. Implementation of the all the curve models using computer codes in an interactive manner.

Surfaces in Geometric Modeling for Design: Differential geometry of surfaces,



parametric representation, Curvatures, Developable surfaces. Surfaces entities (planar, surface of revolution, lofted etc). Free-form surface models (Hermite, Bezier, B-spline surface). Boundary interpolating surfaces (Coon's). Implementation of the all the surface models using computer codes.

Solids in Geometric Modeling for Design: Solid entities, Boolean operations, Topological aspects, Invariants. Write-frame modeling, B-rep of Solid Modelling, CSG approach of solid modelling. Popular modeling methods in CAD software. Data Exchange Formats and CAD Applications.

Text Books:

1. A. Saxena and B. Sahay, Computer-Aided Engineering Design, Anamaya Publishers, New Delhi, 2005.
2. Rogers, David F., An introduction to NURBS: with historical perspective, Morgan Kaufmann Publishers, USA, 2001.
3. Michael E. Mortenson, Geometric Modeling, Tata McGraw Hill, 2013.

Reference Books:

1. David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, TMH, 2008.
2. CAD/CAM: Principles and applications, Rao, P. N., 2017, McGraw-Hill Education, 4th Edition.
3. Geometric Modeling: The mathematics of shapes, Golubev, N. Springer, 2013.



Course Code: ME2122	Manufacturing Science - I Laboratory	0-1-2	Credits 02
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Pre-requisites: ME2071: Manufacturing Science-I

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

CO1	Utilize advanced manufacturing technologies such as robotic welding, injection molding, and 3D printing to fabricate and test various engineering components.
CO2	Perform and analyze metal matrix composite preparation using stir casting, deep drawing, and cup drawing processes
CO3	Implement and interpret results from various non-destructive testing methods, including dye penetrant, ultrasonic flaw detection, and magnetic crack detection.
CO4	Measure and analyze the physical properties of molding sands, including green and dry shear strength, compression strength, and permeability
CO5	Demonstrate Practical Skills in Sand Casting

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

1. Perform the Robotic welding on the given specimen.
2. Prepare a plastic component using the Injection molding approach.
3. To draw a cup by deep drawing process and measure the drawing force on a hydraulic press.
4. To draw a cup by cup drawing process and measure the drawing force on hydraulic press.
5. Dye penetration testing, to study the defects of Casted and Welded Specimens.
6. Ultrasonic flaw detection and Magnetic crack detection to study the defects of Casted and Welded Specimens.
7. Find the green and dry shear strength, compression strength and permeability of the given molding sand.
8. Demonstration on sand casting of at least two products.



Course Code: ME2132	Fluid Mechanics Laboratory	0-0-2	Credits 02
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Pre-requisites: ME2081: Fluid Mechanics

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

CO1	Develop procedure for standardization of experiments.
CO2	Calibrate flow discharge measuring device used in pipes channels and tanks.
CO3	Determine fluid and flow properties.
CO4	Characterize laminar and turbulent flows
CO5	Compute drag coefficients.
CO6	Test the performance of pumps and turbines.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														
CO6														

1 - Slightly; 2 - Moderately; 3 – Substantially

Experiments:

1. Calibration of Venturi – Meter, Orifice meter (discharge measuring device in pipes)
2. Calibration of Orifice and mouthpiece (discharge measuring device in Tanks).
3. Calibration of Triangular – Notch and rectangular notch (discharge measuring device in Channels).
4. Determination of Darcy Friction Factor, relative roughness for laminar and turbulent flows.
5. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades and Pelton bucket.
6. Computation of pressure drag coefficient for flow past a cylinder in a subsonic wind tunnel.
7. Performance Characteristics of single-stage centrifugal pump, multi-stage centrifugal pump.
8. Performance Characteristics of Pelton turbine, Francis turbine, and Kaplan turbine.

Virtual labs links:

1. <https://ce-iitb.vlabs.ac.in/exp1/ori/ori1.php>
2. <https://eerc03-iiith.vlabs.ac.in/List%20of%20experiments.html>
3. <https://fmc-nitk.vlabs.ac.in/List%20of%20experiments.html>
4. <https://fm-nitk.vlabs.ac.in/List%20of%20experiments.html>



Course Code: ME2142	Materials Testing Laboratory	0-0-2	Credits 01
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Pre-requisites: ME1031: Engineering Mechanics

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

CO1	Conduct tension test on steel, aluminium, copper and brass
CO2	Perform compression tests on spring and wood.
CO3	Determine elastic constants using flexural and torsion tests.
CO4	Determine hardness of metals.
CO5	determine the Modulus of elasticity.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

List of Experiments:

1. To study the stress -strain characteristics of (a) Mild Steel and (b) Tor steel by conducting tension test on U.T.M.
2. To study the stress - strain characteristics of (a) Copper and (b) Aluminium by conducting tension test on Hounsfield Tensometer.
3. To find the Compressive strength of wood and punching shear strength of G.I. sheet by conducting relevant tests on Housfield Tensometer.
4. To find the Brinnell's and Vicker's hardness numbers of (a) Steel (b) Brass (c) Aluminium (d) Copper by conducting hardness test.
5. To determine the Modulus of rigidity by conducting Torsion test on (a) Solid shaft (b) Hollow shaft.
6. To find the Modulus of rigidity of the material of a spring by conducting Compression test.
7. To determine the Young's modulus of the material by conducting deflection test on a simply supported beam.
8. To determine the Modulus of elasticity of the material by conducting deflection test on a Propped Cantilever beam.
9. To determine the Modulus of elasticity of the material by conducting deflection test on a continuous beam.

Text Books:

1. Strength of Materials, S. S. Rattan, Tata Mc Graw Hill.
2. Mechanics of Materials, R. C. Hibbeler, Prentice Hall



Course Code: HS2011	Personality Development	1-0-0	Credits 01
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Pre-requisites: NIL

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

CO1	Students will develop a deeper self-awareness, gaining insights into their strengths, weaknesses, values, and emotional triggers.
CO2	Students will enhance their communication skills, enabling them to express themselves more clearly and engage effectively with others.
CO3	Students will improve their emotional intelligence and cultivate a growth mindset, equipping them to navigate challenges with resilience and adaptability.
CO4	Students will strengthen their abilities in conflict management, adaptability, and networking, preparing them for successful interactions in personal and professional contexts.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module 1

Introduction to personality development - self assessment- SWOT - personal values statement - (punctuality, attitude, responsibility, ethics, integrity, values, and trust, and self-confidence) - imposter syndrome, communication skills (verbal and non-verbal, body language and posture, avoiding miscommunication) - techniques for persuasive communication - key principles to increase clarity of communication.

Module 2

Emotional Intelligence - ways to improve emotional intelligence - application of emotional intelligence - identifying emotional triggers - Building rapport and maintaining positive interactions - Fixed and growth mindset - emotions in personal and professional relationships, strategies for effective networking - social and dining etiquette - greetings - dress code.

Text Books:

1. Mitra, Barun K. Personality Development and Soft Skills. 2nd ed. Oxford Higher Education, 2016.
2. Sharma, Prashant. Soft Skills: Personality Development for Life Success. 3rd ed. BPB Publications, India, 2022.



3. Goleman, D. (1995). Emotional intelligence: Why it can matter more than IQ. Bantam Books.

Reference Books:

1. Carnegie, D. (2020). How to Win Friends and Influence People. Srishti Publishers and Distributors.
2. Khera, S. (2014). You can win: A step-by-step tool for top achievers. Bloomsbury India.



Course Code: PE2012	Yoga	0-0-2	Credits 01
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Pre-requisites: NIL

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

CO1	Recognize the concept of yoga and understand its importance.
CO2	Practice of Asanas, Pranayamas, meditation techniques, and yogic kriyas.
CO3	Role of yogic practices in promoting health and preventing health issues.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Meaning & Definitions of Yoga., Need for and Importance of the Present Era.

Yogic Warm Up - Jogging or Spot Marching, Neck Movements, Shoulder Rotations, Spinal Twists Wrist, Knee Movements and Ankle Rotations, **Yogic Coll Down** - Gentle Forward Bendings, knee Twists, Deep Breathing / Pranayama and Shavasana. **Surya Namaskar** (Sun Salutation) - 12 Steps of Surya Namaskar.

Yoga Asanas & Various Categories of Asanas: Meaning and Definitions of Asanas and its benefits, Standing Asanas, Sitting Asanas, Supine Asanas, Prone Asanas Meditative Asanas, Inverted Asanas, Relaxation Asanas

Pranayama & Techniques: Meaning and Definitions of Pranayama & Its Benefits, Nadi Shodhana Pranayama, Surya Bhedana Pranayama, Chandra Bhedana Pranayama Techniques

Yogic Kriyas and Techniques: Meaning and Definitions of Yogic Kriyas and Its Benefits, Yogic Kriyas and Essential Equipments Kapalabhati, Jala Neti, Sutra Neti, Trataka

Yoga and Lifestyle: Definition, Etiological (Causes) Clinical Features (Signs & Symptoms) and Yogic Treatment of Disorders: Arthritis, Cervical Spondylosis, Lumbago, Sciatica, Migraine, Insomnia, Indigestion, Constipation, Ulcer, Obesity, and Diabetes.

Definition, Etiological (Causes) Clinical Features (Signs & Symptoms) and Yogic Treatment of Disorders: Bronchial Asthma, Bronchitis, Hypertension, Hypothyroidism.

Text Books:

1. Certification of Yoga Professionals - Official Guide Book (For Level I &II Instructor and Level II Teacher), Excel Books Pvt. Ltd., 2024



Course Code: ME2151	Theory of Machines	2-1-0	Credits 03
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Pre-requisites: ME1031: Engineering Mechanics

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

CO1	Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, equivalent chains and planar mechanisms for velocity & acceleration.
CO2	Synthesize planar four bar and slider crank mechanisms for specified design requirements
CO3	Evaluate gear tooth geometry and select appropriate gears for the required applications.
CO4	Design cams and followers for specified motion profiles.
CO5	Characterize and design flywheels and understand the gyroscopic effects in ships, aero planes and road vehicles.
CO6	Analyze balancing problems and free and forced vibrations in rotating and reciprocating machinery.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														
CO6														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Kinematics: Basic concepts and definitions of kinematics, Degrees of freedom. Mechanisms: Links, joints, Kinematic pair, Classification of kinematic pairs, Kinematic chain and mechanism, Gruebler's criterion, Inversion of mechanism, Grashof criteria, four bar linkage and their inversions, Single slider crank mechanism, Double slider crank mechanism and their inversion. Transmission angle and toggle position, Mechanical advantage.

Kinematic Analysis: *Velocity Analysis:* Instantaneous center method, Aronhold-Kennedy Theorem, Rubbing velocity at a Pin-joint, Relative velocity method for slider-crank mechanism, and crank and slotted lever mechanism. *Acceleration Analysis:* Klein's construction, slider crank mechanism, Coriolis acceleration component, Crank, and slotted lever mechanism.

Mechanism Synthesis: Dimensional synthesis, function generation, path generation, and motion generation, Synthesis of Four Bar linkage for specified Instantaneous conditions, Hirschhorn's method of components, Computer Aided Kinematic Synthesis.



Gear trains: Classification, Terminology, Law of Gearing, Interferences, methods of avoiding interferences, path of contact, arc of contact. Simple gear train, compound gear train, reverted gear train, planetary/epicyclic gear train, Sun, and planet gears,

Cams: Classification and application of cams. Analysis of Uniform velocity, Harmonic, and cycloidal motion profiles. Graphical and analytical synthesis of planar cams with knife edge, roller, and flat-faced followers.

Flywheels: Working principle of the flywheel, Concept of dynamically equivalent link, Force analysis of single slider crank mechanism, compound pendulum, correction couple, turning moment on the crankshaft, Turning moment diagrams, Maximum fluctuation of energy, Coefficient of fluctuation of speed, Rim and solid type flywheel design.

Gyroscopes: Principle of gyroscope, gyroscopic effect in two-wheeler, car, ship, and aeroplane.

Balancing of reciprocating and rotating masses: Balancing: Balancing and its types, Rotor balancing, Single and two plane balancing. Unbalanced forces and couples. Static and dynamic balancing, Balancing of rotors by analytical method and graphical method. Balancing machines. Balancing of reciprocating machines: primary, secondary, and higher order unbalanced forces, balancing of in-line, V, and radial engines.

Vibrations: Free and forced vibration of single degree of freedom systems, the effect of damping; vibration isolation; resonance; critical speeds of shafts.

Text Books:

1. Theory of Mechanisms and Machines, Amitabha Ghosh and Ashok Kumar Mallik, East West Press Pvt. Ltd., New Delhi, 2017, 3rd edition.
2. Theory of Machines, S.S.Rattan, McGraw-Hill Publications, New Delhi, 2011, 3rd edition.
3. Theory of Machines and Mechanisms, Shigley J. E. and John Joseph, Uicker McGraw-Hill international edition, 2003, 2nd edition.

Reference Books:

1. Design of Machinery - An introduction to Synthesis and Analysis of Mechanisms and Machines, Norton, R.L., McGraw Hill International Editions, New York, 2000, 2nd Edition.



Course Code: ME2161	Manufacturing Science-II	2-0-0	Credits 02
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Pre-requisites: ME2071: Manufacturing Science-I

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

CO1	Understand and Apply Conventional Machining Techniques
CO2	Evaluate tool wear, tool life, and factors affecting these variables through the application of metal cutting mechanics and Merchant's Circle Diagram
CO3	Apply various finishing processes, including grinding and unconventional methods and estimate MRR.
CO4	Conduct economic analyses to make cost-effective and efficient manufacturing decisions
CO5	Investigate and apply advanced machining techniques.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Conventional Removal and Finishing Processes: Importance of Material Removal and allied processes, classification; Chip Formation; Types of Chips; Tool Specification: Coordinate and Orthogonal Systems;

Mechanics of Metal Cutting: Merchant's Circle Diagram, Stress, Strain and Strain Rate, determination of Shear Plane Angle; Tool Wear and Tool Life; Variables affecting Tool Life;

Machining Operations: Turning, drilling, milling; Finishing Operations: Grinding (MRR estimation, Wheel Specifications, Wheel Wear) and other processes;

Economics of machining: Minimum Production Cost Criterion, Maximum Production Rate, and Maximum Profit Rate Criteria.

Unconventional machining processes- Electro Discharge Machining (EDM), Electro Chemical Machining (ECM), Water jet cutting, Ultrasonic machining, Abrasive Jet Machining, Electron Beam Machining; Laser Beam Machining; Finishing Processes-Abrasive Flow Machining (AFM) and Chemical Mechanical Polishing (CMP), Magnetorheological Finishing (MRF).

Micro-Manufacturing and Scaling Laws: Miniaturization and its importance, Micro-Manufacturing Processes, Scaling laws with emphasis on micro-Manufacturing.



Text Books:

1. Machining and Machine Tools, A. B. Chattopadhyay, Wiley, 2017, 2nd Edition.
2. Fundamentals of metal cutting and machine Tools, B L Juneja and G S Sekhon, New Age International publishers, 2017, Revised 2nd Edition.

Reference Books:

1. Manufacturing Science, Amitabha Ghosh and A.K. Mallik, East-West Press, 2010, 2nd Edition.
2. Modern Machining Processes, P. C. Pandey and H. S. Shan, TMH, 2017.
3. Advanced manufacturing Processes, V. K. Jain, Allied Publishers Pvt. Ltd, 2002.



Course Code: ME2173	Machine Drawing and Solid Modelling	2-0-2	Credits 03
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Pre-requisites: ME1013: Engineering Drawing with CAD

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

CO1	Develop the surfaces of different solids
CO2	Draw the machine elements including keys, couplings, and cotters, riveted, bolted and welded joints following the conventions for engineering materials.
CO3	Construct an assembly drawing using part drawings of machine components.
CO4	Create part drawing of machine components using machine assembly
CO5	Create solid modelling and assemble part models using Creo software

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Representation of elements of machine drawing: Engineering Materials, Surface finishes, sectional views, Screw threads.

Drawing Standards & Fits and Tolerances: Limits, Fits – Tolerancing of individual dimensions IS919- Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of Geometric Dimensioning & Tolerancing.

Component Drawings: Bolts and Nuts, Locking devices, Keys and Cotter joints, Knuckle Joint, Riveted joints, Shaft Couplings, Bearings and Pipe joints.

Assembly Drawing Practice: Draw the assembly drawings of Stuffing Box, Eccentric, Swivel bearing, Drill jig, Tail stock, Toolpost, Tool head for shaping machine, machine vice, screw jack, using the component drawings.

Practice of components modelling and assembling using PTC CREO software.

Text Books:

1. Machine Drawing, Bhatt, N.D., Charotar Publishing House, 2003.
2. Machine Drawing, Sidheswar, N., Kannaiah, P. and Sastry, V.V.S., Tata McGraw Hill Book Company, New Delhi, 2000



Course Code: ME2181	IC Engines and Gas Turbines	2-0-0	Credits 02
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Pre-requisites: ME2091: Applied Thermal Engineering

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

CO1	Classify and Differentiate IC Engine Types and Cycles
CO2	Analyze Combustion Phenomena and Engine Systems
CO3	Evaluate Engine Performance Parameters
CO4	Understand Gas Turbine Operation and Efficiency
CO5	Assess Environmental Impact and Emissions

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to IC engines:

IC Engines as Prime Movers; IC Engines- Classification, Air standard cycles -Diesel, Otto, and Dual, Differences between 2-S and 4-S cycle engines, Differences between SI and CI engines.

Spark Ignition Engines: Flame Propagation- Combustion phenomena (Normal and Abnormal), Factors affecting, Detonation, Ignition quality, HUCR-Carburetion, and fuel injection systems for SI Engines.

Compression Ignition Engines: Advantages of CI Engines-Importance of air motion and Compression Ratio, Mixture Preparation inside the CC. Normal and abnormal combustion - Ignition Quality-Cetane Number-Characteristics of a Good Combustion Chamber, Description of Fuel Injection Systems -Individual, Unit and Common Rail (CRDI), Fuel Injectors-Nozzle types, Electronic Control Unit (ECU).

Testing and Performance of IC Engines: Classification of Engine Performance Parameters-Measurement of brake power, indicated power and friction power. Factors affecting performance, Heat loss, Airfuel ratio, Pumping loss, Energy Balance: Pi and Sankey diagrams, Emissions and Pollution Control.



GAS TURBINES AND COMBINED CYCLES:

Gas Turbines: Brayton cycle - Simple and with regeneration, inter-cooling, and reheating, Components of gas turbines - Compressors, combustors, turbines, applications and efficiency improvements.

Combustion Chambers - Gas turbine combustion systems - Introduction, Geometry, Factors affecting Design & Performance, Requirements of the Combustion Chamber, Gas Turbine Combustion Emissions.

Text Books:

1. Internal Combustion Engine Fundamentals, John B. Heywood.
2. Advanced Internal Combustion Engines, K. M. R. Naidu and K. M. Gupta.
3. Gas Turbine Theory, H. Cohen, G.F.C. Rogers, Paul Straznicky, H.I.H. Saravanamuttoo, Andrew Nix, Pearson India, 2017, 7th Edition.

Reference Books:

1. The Internal Combustion Engine in Theory and Practice, Charles Fayette Taylor
2. Fundamentals of Gas Turbines, Philip Walsh and Paul Fletcher.
3. Power Plant Engineering, P.K. Nag, McGraw Hill, 2017, 4th Edition.

Online Resources:

1. <https://nptel.ac.in/courses/112103262>



Course Code: ME2192	IC Engines Laboratory	0-1-2	Credits 02
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Pre-requisites: ME2091: Applied Thermal Engineering

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

CO1	Conduct constant speed and emission tests on IC engines and interpret their performance.
CO2	Estimate energy distribution by conducting heat balance test on IC engines.
CO3	Determine the friction power of an IC engine by motoring, Morse and retardation tests.
CO4	Evaluate performance parameters of steam power plant.
CO5	Evaluate the performance of turbomachines.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

List of Experiments:

1. Performance Test on a Single-Cylinder Four-Stroke Diesel Engine
2. Retardation test on Kirloskar diesel engine
3. Valve timing diagram
4. Determination of COP of a Vapor Compression Refrigeration System
5. Performance Test on a Two-Stage Air Compressor
6. Performance characteristics of an Axial flow fan
7. Determination of Effectiveness of a Shell and Tube Heat Exchanger
8. Heat balance test on CI engine
9. Performance Analysis of an Air Conditioning Test Rig
10. Demonstration of boiler

Virtual labs links:

1. <https://weblab.mit.edu/>
2. <https://learncheme.com/simulations/thermodynamics/thermo-1/>



Course Code: ME2202	Manufacturing Science - II Laboratory	0-0-2	Credits 01
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Pre-requisites: ME2161: Manufacturing Science-II

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

CO1	Perform different operations on a lathe.
CO2	Evaluate the effect of process parameters on shear angle, cutting forces and surface finish in machining
CO3	Evaluate the effect of process parameters on MRR and surface finish in EDM.
CO4	Perform indexing to machine spur and helical gears on milling machine.
CO5	Evaluate internal and external taper angles, straightness and flatness of a given surface.
CO6	Evaluate dimensional and form accuracies of thread and gear profiles.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														
CO6														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

List of Experiments

Machining Cycle:

1. Turning, Taper turning, Facing, Thread cutting and chamfering on lathe (Demo: Split-half nut).
2. Eccentric turning (Demo: Different types of chucks, Belt, Chain and Gear drives).
3. Spur Gear and Helical milling (Demo: Indexing).
4. Chip reduction coefficient on shaper (Demo: 1. Quick-return mechanism, 2. Pawl and Ratchet mechanism, 3. Rack & Pinion mechanism).
5. Measurement of cutting forces and surface finish in turning (Demo: Dynamometer and its setup).
6. Measurement of thrust force and torque in drilling machine.
7. Introduction to unconventional machining process (demo).

Metrology Cycle:

1. Internal and external taper measurement.
2. Thread measurement using floating carriage diameter measuring machine.
3. Straightness measurement using auto-collimator.
4. Measurement of Thread and Gear profiles for their form and geometrical accuracies.



5. Demonstration Coordinate Measuring Machine for the evaluation of form errors

Reference Books:

1. Manufacturing, Engineering & Technology, Kalpakjian S. and Steven R. Schmid, Pearson, 2007.
2. Engineering Metrology, I.C. Gupta, DhanpatRai and Sons, 2003.



Course Code: ME2212	Theory of Machines Laboratory	0-1-2	Credits 02
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Pre-requisites: ME2151: Theory of Machines

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

CO1	Analyse the kinematics of different mechanisms.
CO2	Identify the essential system properties and physically visualize the concepts of frequency and time period of vibrations under free vibration.
CO3	Explain the mechanism of forced vibration to analyse the damping properties.
CO4	Evaluate the mechanism of forced vibration to analyse the different mode shapes and critical speed of shaft.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

List of Experiments

1. To determine the link lengths of the bar chain, Single slider crank chain, and Double slider crank chain mechanisms.
2. To study the belt, rope, and chain drives
3. To identify the motion of cam and follower mechanism
4. Basic ideas concerning to clutch drive and gear and gear trains
5. To estimate the acceleration due to gravity using bifilar pendulum.
6. To determine the mass moment of inertia of a given object using a Trifilar pendulum.
7. To verify the natural frequency of a bar resting on a cylindrical surface to verify the natural frequency of a semi cylindrical shell resting on a horizontal surface.
8. To find the location of the center of mass G and the moment of inertia about IG of a given connecting rod (Compound pendulum).
9. To determine the viscous damping coefficient of a given viscous damper
10. To estimate the damping in given vibrating system through Logarithmic decrement.
11. To determine the viscous damping coefficient of a viscous damper by observing free vibrations of Spring-Mass-Damper system.
12. To determine the coefficient of friction between two surfaces.



Course Code: HS2052	National Service Scheme (NSS)	0-0-2	Credits 01
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Pre-requisites: None

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

CO1	Understand the real-world problems and brain storm to address the problems with innovative ideas.
CO2	Create awareness on various social issues to the community and youth effectively.
CO3	Use their expertise to devise the solution and implement on the real time problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Activities

Introduction to several activities of course, skills and innovative ideas, orientations, road maps, displaying success stories, motivational biopics, award winning movies on sciential issues, Talent shows of individual skills

Module I

Wastes management services

- Wastes segregation and composting methods
- Posters and sign boards, and competition to display environmental issues and awareness
- Recycling, reduce, and reuse (3R) concepts, Environmental article writing competition
- Zero wastes day celebration
- Virtual demonstration of different eco-friendly approaches for sustainable living
- Summary of article or book on recent environmental issues.

Module II

Community engagement and social responsibility

- Conducting awareness programme on health issues, communicable diseases, etc.
- Conducting consumer awareness and legal provisions
- Woman empowerment programme, forms of harassment, Adolescent health and population education, Children educations
- Any activities in collaboration with NGOs and Charity.



- Awareness on Road Safety and First – Aid
- Visit to hospitals & support activities
- Health awareness and conduct of health camps / yoga camps
- Blood donation & blood grouping
- Visit to old age homes, orphanages & institutions for differently abled
- Swacch Bharat Mission – maintaining cleanliness in the campus
- Campus beautification & planting of saplings

Modules III

Internet Security awareness

- Internet and its uses - Schemes
- Cyber security issues and awareness programme
- Digital services and accounting (Banking, health, Central/state govt services)

Module IV

Training Youth

- Imparting Basic Technical Training to Rural Youth in Simple Trades
- Self-Employment Training to Rural Women
- Training on Disaster Management
- Soft Skills / Technical Skills to Rural Youth
- Career Guidance to Educated / Uneducated Youth
- Cultural and Sports Activities
- Conducting one-day special camp in villages, Survey, identification of potential problem, rendering help to solve via self-media-authorities-experts etc.

Text Books:

1. Certification of Yoga Professionals - Official Guide Book (For Level I & II Instructor and Level II Teacher), Excel Books Pvt. Ltd., 2024.
2. Brown, F. Y. (2000). How to use yoga. Delhi: Sports Publication.
3. Thirumalai Kumar. S and Indira. S (2011) Yoga in Your Life, Chennai: The Parkar Publication
4. Helen Purperhart (2004), The Yoga Adventure for Children. Netherlands: A Hunter House book



Course Code: ME3221	Design of Machine Members	2-1-0	Credits 03
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Pre-requisites: ME2101: Mechanics of Solids

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

CO1	Identify the preferred sizes and codes, and selection of proper material for design of machine element.
CO2	Design the machine element under static and dynamic loading conditions.
CO3	Design the temporary and permanent joints required to assemble the machine elements.
CO4	Design the required spring for the given application.
CO5	Understand the design concept of bearings.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Engineering Design and classification, Basic design procedure, requirement of machine element, traditional design methods, standards and codes, selection of preferred sizes, Engineering material and its classification, Mechanical properties of engineering materials, Selection of materials, Manufacturing considerations and their selection.

Static Loading: Basics- Stresses in members subjected to different types of loads, Modes of failure, Principal stresses, Theories of failure- Rankine theory, Guests theory and Von Mises theory, Selection of failure theories to design simple machine parts.

Dynamic Loading: Stress concentration and its Importance in design, Methods to reduce stress concentration, Stress concentration factor-Theoretical and actual stress concentration factors, Notch sensitivity, Design of stress concentrated members subjected to various loads-Problems, Types of variable/Cyclic loads, Mean & amplitude Stresses, Fatigue Failure, Endurance Limit & Strength, S-N Diagram, Goodman and Soderberg criterion, Modifying factors: Size effect, surface effect, Reliability, stress concentration effects etc., Problems on design of members for finite & infinite life in members subjected to individual & combined loading, Cumulative damage in fatigue.

Design of Temporary Joints: Types of temporary joints- cotter joints, knuckle joint and fasteners, Design of cotter and knuckle joint, Forms of screw threads, Nomenclature of screw thread, Thread series and its designation, Power screws and their advantages over v-threads, Stress in screwed threads, Design of bolts based on uniform strength, Empirical relation for initial tightening, Design of screw & Nut for power Screw-Problems.



Design of Permanent Joints: Types of permanent Joints-Riveted and Welded Joints, Rivet heads, Terminology, Caulking and fullering, Analysis of riveted joint, Efficiency of a riveted joint, welding process, merits and demerits of welded joint over riveted joints, weld symbols, Strength of parallel and fillet weld, eccentrically loaded welded joints, Weld subject to bending moment and torsional moment, Problems.

Design of Springs: Types of Springs, Spring materials, terminology - Stresses in Helical coil springs of circular and non-circular cross sections, Compression-spring surge, Springs under eccentric loading and fluctuating loads, - Energy stored in springs, torsion, Belleville springs. Leaf Springs: Stresses in leaf springs, Nipping. Equalized stresses.

Design of Bearings: Sliding contact and rolling contact bearings- Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, Selection of Rolling Contact bearings.

Text Books:

1. Design of Machine Elements, Bhandari, V B., Tata McGraw Hill Book Company, New Delhi, 2009, 3rd Edition.
2. Machine Design: An Integrated Approach, Norton, R. L., Pearson, 2004, 3rd Edition.
3. Mechanical Engineering Design, Shigley, J.E and Mischke, C. R., Tata McGraw Hill, 2005, 6th Edition.

Reference Books:

1. Machine Design, Paul H Black and O. E. Adams, P., McGraw Hill Book Company, Inc., New York, USA., 2007, 3rd Edition.
2. Machine Design, Kannaiah, P., Scitech Publication Pvt. Ltd., 2009, 2nd Edition.
3. A text book of Machine Design by P.C. Sharma and D. K. Agarwal, S. K. Kataria and sons, 1998.

Online Resources:

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



Course Code: ME3231	Industrial Engineering and Management	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Comprehensive understanding of industrial engineering.
CO2	Proficiency in work system design.
CO3	Understand planning and design.
CO4	Competence in value engineering.
CO5	Understand quality control and inventory management.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Introduction, Definition and objectives of Industrial Engineering, Scope of Industrial Engineering, Production systems and their classifications; Productivity-Total and partial productivity, Reasons and remedy for poor productivity.

Work System Design: Definition, objectives, step-by-step procedure, charts and diagrams for recording data. principles of motion economy. Various techniques of work-measurement, work sampling, time study & its procedure. Rating, methods of rating, allowances and their types, standard time, numerical problems. Introduction to Ergonomics, man-machine system and its components.

Facilities planning and design: Plant layout, material handling and their interrelationship, objectives of a good plant layout, principles of a good layout, classical types of layouts, lean manufacturing.

Value engineering: Value analysis, methodology of value engineering.

Quality Control: Process control and product control, difference between SQC and SPC, chance and assignable causes of quality variation, Shewhart control charts. 100% inspection, no inspection and sampling inspection. Application of hyper geometric, binomial & Poisson distributions in acceptance inspection.

Inventory Management: Introduction, materials productivity and role of materials management techniques in improved materials productivity, Inventory Classifications, Wilson’s lot size model, inventory costs, hidden costs, composition of costs, estimation of inventory related costs, lead time, stock out point, number of time periods, calculating Economic Order Quantity (EOQ), sensitivity analysis of EOQ model, Inventory Controls.



Project Management: Gantt chart, milestone chart. Network scheduling terminology. Path enumeration, Activity on node & activity on arc network precedence diagrams, PERT, CPM and Crashing.

Text Books:

1. Production and Operation Management, R Panneer Selvan, Prentice Hall India, New Delhi, 2002.
2. Operations Management, Krajewski L J and Ritzman L P, Pearson Education Asia, 2004, 6th Edition.

Reference Books:

1. Modern Production/operations Management, Buffa, Wiley Eastern, New York, 1999.
2. Production and Operations Management, Muhlemann Alan, Oakland John and Lockyer Keith, Macmillan India Publications Ltd. 2001.
3. Production and Operation Management, Adam and Ebert Pearson Education Asia, 2003, 5th Edition.



Course Code: ME3241	Measurements and Instrumentation	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Understand fundamentals of measurement principles and accuracy
CO2	Proficiency in gauge design and use
CO3	Understand comparators and measurement techniques
CO4	Expertise in surface texture and screw thread measurement
CO5	Understand the instrumentation and special measuring equipment

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to measurements, various principles of measurements, errors in measurement, basic statistics, calibration procedures, distinction between precision and accuracy. Limits, fits and tolerances, Terminology, Clearance Fit, Transition Fit, Interference Fits and their uses, Allowance, Tolerance grades, Types of fits, IS919, GO and NO GO gauges- Taylor’s principle, design of GO and NO GO gauges, filler gauges, plug gauges and snap gauges.

Comparators - Constructional features and operation of mechanical, optical, electrical/electronic and pneumatic comparators, advantages, limitations and field of applications. Principles of interference, concept of flatness, flatness testing, optical flats, optical interferometer and laser interferometer.

Surface Texture Measurement - importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters- Ra, Ry, Rz, RMS value, Flaw, Lay etc., surface roughness measuring instruments – Tomlinson and Taylor Hobson versions, surface roughness symbols.

Screw Thread Measurement - Two wire and three wire methods, floating carriage micrometer. Gear Measurement - Gear tooth comparator, Master gears, measurement using rollers and Parkinson’s Tester. Special Measuring Equipment - Principles of measurement using Tool Maker’s microscope profile projector & 3D coordinate measuring machine.

Instrumentation: Displacement measurement, measurement of temperature, measurement of pressure, measurement of fluid flow, obstruction meters, measurement of fluid velocities, thermal anemometry, strain gauges, measurement of force, torque and power, load cells,



torque cells, dynamometers, vibration measurement, velocity and acceleration measurement.

Text Books:

1. Experimental Methods for Engineers, J P Holman, Tata McGraw Hill publications
2. Mechanical Measurements by Thomas G Beckwith, Pearson publications.
3. Measurement systems by Ernest O Doebelin, Tata McGraw Hill publications
4. Engineering Metrology, I.C. Gupta, Dhanpat Rai & Sons, 2003
5. Engineering Metrology, R. K. Jain, Khanna Publishers, 19/e, 2005.

Reference Books:

1. Handbook of Industrial Metrology, ASTM, Prentice-Hall Inc., Englewood Cliffs.
2. Coordinate Measuring Machines and Systems, Bosch, J. A., Marcel Dekker, Inc.
3. Machine Vision: Theory, Algorithms, Practicalities, Davies, E. R., Morgan Kaufmann Publishers, San Francisco.
4. Metrology for Engineers, Galyer, J. F. W. and C. R. Shotbolt, Cassell Publishers, London.



Course Code: ME3251	Heat Transfer	2-0-0	Credits 02
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Pre-requisites: ME1051: Engineering Thermodynamics

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

CO1	Understand the modes of heat transfer and apply the basic laws to formulate engineering systems.
CO2	Understand and apply the basic laws of heat transfer to extended surface, composite material and unsteady state heat transfer problems.
CO3	Analyze heat conduction through numerical methods and heat transfer due to free and forced convective heat transfer.
CO4	Understand and apply the fundamental principle to solve radiation heat transfer problems.
CO5	Understand the design and performance analysis of heat exchangers and their practical applications, Condensation and Boiling phenomena.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Heat Transfer - Different Modes, Governing Laws, Applications to Heat Transfer, Numerical Problems.

General Heat Conduction Equation: Derivation of the equation in (i) Cartesian, (ii) Polar and (iii) Spherical Co-ordinate Systems.

Steady-state one-dimensional heat conduction problems in Cartesian System: Steady-state one dimensional heat conduction problems (i) with and without heat generation and (ii) with and without varying thermal conductivity - in Cartesian system with various possible boundary conditions, Thermal Resistances in Series and in Parallel, Numerical Problems.

Steady-state radial heat conduction problems in Polar System: Steady-state one-dimensional heat conduction problems (i) with and without heat generation and (ii) with and without varying thermal conductivity - in cylindrical system with various possible boundary conditions, Thermal Resistances in Series, Numerical Problems.

Steady-state radial heat conduction problems in Spherical System: Steady-state one-dimensional heat conduction problems (i) with and without heat generation and (ii) with and without varying thermal conductivity - in Spherical system with various possible boundary conditions, Thermal Resistances in Series, Numerical Problems.



Critical Thickness of Insulation: Concept, Derivation and Numerical Problems.

Extended Surfaces or Fins: Classification, Straight Rectangular and Circular Fins, Temperature distribution and Heat Transfer Calculations, Fin Efficiency and Effectiveness, Applications, Numerical Problems.

Transient [Unsteady-state] heat conduction: Definition, Different cases - Negligible internal thermal resistance, negligible surface resistance, comparable internal thermal and surface resistance, Lumped body, Infinite Body and Semi-infinite Body, Numerical Problems, Heisler and Grober charts: Solutions to various one-dimensional problems using the charts, Numerical problems.

Forced Convection: Boundary Layer Theory, Velocity and Thermal Boundary Layers, Prandtl number, Governing Equations - Continuity, Navier-Stokes and Energy equations, Boundary layer assumptions, Integral and Analytical solutions to above equations, turbulent flow, Various empirical solutions, Numerical Problems, Forced convection flow over cylinders and spheres, Internal flows -laminar and turbulent flow solutions, Numerical Problems.

Free convection: Laminar and Turbulent flows, Vertical Plates, Vertical Tubes and Horizontal Tubes, Empirical solutions, Numerical Problems

Thermal Radiation: Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien's, Rayleigh-Jeans' and Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws, View factor, View factor algebra, Net radiation exchange in a two-body enclosure, Typical examples for two-body enclosures, Radiation Shield, Numerical problems.

Heat Exchangers: Definition, Classification, LMTD method, Effectiveness - NTU method, Analytical Methods, Numerical Problems, Chart Solution for Heat Exchanger Problems: Correction Factor Charts and Effectiveness-NTU Charts, Numerical Problems.

Text Books:

1. Fundamentals of Heat and Mass Transfer, Frank P. Incropera, David P. DeWitt, Wiley, 2011, 7th Edition.
2. Heat and Mass Transfer, J.P. Holman, McGraw Hill, 2010, 10th Edition.

Reference Books:

1. Principles of Heat Transfer, Frank Kreith, Raj M. Manglik, Mark S. Bohn, Cengage Learning, 2010, 7th Edition.
2. Heat and Mass Transfer, P.K. Nag, McGraw Hill, 2018, 4th Edition.

Online Resources:

1. Heat and Mass Transfer, Prof. S.P. Sukhatme, Prof. U.N. Gaitonde, IIT Bombay, <https://nptel.ac.in/courses/112101097>
2. Heat and Mass Transfer, Prof. Pradip Dutta, IISc Bangalore, <https://nptel.ac.in/courses/112108149>



Course Code: ME3262	Heat Transfer Laboratory	0-0-2	Credits 01
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Pre-requisites: ME3251: Heat Transfer

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

CO1	Measure important properties of fuels and oils.
CO2	Evaluate the variation of volumetric efficiency of a two-stage reciprocating air compressor as a function of receiver pressure
CO3	Estimate heat transfer coefficient in forced convection and compare with theoretical and empirical values.
CO4	Measure heat transfer coefficient in free convection and compare with empirical values.
CO5	Estimate the efficiency and effectiveness of a pin-fin and equivalent thermal resistance of a composite slab.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Experiments:

1. Determination of theoretical and experimental values of equivalent thermal resistance of a composite slab.
2. Determination of Thermal Conductivity of Liquid
3. Determination of temperature distribution, efficiency and effectiveness of a fin working in forced convection environment.
4. Determination of Critical Heat Flux.
5. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
6. Determination of convective Heat Transfer Coefficient in a free/natural Convection from a Heated Vertical Cylinder
7. Determination of theoretical, experimental, and empirical values of forced convection heat transfer coefficient for flow through a circular pipe.
8. Determination of surface emissivity of a given test plate at a given absolute temperature.
9. Determination of Stefan Boltzmann Constant.
10. Demonstration of isothermal characteristic exhibited by a heat pipe in comparison to other pipes.



Virtual labs links:

1. <https://htv-au.vlabs.ac.in/>
2. <https://aero04-iitb.vlabs.ac.in/exp3/index.html#>



Course Code: ME3272	Measurements and Instrumentation Laboratory	0-0-2	Credits 01
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Pre-requisites: ME3241: Measurements and Instrumentation

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

CO1	Proficiency in using coordinate measuring machines.
CO2	Skill in straightness measurement with autocollimators.
CO3	Expertise in screw thread measurement using tool maker’s microscope.
CO4	Accuracy in effective diameter determination using three-wire method.
CO5	Demonstration and comparison of measurement instruments.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

1. Use a CMM for 3D measurement of a component
2. Measurement of straightness using an autocollimator.
3. Screw thread measurement by using Tool makers Microscope.
4. Determination of effective diameter of screw threads by three- wire methods.
5. Demonstrate the working principle of LVDT and compare with micrometer.
6. Demonstrate the working of IR thermal transducer and recording high temperatures.
7. Compare the temperature reading recorded by thermocouples, RTD, thermometers.
8. Measurement of angles of tapers surface using Bevel Protractor.

Text Books:

1. Engineering Metrology, I.C. Gupta, DhanpatRai and Sons, 2003.
2. Mechanical Measurements by Thomas G Beckwith, Pearson publications.



Course Code: SM3011	Introduction to Entrepreneurship	1-0-0	Credits 01
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Pre-requisites: NIL

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

CO1	Acquaint themselves with starting new ventures and introducing new products and service ideas
CO2	Explore the processes of establishing a start-up and develop strategies and methods to mobilize resources
CO3	Create venture capitalists, consultants to new firms or new business development units of larger corporates

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

The entrepreneur’s role, task, and personality- typology of entrepreneurs: entrepreneurship as a style of management

Identify problems worth solving-political economical, and social- technical analysis-opportunity recognition-business model identification-new product franchising- sponsorship and acquisition- internal & external entry strategies

Startup ecosystem and support system- role of incubators- government initiatives

Writing and pitching business plan-entrepreneurial tool-venture capital and other forms of financing-sources of external support-developing entrepreneurial marketing-competencies-maintaining competitive advantage

Text Books:

1. B.D.Singh. Managing Conflict and Resolution. Excel Books.2008
2. B. R. Barringer and D. Ireland, Entrepreneurship, Prentice Hall,2009.
3. G. Kawasaki, L. Filby, The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything, Penguin,2015.

Reference Text Books:

1. R. Bansal, Connect the Dots, Westland, 2011.
2. Ries, Eric The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Crown Business, 2011.
3. S. S. Khanka, Entrepreneurial Development, S. Chand & Co.2006.



Course Code: ME3281	Smart Manufacturing	2-0-0	Credits 02
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Pre-requisites: ME2071: Manufacturing Science-I

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

CO1	Understand the Fundamentals of Numerical Control (NC) and CNC Machine Tools.
CO2	Identify and apply preparatory functions, G-codes, and miscellaneous functions (M-codes) used in CNC part programming.
CO3	Explain Computer Aided Process Planning (CAPP) and Flexible Manufacturing Systems (FMS).
CO4	Describe the Computer Integrated Manufacturing (CIM) and Smart Manufacturing.
CO5	Understand Emerging Technologies in Manufacturing.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Computer Aided Manufacturing (CAM): Introduction to Numerical Control (NC), Numerical control modes, NC elements, Structure of CNC machine tools, Spindle design, Drivers, Designation of axes, Drives & actuation systems, Feedback devices, CNC tooling, Automatic tool changers & Work holding devices.

CNC Part Programming: Preparatory functions, G- Codes, Miscellaneous Functions M Codes, Writing Part programs for typical components, Tool length compensation, Canned cycles, Cutter radius compensation.

Computer Aided Process Planning (CAPP): Introduction to CAPP, Variant & Generative methods of CAPP, advantages of CAPP. **Flexible Manufacturing System (FMS):** Components of FMS, FMS equipment & control, FMS case studies.

Computer Integrated Manufacturing (CIM): Elements of CIM, CIM case studies.

Smart Manufacturing: Definition and principles of Smart Manufacturing, History and evolution of Smart Manufacturing.

Industrial Internet of Things (IIoT): Definition and applications of IIoT, IIoT devices and sensors, IIoT communication protocols.



Cyber-Physical Systems: Definition and examples of cyber-physical systems, CPS architecture and components, CPS applications in manufacturing.

Digital Twins: Definition and applications of digital twins, Digital twin technology and platforms, Digital twin use cases in manufacturing.

Implementation and Management of Smart Manufacturing Systems: Implementation strategies for Smart Manufacturing systems, Management and maintenance of Smart Manufacturing systems, Case studies of successful Smart Manufacturing.

Text Books:

1. CAD/CAM Principles and Applications, P.N. Rao, Tata McGraw Hill, New Delhi, 2010, 3rd Edition.
2. CAD/CAM: Computer Aided Design and Manufacturing, Grover M. P. and Zimmers E.W. Prentice Hall of India, 2010.
3. Computer Control of Manufacturing Systems, Yoram Koren, McGraw Hill Publications, 2005.
4. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2/e, Springer, 2015.

Reference Text Books:

1. Computer Aided Manufacturing, T.C. Chang, R.A. Wysk, H.P. Wang, Pearson Prentice Hall, 2006, 3rd Edition.
2. 3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2015, 4th Edition.
3. Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, Apress, 2016.



Course Code: ME3291	Finite Element Method	2-0-0	Credits 02
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Pre-requisites: Nil

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

CO1	Apply finite element method to solve problems in solid mechanics and Heat transfer.
CO2	Formulate and solve problems in one dimensional structures including trusses, beams and frames.
CO3	Formulate FE characteristic equations for two dimensional elements and analyse plain stress, plain strain, and axi-symmetric and plate bending problems.
CO4	Implement and solve the thermal and fluid mechanics problems.
CO5	Implement and solve the finite element formulations using MATLAB.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Overview of the course, examination and evaluation patterns, history, and basic concept of finite element method and direct FEM.

Fundamental concepts: Calculus of variation and solving differential equations, Ritz method, Galerkin method, least squares, collocation and subdomain methods, Case studies for Ritz and Galerkin methods, Ritz FEM formulation, Galerkin FEM formulation.

One-Dimensional Problems: Finite element formulation for 1-D problems, elimination method, penalty method, computer implementation and case studies.

Trusses: Introduction, fem formulation, plane trusses, three dimensional trusses, frames and case studies.

Two-Dimensional Problems: Finite element formulation for 2-D problems, constant strain triangle, various elements, iso parametric, sub parametric and super parametric elements, interpolation functions, computer implementation and case studies.

Numerical Integration and 2-D problems of Elasticity: Introduction to numerical integration, twodimensional integrals, plane stress, plane strain, axisymmetric, plate bending problems.

Eigen value Problems: Axial vibration of the rod (1D), formulation and implementation, transverse vibration of beams (2D), formulation and implementation.



Thermal Applications: Two - dimensional heat conduction analysis, formulation of functional, element matrices and case studies.

Fluid Mechanics Applications: Stream function formulation, velocity potential formulation and torsional analysis of a prismatic bar.

Text Books:

1. Textbook of Finite Element Analysis, Seshu P., PHI, 2009.
2. Finite Element Method in Engineering, Reddy, J.N., Tata McGraw Hill, 2007.
3. Finite Element Procedures in Engineering Analysis, Bathe, K.J., 2nd Edition, Prentice-Hall, 2009.

Reference Books:

1. The Finite Element Method for Solid and Structural Mechanics, Zeincoiwicz, Elsevier 2007, 4th Edition.
2. The Finite Element Method, Hughes, T.J.R., Prentice-Hall, 1986.
3. Concepts and Applications of Finite Element Analysis, Cook, R.D., Malkus, D.S., and Plesha, M.E., John Wiley, 2007, 4th Edition.



Course Code: ME3301	Operations Research	2-0-0	Credits 02
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Pre-requisites: Nil

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

CO1	Understand the concepts of operations research modelling approaches.
CO2	Formulate engineering and managerial situations as LPP, transportation and Assignment problems.
CO3	Solve LPP, Transportation and Assignment problems
CO4	Formulate multi-stage applications into a dynamic programming framework.
CO5	Solve Integer programming problems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Linear Programming: Formulation and graphical solution of LPP's. The general LPP, slack, surplus and artificial variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method, Two-phase method. Solution in case of unrestricted variables. Dual linear programming problem. Solution of the primal problem from the solution of the dual problems.

Transportation Problems: Balanced and unbalanced Transportation problems. Initial basic feasible solution using N-W corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method. Optimal Solutions-U-V method. Degeneracy in Transportation problems. Queuing Theory: Poisson process and exponential distribution. Poisson queues - Model (M/M/1): (∞ /FIFO) and its characteristics, Customer's Attitude, Average number of customer and waiting time in system and queue.

Elements of Inventory Control: Economic lot size problems - Fundamental problems of EOQ. The problem of EOQ with finite rate of replenishment. Problems of EOQ with shortages - production instantaneous, replenishment of the inventory with finite rate. Stochastic problems with uniform demand (discrete case only).

Text Books:

1. Introduction to Operations Research, K. Swarup, Manmohan & P.K.Gupta, S.Chand & Co., 2006.
2. Introduction to Operations Research, J.C. Pant, Jain Brothers, New Delhi, 2008.
3. Mathematical Programming Techniques, N.S. Kambo, East-West Pub., Delhi, 1991.



Course Code: ME3312	Smart Manufacturing Laboratory	0-0-2	Credits 01
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Pre-requisites: ME3281: Smart Manufacturing

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

CO1	Proficiency in CNC part program development using CAD/Mastercam software.
CO2	Generate tool paths for 2D milling operations.
CO3	Simulate and verify 2D machining operations.
CO4	Write and simulating basic G code and M code programs.
CO5	Perform CNC Turning and Milling operations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

1. CNC part program development using CAD/Mastercam software
2. Generate tool paths for 2D contour milling and pocket milling
3. Simulate and verify 2D machining operations
3. Write and simulate basic G code and M code programs for CNC machining
4. Turning of components on CNC Lathe. (2 Exercises)
5. Milling of components on CNC Milling Machine. (2 Exercises)
6. Fabrication of a components using 3D printer.

Text Books:

1. Computer Numerical Control: Operation and Programming, John Stenerson and Kelly Curran, PHI, New Delhi, 2009.
2. Computer Aided Manufacturing, T. C. Chang, R.A.Wysk and H. P. Wang, PHI, New Delhi, 2009.



Course Code: ME3322	CAE Laboratory	0-0-2	Credits 01
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Pre-requisites: ME3291: Finite Element Method

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

CO1	Understand the software to solve various engineering problems.
CO2	Solve different structural engineering elements using FEA software.
CO3	Solve beam problems for model and harmonic analyses.
CO4	Solve and analyse various stress problems in plates and shells .
CO5	Solve various thermal engineering problems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Computer-Aided Simulation Using ANSYS:

1. Introduction to FEA software.
2. Structural analysis of 1D bar or rod problems.
3. Solving truss problems.
4. Model analysis of Beams and Frames.
5. Harmonic analysis of simple systems
6. Stress analysis of flat plates and simple shells.
7. Stress analysis of axi-symmetric components.
8. Thermal stress and heat transfer analysis of plates.
9. Thermal stress analysis of cylindrical shells.



Course Code: HS3011	English for Engineers II	2-0-2	Credits 03
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Pre-requisites: English for Engineers I

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

CO1	To equip students to develop Questionnaire and to pitch ideas
CO2	To cultivate delegation skills and strategic planning
CO3	To equip students to creating career related documents
CO4	To equip students with technical and business writing
CO5	To improve oral communication and interview readiness

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Module 1: Cover letter - resume - statement of purpose

Module 2: Technical report writing - proposal writing - minutes of the meeting

Module 3: Pitching ideas - client correspondence - preparation of questionnaire

Module 4: Diplomacy skills - strategic planning - delegation skills - feedback

Language Laboratory

Group presentation-presentation with emphasis on body language- public speaking- extempore speech, Pronunciation practice (Automatic Speech Recognition).

Mock interview: Interview etiquette, common interview questions

Text Books:

1. Brown, Carla L. Essential Delegation Skills. Routledge, 2017.
2. Carter, Ronald and Michael McCarthy. Cambridge Grammar of English: A Comprehensive Guide. Cambridge University Press, 2006.
3. Harris, David.F. Complete Guide to Writing Questionnaires. I&M Press, 2014.
4. Hering, Lutz and Heike Hering. How to Write Technical Reports: Understandable Structure, Good Design, Convincing Presentation. Springer; 2010.
5. Mohan, Krishna and Meera Banerji. Developing Communication Skills. Macmillan India Limited, 2000.
6. Muralikrishna and Sunitha Mishra. Communication Skills for Engineers. Pearson, 2011.



References

1. Busan, Tony. Mind Map Mastery. Walkins, 2018.
2. Huckin N. Thomas and Leslie A. Olsen Technical Writing and Professional Communication for Non-native Speakers. McGraw-Hill Education, 1991.
3. Laplante, Phillip A. Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals. CRC Press, 2018.
4. Mc Quail, Dennis. Audience Analysis. Sage, 1997
5. Ogden, Richard. Introduction to English Phonetics. Edinburgh University Press, 2017.
6. Parker, Glenn M. Team Players and Teamwork: New Strategies for Developing Successful Collaboration. Wiley, 2011.
7. Seely, John. Oxford Guide to Effective Writing and Speaking: How to Communicate Clearly. Oxford University Press: 2013.



Course Code: SM3021	Design Thinking	1-0-0	Credits 01
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Pre-requisites: NIL

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

CO1	Understand and apply advanced Design Thinking techniques for problem-solving.
CO2	Develop proficiency in ideation and visualization tools to structure innovative concepts, analyze biases in user and developer perspectives to enhance communication.
CO3	Implement frameworks to sustain a culture of innovation, apply Design Thinking principles to real-world challenges through exercises and case-based discussions.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Listening and empathizing techniques, observation techniques, structured open-ended approaches, overcoming cognitive fixedness, behavior models, innovation heuristics, case-based discussions-exercises.

Use of diagrams and maps in design thinking, empathy map, affinity diagram, mind map, journey map-combining ideas into complex innovation concepts, storytelling and scenario planning-improvisation, scenario development, evaluation tools, frog design-prototyping, interactive workshops, case-based discussions.

Text Books:

1. Roger Martin, The Design of Business: Why Design Thinking is the Next Competitive Advantage, Harvard Business Press, 2009.
2. Christoph Meinel, Larry Leifer, and Hasso Plattner (eds), Design Thinking: Understand – Improve– Apply, Springer, 2011.

Reference Books:

1. Idris Mootee, Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, John Wiley & Sons, 2013.



Course Code: ME4334	Professional Major Work	0-0-6	Credits 06
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Pre-requisites: Nil

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

CO1	
CO2	
CO3	
CO4	
CO5	

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Guidelines:



Course Code: ME4343	Mechatronics	1-0-2	Credits 02
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Pre-requisites: Nil

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

CO1	Model and analyse mechatronic systems for an engineering application.
CO2	Identify sensors, transducers and actuators to monitor and control the behaviour of process or product.
CO3	Develop various control systems.
CO4	Develop PLC programs for an engineering application.
CO5	Evaluate the performance of mechatronic systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: overview of a mechatronic system, applications and significance of a mechatronics system, elements of a mechatronics system, future advances in mechatronics system.

Sensors and Transducers: Tachometers, position sensors, proximity and range sensors, force, fluid pressure, liquid flow sensors, temperature sensors, accelerometers, gyroscopes, SONAR and RADAR, vision sensor, encoders and resolvers.

Actuators: electrical actuators-DC motor, stepper motor, drives, servo motor, relays and solenoids. Hydraulic and pneumatic devices- design. Gear trains, limit switches, power supply and hazards.

Control design: Classification of control systems, Feedback, closed loop and open loop systems, Continuous and discrete processes, control modes, Two step Proportional, Derivative, Integral, PID controllers.

PLC Programming: PLC Principles of operation PLC sizes PLC hardware components I/O section Analog I/O section Analog I/O modules, digital I/O modules CPU Processor memory module Programming. Ladder Programming, ladder diagrams, timers, internal relays and counters, data handling, analogue input and output. Application on real time industrial automation systems.

Case studies of Mechatronics systems: Pick and place robot, Bar code, Engine Management system, Washing machine etc.



Laboratory Experiments:

1. Principle & Characteristics of Strain Gauge
2. Characteristics of Summing Amplifier
3. Characteristics of Reflective Opto Transducer
4. Ladder programming on Logic gates, Timers & counters
5. Ladder Programming for digital & Analogy sensors
6. Ladder programming for Traffic Light control, Water level control and Lift control Modules
7. Draw & Simulate the Hydraulic circuit for series & parallel cylinders connection
8. Draw & Simulate Meter-in, Meter-out and hydraulic press and clamping.

Text Books:

1. Mechatronics, W. Bolton, Addison Wesley Longman Ltd, 2010, 5th Edition.
2. Mechatronics System Design, Devdas Shetty & Richard Kolk, PWS Publishing, 2009, 3rd Edition.

Reference Books:

1. Introduction to Mechatronics and Measurement systems, Alciatore David G and Histan Michael B, Tata McGraw Hill, 2012, 4th Edition.
2. Mechatronics: A foundation course, Clarence W. de Silva, CRC Press, 2010.
3. Mechatronics handbook, Bishop R. H, CRC Press, 2007.

Online Resources:

1. http://video_demos.colostate.edu/mechatronics
2. <http://mechatronics.me.wisc.edu>



Course Code: ME4354	Semester-Long Internship (SLI) / Additional Project at the Institute / Additional department elective courses for 6 credits	0-0-6 / 0-0-6 / 6-0-0	Credits 06
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Pre-requisites: Nil

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

CO1	
CO2	
CO3	
CO4	
CO5	

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Guidelines for:

Semester-Long Internship (SLI)

Additional Project at the Institute

Additional department elective courses for 6 credits



Departmental Elective Courses

Departmental Elective (DE-1) Courses

Course Code: ME2361	Advanced Casting and Forming Technologies	3-0-0	Credits 03
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Pre-requisites: ME2071: Manufacturing Science-I

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

CO1	Recommend remedies for the defects in castings.
CO2	Model components for castings using CAD tools.
CO3	Design gating system for metal casting processes.
CO4	Develop process maps for metal forming processes using plasticity principles.
CO5	Estimate formability limits for sheets and bulk metals.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Solid modeling of castings: casting features, modeling techniques, graphical user interface, model representation model exchange formats, and model verification.

Pattern, mould, and core design: Orientation and parting, mould parting analysis, pattern design, Pattern Allowance, Pattern Materials, Types of Pattern, cored features, core print design and analysis, mould cavity layout.

Feeder design and analysis: Casting yield, casting solidification, cooling curve, solidification time and rate, feeder location and shape, feeder and neck design, feed aid design, solidification analysis, vector element method, optimization, and validation.

Gating design and analysis: Mould filling, gating system and types, gating channel layout, optimal filling time, gating element design, mould filling analysis, numerical simulation, optimization and validation.

Theoretical analysis: Theory of plasticity, Stress-strain relationship, Strain hardening, Material incompressibility, Work of plastic deformation, Work hardening, Yield criteria, Flow rule, Yield criterion and flow rule for Anisotropic material, Initiation, and extent of plastic flow- Upper Bound - Slip-Line-Slab Analysis - Problems.

Sheet Forming Processes: Bulk forming, Blanking, piercing, Clearance, Punching Force, Force required with shear on Punch, press bending, deep drawing, Force required in Wire



Drawing, stretch forming, formability tests, forming limit diagrams, process simulation for deep drawing and numerical approaches, Case studies.

Text Books:

1. Metal casting: CAD and Analysis, B. Ravi, PH Publication, 2014.
2. Principles of Foundry Technology, P.L.Jain, 2012.
3. Theory of Engineering Plasticity, R. Narayanasamy, R Ponalagusamy, Ahuja Book Company, 2000.

Reference Books:

1. Applied Metal Forming - Including FEM Analysis, Henry S. Valberg, Cambridge University Press, 2010.
2. Modeling Techniques for Metal Forming Processes, G.K. Lal, P.M. Dixit and N. Venkat Reddy, Alpha Science, 2011.
3. Metal Forming: Mechanics and Metallurgy, William F. Hosford and Robert M. Caddell.
4. Jones, Michael T., and Laura S. Brown. Sheet Metal Forming: Processes and Applications. Chicago: MetalTech Publishing, 2018.
5. Casting Technology: Science, Technology, and Applications, Smith, John A., and Robert B. Jones. New York: Tech Press, 2020.



Course Code: ME2371	Non-destructive Technologies and Evaluation	3-0-0	Credits 03
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Pre-requisites: ME2071: Manufacturing Science-I

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

CO1	Understand general principles of NDT technologies.
CO2	Conduct NDT techniques and interpret the results.
CO3	Select appropriate NDT techniques in practical applications
CO4	Apply codes and standards used in NDT techniques
CO5	Evaluate the Industrial applications of NDE

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Destructive and non-destructive testing, Importance and scope of NDT. Overview of non-destructive test and evaluation technology, materials, manufacturing processes, and non-destructive testing materials, Designs, and non-destructive testing, ethics, morality, and technology of NDE.

Liquid penetrant test: Liquid penetrant test basic concepts, liquid penetrant system, test procedure, effectiveness and limitations of liquid penetrant testing.

Magnetic particle test: magnetic materials, the magnetization of materials, demagnetization of materials, principle of magnetic particle test, magnetic particle test equipment, magnetic particle test procedure, standardization, and calibration, interpretation and evaluation, effective applications and limitations of the magnetic particle test.

Eddy current test: Principle of eddy current, eddy current test system, applications of eddy current testing, effectiveness of eddy current testing.

Radiography: Sources of x and gamma rays and their interaction with matter, equipment, general radiographic procedure, radiographic technique, acceptance standard, special radiographic techniques, and safety aspects of industrial radiography.

Ultrasonics: Principle of wave propagation, reflection, refraction, diffraction, mode conversion and attenuation, sound field, piezo-electric effect, ultrasonic transducers and their characteristics, ultrasonic equipment and variables affecting ultrasonic test, ultrasonic testing, interpretations and guidelines for acceptance/rejection, effectiveness and limitations of ultrasonic testing.



Acoustic emission testing: Basic principle, Sources of acoustic emission, Source parameters, Kaiser-Felicity theory, Equipment and Data display, Source location schemes.

Industrial applications of NDE: Span of NDE activities, railways, nuclear, non-nuclear and chemical industries, aircraft and aerospace industries, automotive industries, offshore gas and petroleum projects, and coal mining industry.

Text Books:

1. Non-Destructive Test and Evaluation of Materials, J Prasad C. G. Krishnadas Nair, McGraw-Hill Education, 2011, 2nd Edition.
2. Nondestructive Evaluation: Theory, Techniques and Applications, Peter J Shull, Marcel Dekkar, 2002.
3. Non-Destructive Testing Handbook, P. McIntire (Ed.), Vol. 4, American Society for Non-Destructive Testing, 2010.

Reference Books:

1. Metal Handbook, D. L. Olson, T. A. Siewert, Vol 06, Welding, Brazing and Soldering, ASM International Hand book Metals Park, Ohio USA, 2015.
2. Non-Destructive Testing and Quality Control, ASM Metals Handbook, Vol. 17, ASM, 1989.
3. Practical Non-Destructive Testing, Baldev Raj, M. Thavasimuthu, T. Jaya kumar, 3rd Edition, Narosa Publishing House, 2009.



Course Code: ME2381	Micro and Nano manufacturing	3-0-0	Credits 03
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Pre-requisites: ME2071: Manufacturing Science-I

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

CO1	Understand manufacturing considerations at the micro and nano scale.
CO2	Create and characterize nanostructures for a particular industrial application.
CO3	Select appropriate manufacturing methods to create micro sized components.
CO4	Design and select industrially-viable processes, equipment and manufacturing tools for specific industrial products.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to micro-manufacturing: definition, need/importance, applications. Size effect. Classification of micro-manufacturing processes.

Micro-machining processes: molecular dynamics at atomistic scale, diamond micro-machining and grinding, ultrasonic micro-machining, micro-EDM, laser beam micro-machining, micro-ECM, electron beam micro-machining, focused ion-beam techniques, abrasive micro-finishing techniques.

Micro-forming techniques: laser micro-bending, micro-deep drawing, and micro-extrusion. Micro-welding and joining techniques. Micro-fabrication using deposition techniques such as epitaxial, sputtering, chemical vapor deposition (CVD) techniques and Lithography (LIGA) based techniques. Sensors and actuators for micro-manufacturing. Metrology for micro-manufacturing. Introduction to nano-scale manufacturing.

Nanofabrication Techniques: E-Beam and Nano-Imprint Fabrication, Epitaxy, and Strain Engineering, Scanned Probe Techniques, Self-Assembly, and Template Manufacturing.

MEMS devices and applications: Pressure sensor, inertial sensor, Optical MEMS, and RFMEMS, Micro-actuators for dual-stage servosystems.

Micro feature characterization: Optical microscopy, electron microscopy (SEM and TEM), energy and wavelength-dispersive spectroscopy, X-ray diffraction – grain size and grain size measurement.

Text Books:

1. Introduction to Micromachining, V. K. Jain, Alpha Science, 2014, 2nd Edition.
2. MEMS and Microsystems: Design and Manufacture, Tai-Ran Hsu, McGraw- Hill, 2008.



3. Microfabrication and Nano manufacturing, Mark James Jackson, CRC Press, 2005.

Reference Books:

1. Introduction to Nanoscience and Nanotechnology, Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta & John J Moore, CRC Press, 2009.
2. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, Ray F. Edgerton, Springer, 2005.
3. Elements of X-Ray Diffraction, B.D. Cullity, Prentice Hall, 2002, 3rd Edition.



Course Code: ME2391	Design For Sustainability	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Apply Principles of Sustainable Design
CO2	Apply CADM and various methods and tools to encourage sustainable practices and evaluate their effectiveness
CO3	Conduct Environmental Impact Assessments
CO4	Design Integrated Product-Service Systems (PSS)
CO5	Develop Systemic Approaches for Sustainable Design

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Addressing sustainability by design – Challenges-evolution for sustainability – Need and impact – Responses from design – Product lifecycle design – Design for eco-efficient product service systems –Eco design principles and strategies – Green design – Principles and strategies. Product life cycle design tools.

Design for Sustainable Behaviour (DSB): Triggering and supporting changes in human behaviour – Comprehensive action determination model (CADM) – Design practices – Decision support framework for promoting sustainable behaviour – Benefits – DSB Methods and tools – Middle ground – Individual cognitive methods – Context driven methods – Future research direction.

Design for Environment: Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T’s environmentally responsible product assessment – Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency.

Product Service Design for Sustainability: Design of individual products to integrated set of products and services – Categories – Need to implement – Design practice – PSS design for sustainability examples – Methods and tools – Benefits and limitations – Future research direction – Case studies.



Systemic Design and Future of Design for Sustainability: Sustainable productive systems at a territorial scale – Design practice – Design for sustainability transitions – Framework to capture DfS – Approach – Innovation levels – Evolution of DfS – Design to regulations and standards.

Text Books:

1. Design for sustainability: A Multi-Level Framework from Products to Socio-technical System, Fabrizio Ceschin and Idil Gaziulusoy, Routledge focus on environment and sustainability, 2020.
2. Design for Assembly Automation and Product Design, Boothroyd,G, NewYork, Marcel Dekker, 1980.
3. Design for Manufacture Handbook, J. G. Bralla, McGrawhill,1999.
4. Product Design for Manufacture, Boothroyd, G, Hertz and Nike, Marcel Dekker,1994.
5. Product-service system design for sustainability, Vezzoli, C., Kohtala, C., Srinivasan, A., Xin, L., Fusakul, M., Sateesh, D. and Diehl, J.C., 2017.

Reference Books:

1. Engineering Design and Design for Manufacture and Structural Approach, Dickson, John.R, and Corroda Poly, Field Stone Publisher, USA,1995.
2. Design for the Environment, Fixel, J., McGraw Hill., 1996.
3. Design for the Environment, Graedel T.E. and B. R. Allenby, Pearson, 1996.
4. Product Design, Kevin Otto and Kristin Wood, Pearson Publication, 2009.

Online Resources:

1. <https://archive.nptel.ac.in/courses/107/103/107103081/>
2. https://onlinecourses.nptel.ac.in/noc19_de03/preview



Course Code: ME2401	Design Optimization Methods	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Formulate a design task as an optimization problem
CO2	Solve unconstrained optimization problems
CO3	Formulate constrained optimization problem and solve using corresponding methods
CO4	Solution of discontinuous optimization problems using special methods
CO5	Solve the nonlinear optimization problems with evolutionary methods

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to optimization in design: Problem formulation, Optimization problems in Mechanical Engineering, Classification of methods for optimization.

Single-variable Optimization: Optimal criteria, Derivative-free methods (bracketing, region elimination), Derivative based methods, root-finding methods.

Multiple-variable Optimization: Optimal criteria, direct search methods (Box’s, Simplex, Hooke-Jeeves, Conjugate methods), Gradient-based methods (Steepest Descent, Newton’s, Marquardt’s, DFP method). Formulation and Case studies.

Constrained Optimization: KKT conditions, Penalty method, and Sensitivity analysis, direct search methods for constrained optimization, quadratic programming, GRG method, Formulation and Case studies.

Specialized algorithms: Integer programming (Penalty function and branch-and-bound method), Geometric programming.

Evolutionary Optimization algorithm: Genetic algorithms, simulated annealing, Ant-colony optimization, Particle swarm optimization.

Multi-objective Optimization: Terminology and concepts, the concepts of Pareto optimality and Pareto optimal set, formulation of multi-objective optimization problem, NSGA.

Case studies and Computer Implementation: Representative case studies for important methods and development of computer code for the same to solve problems.



Text Books:

1. Jasbir Arora, Introduction to Optimum Design, Academic Press, 2004.
2. Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, PHI, 2004.
3. Engineering Optimization: Theory and Practice, Fourth Edition Singiresu S. Rao, John Wiley & Sons, Inc. 2009.

Reference Books:

1. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley, 2001.



Course Code: ME2411	Robotics	2-1-0	Credits 03
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Pre-requisites: ME1031: Engineering Mechanics

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

CO1	Understand the basic components of robots, classification and robot grippers.
CO2	Model forward and inverse kinematics of robot manipulators.
CO3	Analyze forces in links and joints of a robot.
CO4	Programme a robot to perform tasks in industrial applications
CO5	Design intelligent robots using sensors.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Robotics-classification, Sensors-Position sensors, Velocity sensors, Proximity sensors, Touch and Slip Sensors, Force and Torque sensors. Grippers and Manipulators- Gripper joints, Gripper force, Serial manipulator, Parallel Manipulator, selection of Robot- Selection based on the Application

Kinematics: Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation.

Statics & dynamics: Differential Kinematics and static- Dynamics-Lagrangian Formulation, Newton Euler Formulation for RR & RP Manipulators, Applications.

Trajectory planning: Motion Control- Interaction control, Rigid Body mechanics.

Control: architecture- position, path velocity and force control systems, computed torque control, Adaptive control, and Servo system for robot control.

Robot programming: Programming of Robots and Vision System- overview of various programming Languages.

Applications: Application of Robots in production systems- Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection.



Text Books:

1. Introduction to Robotics – Mechanics and Control, Craig J.J., Pearson Prentice Hall, 2005.
2. Introduction to robotics, Saha, Subir Kumar, Tata McGraw-Hill Education, 2014.
3. Robotic Engineering, Richard Klafter.

Reference Books:

1. Robot modeling and control, Spong, Mark W., Seth Hutchinson, and Mathukumalli Vidyasagar, Vol. New York: Wiley, 2006.



Course Code: ME2421	Advanced Thermodynamics	3-0-0	Credits 03
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Pre-requisites: ME1051: Engineering Thermodynamics

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

CO1	Study laws of thermodynamics, availability and irreversibility.
CO2	Understand Maxwell's and thermodynamic relations of gas mixtures.
CO3	Understand Exergy analysis, Dead state, irreversibility and Second law efficiency,
CO4	Analyze reactive and non-reactive gas mixtures using the concepts of statistical thermodynamics and kinetic theory of gases
CO5	Identify the models to estimate the properties of real gases.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Review of Laws: Basic definitions and concepts, Basic laws of thermodynamics, Entropy flow and Entropy production, 3rd law of thermodynamics, Availability in steady flow open system and in a closed system, Energy analysis of typical Irreversibility.

Equation of State for Real Gases: Compressibility factor and generalized compressibility chart, Law of corresponding state, Law of pseudo critical pressure and temperature, Reduced coordinate, Wander- Walls equation of state and other equation of state.

Thermodynamic Property Relation: Residual property function, Property of saturation state, Thermodynamic properties of homogeneous mixture

Exergy Analysis: Concept of exergy, Energy analysis for open and closed systems with fixed and moving boundaries, Dead state and irreversibility, Exergy loss due to mixing of fluids, Second law efficiency, Exergy analysis for power and refrigerating cycles.

Reacting Systems and Chemical Equilibrium: Chemical systems, Enthalpy of reaction, Combustion and formation, 1st and 2nd law analysis of reacting systems, Adiabatic flame temperature, Fuel cells types and applications, Criteria for chemical equilibrium, Chemical potential fugacity and fugacity coefficient, Henry and Rault's law, Gibbs phase rule, Hess's law.

Real Gases: Assumptions of real gases, Equations of state for real gases, Compressibility factor, Compressibility chart, Reduced pressure and temperature, Pressure and energy



equations using kinetic theory, RMS velocity, Equi-partition of energy, Mean free path, Maxwell distribution function.

Text Books:

1. Advanced Engineering Thermodynamics by A. Bejan, John Wiley and Sons.
2. Advanced Thermodynamics for Engineers by K. Wark, McGraw Hill.

Reference Books:

1. Fundamentals of Thermodynamics by R.E. Sonntag, C. Borgnakke and G.J. Van Wylen, Wiley.
2. Principles of engineering thermodynamics by M.J. Moran, H.N. Shapiro, Wiley.

Online Resources:

1. Advanced Thermodynamics, Prof. Nanda Kishore, IIT Guwahati
<https://nptel.ac.in/courses/103103162>



Course Code: ME2431	Energy engineering	3-0-0	Credits 03
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Pre-Requisites: ME2091: Applied Thermal Engineering

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

CO1	Understand Importance of energy engineering and Energy conservation strategies and technologies.
CO2	Evaluate efficiency and power output, Fuel consumption of Conventional Energy Sources.
CO3	Estimate Solar panel efficiency calculations, Wind power output
CO4	Analyze Geothermal power plant performance, Fuel cell efficiency and power output.
CO5	Analyze Energy Economics, Energy audit and efficiency

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Energy Engineering: Introduction to Energy, Definitions, forms of energy, energy resources, Importance of energy engineering in sustainable development, Global and Indian energy scenario, Energy Conversion and Conservation, Basic principles of energy conversion, Laws of thermodynamics and their applications, Energy conservation strategies and technologies

Numerical Problems: Energy conversion efficiency calculations, Thermodynamic cycle analysis

Conventional Energy Sources: Fossil Fuels, Coal, oil, natural gas: formation, extraction, and utilization, Environmental impacts and mitigation measures, Nuclear Energy, Nuclear reactions, types of reactors, nuclear fuel cycle, Safety and waste management, Thermal Power Plants, Layout, working principles, and components, Performance evaluation and environmental impacts.

Numerical Problems: Calculation of thermal efficiency and power output, Fuel consumption and emission calculations

Renewable Energy Sources: Solar Energy, Solar radiation, solar thermal systems, and solar photovoltaics, Design and performance analysis of solar systems, Wind Energy, Wind characteristics, wind turbines, and wind farm layout, Performance and energy yield calculations, Hydropower, Hydrological cycle, types of hydroelectric power plants, Design and performance evaluation, Biomass Energy, Types of biomass, conversion technologies, and applications



Numerical Problems: Solar panel efficiency calculations, Wind power output and capacity factor

Emerging Energy Technologies: Geothermal Energy, Sources, extraction methods, and applications, Ocean Energy, Tidal, wave, and ocean thermal energy conversion systems, Fuel Cells, Types, working principles, and applications, Energy Storage Systems, Types of energy storage (batteries, flywheels, super capacitors), Applications and performance analysis.

Numerical Problems: Geothermal power plant performance calculations, Fuel cell efficiency and power output

Energy Management and Policy: Energy Management, Principles of energy management, audit, and planning, Energy efficiency in industrial, commercial, and residential sectors, Energy Economics, Cost analysis, economic evaluation of energy projects, Life cycle assessment and payback period calculations, Energy Policy and Legislation, National and international energy policies, Environmental regulations and standards, Sustainable Energy Strategies, Integrated energy planning, smart grids, and micro grids,

Numerical Problems: Economic evaluation of energy projects, Energy audit and efficiency calculations.

Text Books

1. Energy Engineering and Management, Chakrabarti A., Sharma S. PHI Learning, 2011, 1st Edition.
2. Non-Conventional Energy Resources, Khan B. H. Tata McGraw-Hill, 2017, 3rd Edition.
3. Principles of Energy Conversion, Culp A. W., McGraw-Hill Education, 2001, 2nd Edition.
4. Renewable Energy Sources and Emerging Technologies, Rai G. D. New Age International, 2020, 3rd Edition.

Reference Books

1. Energy Systems Engineering: Evaluation and Implementation, Francis Vanek, Louis Albright, McGraw-Hill Education, 2016, 2nd Edition.
2. Fundamentals of Renewable Energy Processes, Aldo da Rosa, Academic Press, 2012, 2nd Edition.
3. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 2012, 3rd Edition.
4. Energy Management Handbook, Wayne C. Turner, Steve Doty, Fairmont Press, 2012, 8th Edition.

Online Resources

1. Energy Resources & Technology, Prof. S. Banerjee, IIT Kharagpur, <https://nptel.ac.in/courses/108105058>
2. Sustainable Energy Technology, Dr. Sayak Banerjee, IIT Hyderabad, <https://nptel.ac.in/courses/112106318>
3. Non-Conventional Energy Resources, Dr. Prathap Haridoss, IIT Madras, <https://nptel.ac.in/courses/121106014>
4. Solar Photovoltaics: Principles, Technologies & Materials, IIT Kanpur, Dr. Ashish Garg, <https://nptel.ac.in/courses/113104084> Wind Energy Technology - NPTEL



Course Code: ME2441	Experimental Methods in Thermal Engineering	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Understand Importance of experimental analysis & planning
CO2	Design process chart for Measuring systems.
CO3	Analyze data produced from experiments
CO4	Determine Design of Experiment
CO5	Testing and Develop mathematical model

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Basic Concepts: Definition of terms, Calibration, System response, Importance of experimental analysis & planning.

Measuring Systems: Selection of measuring system, Static & dynamic characteristics, Response of general form of instrument, Random and transient input, Instrument loading under static and dynamic condition, Transducer and sensor, Measurement of pressure, Temperature, Flow, Measurement of emissivity, Viscosity, Flow visualization methods, Shadow graph, Schlieren, Interferometer, Laser Doppler Anemometer.

Analysis of Experimental Data: Causes and type of experimental errors, Uncertainty analysis, Statistical analysis of experimental data, Statistical distributions, Estimators, Confidence levels, Sample size, Test of hypothesis, Goodness-of-fit test, Chauvenet's criteria, Regression analysis, Co-relations.

Design of Experiment: Inferences about means and standard deviations and considerations of different hypothesis, Factorial design, 2k and 3k factorial design, Blocking and confounding techniques in 2k factorial design, Concept of fractioning of factorial design, Response surface method, Introduction to robust design, robust parameter design for single response system, Experiments with non-normal data, Problems related to thermal engineering.

Statistics: Hypothesis Testing rationale, Introduction to Factorial Experiments and DOE Terminology, Yate's algorithm for calculation of effects in a 2k design, Testing significance of effects in a 2k factorial experiment, Developing a mathematical model, Residual Analysis, Testing for model adequacy, Finding the structure of a Fractional factorial, Strategy, Principle and application of DOE.



Text Books:

1. Experimental methods for Engineers by Holman, McGraw Hill.
2. Experiments by Wu and Hamada, John Wiley.

Reference Books:

1. Mechanical measurements, Beckwith, Marangoni and Lienhard, Pearson Publications.
2. Design and Analysis of Experiments by Douglas C. Montgomery, Wiley.

Online Resources:

1. Experimental Methods in Fluid Mechanics, Prof. Pranab K. Mondal, IIT Guwahati,
<https://nptel.ac.in/courses/112103290>



Departmental Elective (DE-2) Courses

Course Code: ME3451	Laser Processing of Materials	3-0-0	Credits 03
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Pre-requisites: ME2071: Manufacturing Science-I

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

CO1	Understand the basic principles of laser physics.
CO2	Understand processing fundamentals and application laser materials
CO3	Explain the working principles and output beam characteristics of major industrial lasers.
CO4	Apply laser processing techniques for industrial applications.
CO5	Assess the safety standards and procedures related to laser applications

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Fundamentals of Laser: Basic principles- spontaneous emission, stimulated emission, population inversion, and optical cavities, gain medium, optical resonator, laser pump source, Laser oscillation and amplification- modes and modes of operation, beam delivery system; Key parameters-wavelength, monochromaticity, brightness, coherence, beam quality, power density, pulse energy.

Industrial lasers: He-Ne, CO₂, Excimer, Nd:YAG, Diode, Fiber and Ultrashort pulse lasers and their output beam characteristics; laser beam delivery systems, Applications,

Laser beam interaction: Laser beam interaction (absorption, emission, scattering) with metal, semiconductor and insulator, Ultra-short laser pulse interaction, heat flow theory and metallurgical considerations;

Laser cutting and drilling: Process characteristics, material removal modes, practical performances.

Application of Lasers in welding: Process mechanisms like keyhole and plasma effect, operating characteristics and process variation

Application of Lasers for Surface modification: Heat treatment, surface remelting, surface alloying and cladding, surface texturing, LCVD and LPVD. Laser rapid manufacturing; Laser metal forming- Mechanisms involved including thermal temperature gradient, buckling, upsetting. Laser peening: Fundamentals of Laser Shock Processing,



Effects of various laser and process parameters, Mechanical effects and microstructure modification during laser shock processing. Theoretical modelling of laser material processing.

Other Scientific Applications: Metrological applications, Holography, Laser Isotope Separation, Laser fusion.

Economics of Laser Applications in Manufacturing, Laser safety standards and safety procedures.

Text Books:

1. "The Mathematics of Thermal Modeling: An Introduction to the Theory of Laser Material Processing" John Michael Dowden, Chapman and Hall/CRC, 2001.
2. Laser Physics, Milonni, Peter W., and Joseph H. Eberly, Hoboken: Wiley, 2010.
3. Principles of Laser Materials Processing, E Kannatey-Asibu, Wiley, 2009.
4. Laser Material Processing, W M Steen and J Mazumder, Springer, 2010, 4th Edition.

Reference Books:

1. Laser Processing of Materials - Fundamentals, Applications and Developments, Schaaf, Peter, Springer, 2010.
2. Physics of Laser Materials Processing: Theory and Experiment, Gennady G.Gladush and Igor Smurov, Springer, 2011.
3. Laser Fabrication and Machining of Materials, N B Dahotre and S P Harimkar, Springer, 2008.
4. Laser Processing of Engineering Materials: Principles, Procedure and Industrial Applications, John C Ion, Elsevier, 2005.



Course Code: ME3461	Industrial Automation	3-0-0	Credits 03
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Pre-requisites: ME3281: Smart Manufacturing

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

CO1	Understand principles, strategies and advantages of industrial automation
CO2	Design material handling and material storage systems for an automated factory.
CO3	Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.
CO4	Outline the IoT Technologies used in a manufacturing plant and their role in Industry.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Principles and Strategies of Automation: Power to Accomplish the Automated Process, program of Instruction, Control System, Advanced automation Functions: safety Monitoring, maintenance and repair Diagnostics, error Detection and Recovery, levels of automation, Merits and Demerits of automation.

Material Handling Systems and Design: Introduction to Material Handling, Material Transport Equipment, analysis of Material Transport Systems, Storage Systems- Storage System Performance and Location Strategies, Conventional Storage Methods and Equipment, Automation Storage Systems, Engineering Analysis of Storage Systems.

Automatic Identification Methods: Overview of Automatic Identification Methods, Bar Code Technology, Radio Frequency Identification, and Other AIDC Technologies.

Programmable Logic Controllers (PLCs): Introduction to PLCs, architecture and programming, PLC programming languages (Ladder Logic, Function Block Diagram, etc.) PLC interfacing with sensors, actuators, and human-machine interfaces (HMIs)

Advanced Automation Technologies: Machine vision systems and applications, Artificial Intelligence (AI) and Machine Learning (ML) in industrial automation, Robotics automation cells and flexible manufacturing systems

Emerging Trends: Smart factories and Industry 4.0 concepts, Internet of Things (IoT) in industrial automation, Sustainability and environmental aspects of automation technologies



Text Books:

1. Automation Production Systems and Computer Integrated Manufacturing, Groover M. P., Pearson Education, 2013.
2. Introduction to Industrial Automation, Stamatios Manesis, George Nikolakopoulos, CRC Press, 2018.
3. An Introduction to Automated Process Planning Systems, Tiess Chiu Chang and Richard A. W., Tata McGraw-Hill Publishing Company, New Delhi, 2012.

Reference Books:

1. Robot Engineering-An Integrated Approach, Klafter, R.D., Chmielewski, T. A. and Negin M., Prentice Hall of India, New Delhi, 2012.
2. Introduction to Robotics Mechanics and Control, Craig J. J., Pearson Higher Education, 2014, 3rd Edition.



Course Code: ME3471	Sustainable Manufacturing	3-0-0	Credits 03
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Pre-requisites: ME3231: Industrial Engineering and Management

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

CO1	Understand the concept of sustainable manufacturing relates to current technologies and manufacturing decisions and Industry 4.0.
CO2	Describe Role of Industrial Internet of Things (IIoT) in Manufacturing, Big data, Cyber Physical Systems (CPS). Networking for Industry 4.0.
CO3	Develop Expert Decision Support System for Industry 4.0, Augmented Reality, Simulation, and Optimization.
CO4	Evaluate the economics and environmental impact of sustainable manufacturing alternatives – Case studies.
CO5	Design Factories of the Future and Process Based Framework Model for Industry 4.0.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Concept of Industry 4.0. Introduction and Evolution of Industry 4.0. Characteristics and Design Principles of Industry 4.0. Applications and Impact of Industry 4.0 on Manufacturing. Sustainable Manufacturing and Industry 4.0. Environmentally Conscious Manufacturing and its Need. Design for Sustainability and its Framework. Orientation of Sustainable Product Development. Influence of Sustainability on Industry 4.0.

Innovation in Manufacturing for Sustainable Smart Factories. Role of Industrial Internet of Things (IIoT) in Manufacturing. Big data and its Importance in Manufacturing. Intelligent Manufacturing using Cyber Physical Systems (CPS). Networking for Industry 4.0. Cloud Manufacturing and Importance of Cyber-Security. Adoption of Information and Communication Technology (ICT) for Industry 4.0.

Decision Making to Achieve Sustainability in Factories. Expert Decision Support System for Industry 4.0. Data Analytics and Industry 4.0. Artificial Intelligence and Industry 4.0. Role of Machine Learning in Industry 4.0. Software Development for Industry 4.0. Applications of Augmented Reality, Simulation, Optimization.

Sustainable SMART Factories: Compliance to Environmental Standards. Smart Eco Conscious Manufacturing and Clean Development Mechanism. Industrial Symbiosis and



Circular Economy for Future Factories. Resource Conservation and Recycling in Industry 4.0. Monitoring Manufacturing Process Parameters for Negative Environmental impacts.

ERP Systems and Supply Chain Management in Industry 4.0: Factories of the Future. End of Life Disposal and Sustainable Industrial Waste Management in Industry 4.0.

Ensuring Sustainability in Industry 4.0: Implementation Framework. Understanding Manufacturing Sustainability Characteristics. Guidelines for Ensuring Sustainability in Industry 4.0. Development of Process Based Framework Model for Industry 4.0. Case Studies: Sustaining the Global Competitiveness with Industry 4.0.

Text Books:

1. Sustainable Manufacturing for Industry 4.0: An Augmented Approach, K. Jayakrishna, Vimal K.E.K., S. Aravind Raj, Asela K. Kulatunga, M.T.H. Sultan and J. Paulo Davim, CRC Press, 2020.
2. Sustainable Manufacturing: Shaping Global Value Creation, Günter Seliger, Paul Eysers, and Marc F. Zaeh.

Reference Books:

1. Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives, G. Seliger, M. Khraisheh, I. Siller, M. O'Sullivan.
2. Handbook of Sustainable Engineering, Panos M. Pardalos, Vijay P. Singh, and Constantine S. Psomopoulos.



Course Code: ME3481	Engineering Fracture Mechanics	3-0-0	Credits 03
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Pre-requisites: ME2101: Mechanics of Solids

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

CO1	Apply Principles of Solid Mechanics to Analyze Deformable Bodies
CO2	Analyze Fracture Mechanics Concepts for Different Modes of Fracture
CO3	Evaluate Static Loading Effects on Stationary Cracks
CO4	Understand and Analyze Fatigue Failure and Environmental-Assisted Fracture
CO5	Apply Fracture Mechanics in Practical Applications

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Elements of Solid Mechanics: Introduction to Failure and Fracture – Spectacular Failures-Basics Principles – Governing equations for the deformable body – Stress-Strain relations and general equations of elasticity in Cartesian and Polar Coordinates – Vectors and tensors – Differential equations of equilibrium – Compatibility – Boundary conditions – Representation of three-dimensional stress system – Generalized hook's law – Plane stress and strain problems – Airy's stress function – Methods of formulation of Governing Differential equations for plane elasticity – Naviers Equation – Biharmonic equation in Cartesian and Polar coordinates.

Stress and Displacement Around the Crack Tip for Different Modes of Fracture: Brittle and Ductile Fracture – Modes of Fracture – Weakness of the components due to Flaws – Need for Linear Elastic Fracture Mechanics (LEFM) – Evaluation of Structural Design – Stress and displacement around the crack tip in K – Annulus for Mode-I and Mode-II plane crack problems – Stress and displacement around the crack tip in K – Annulus for Mode III crack problems.

Stationary Crack Under Static Loading: Griffith analysis – Irwin's approximation – CTOD and stress ahead of the crack tip – Westergaard's solutions: Analytical Calculations for SIF for different crack geometries – Critical crack length and fracture stress calculations – Two dimensional elastic fields – Analytical solutions for small scale yielding near a crack front – Plastic zone size – Specimen size calculations: K_{1c} Testing for Fracture toughness of the Material.



Fatigue Failure and Environmental-Assisted Fracture: Introduction to fatigue failure – S-N Curve – Crack Initiation – Crack propagation – Effect of an Overload – Variable amplitude Fatigue load – Crack closure – Characteristics of fatigue crack – Paris Law – Fatigue Crack Growth Test to evaluate Paris constants – Life calculations for a given load amplitude – Effects of changing the load spectrum Environmental-assisted Fracture – Micro mechanisms – Factors influencing Environmental-assisted fracture – Environment-assisted Fatigue Failure affecting fatigue performance, fatigue loading, constant and variable amplitude loading.

Applications of Fracture Mechanics: J-integral, Mixed-mode fracture, Crack arrest methodologies – Case studies: Analysis on failed components and design for the extension of its life.

Text Books:

1. Elementary Engineering Fracture Mechanics, Broek, David, Springer Netherlands, 1982.
2. Fatigue and fracture control in structures, John M. Barson and Stanely T. Rolfe, Butterworth-Heinemann; 1999, 3rd Edition.
3. Introduction of Fracture Mechanics, Kare Hellan, McGraw-Hill Book Company, 1985.
4. Elements of Fracture Mechanics, Prashant Kumar, Tata McGraw-Hill Publishing Company Ltd, 2009.
5. Fracture mechanics: fundamentals and applications, Maiti, S. K., Cambridge University Press, 2015.

Reference Books:

1. Ted L. Anderson, "Fracture Mechanics: Fundamentals and Applications", CRC Taylor and Francis, 2017, 4th Edition.
2. Tribikram Kundu, "Fundamentals of Fracture Mechanics", Ane Books Pvt. Ltd. New Delhi/ CRC Press, 1st Indian Reprint, 2012.

Online Resources:

1. <https://archive.nptel.ac.in/courses/112/106/112106065/>



Course Code: ME3491	Design and Analysis of Advanced Mechanisms	3-0-0	Credits 03
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Pre-requisites: ME2151: Theory of Machines

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

CO1	Apply concepts of gross motion capability and develop multi loop kinematic chains and equivalent mechanisms.
CO2	Determine velocity and acceleration of complex mechanisms.
CO3	Evaluate inflection points and draw the inflection circle.
CO4	Synthesize planar mechanisms.
CO5	Design of six bar coupler driven mechanisms and cam mechanisms.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion Concepts-Basic kinematic structures of serial and parallel robot Manipulators-Compliant Mechanisms Equivalent mechanisms.

Kinematic Analysis: Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration Analysis– four bar linkage jerk analysis. Plane complex mechanisms-auxiliary point method. Spatial RSSR mechanism- Denavit Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

Path Curvature Theory, Coupler Curve: Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature. Four bar coupler curve-cusp -crunode - coupler driven six bar mechanisms-straight line mechanisms.

Synthesis of Four Bar Mechanisms: Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods-Pole technique inversion technique point position reduction-two, three and four position synthesis of four- bar mechanisms. Analytical methods-Freudenstein’s Equation-Bloch’s Synthesis.

Synthesis of Coupler Curve Based Mechanisms and Cam Mechanisms: Cognate Linkages-parallel motion Linkages. Design of six bar mechanisms-single dwell-double dwell



double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms- determination of optimum size of cams. Mechanism defects.

Text Books:

1. Theory of Mechanism and Machines, Amitabha Ghosh and Asok Kumar Mallik, EWLP, Delhi, 1999.
2. Kinematics, Dynamics and Design of Machinery, Kenneth J, Waldron, Gary L. Kinzel, John Wiley-sons, 2016.
3. Design of Machinery, Robert L.Norton., Tata McGraw Hill, 2012

Reference Books:

1. Advanced Mechanism Design Analysis and Synthesis, Sandor G.N., and Erdman A.G., Prentice Hall, 1984.
2. Theory of Machines and Mechanisms, Uicker, J.J., Pennock, G. R. and Shigley, J.E., Oxford University Press, 2017.
3. Kinematics and linkage design, Hall, A.S, Prentice Hall of India, 1964.



Course Code: ME3501	Industrial Tribology	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Analyze properties of lubricant and selection of proper lubricant for the given application.
CO2	Identify the lubrication regime for the given mechanical application.
CO3	Determine tribological performance parameters of sliding contact in hydrodynamic lubrication regimes.
CO4	Analyse Applications of hydrodynamic lubrication theory.
CO5	Evaluate the friction and wear behavior of the given materials.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: History and basic concept of friction wear and lubrication, Types of lubricants, Objectives and selection of lubricant, Physical properties of lubricants.

Lubrication: Regimes of lubrication - hydrodynamic, Elasto-hydrodynamic, mixed and boundary lubrication, Reynolds' equation, Hydrodynamic lubrication of roughened surfaces.

Theories of other Lubrication: Externally pressurized lubrication, Squeeze-film lubrication, Elasto-hydrodynamic lubrication, Rheological lubrication regime, Functional lubrication regime.

Applications of hydrodynamic lubrication theory - Journal bearing, inclined thrust pad bearing, Rayleigh step bearing.

Friction and Wear: Origin of sliding friction, Causes of Friction, Laws of Rolling Friction. Friction Instability, Contact between two bodies in relative motion, Wear classification - Wear between solids - Wear between solid and liquid - Factors affecting wear - Measurement of wear, Types of wear and their mechanisms - Adhesive wear-adhesion junction growth, Abrasive wear, Wear due to surface fatigue and wear due to chemical reactions, wear of metallic materials.

Text Books:

1. Engineering Tribology, Stachowaik, G.W., Batchelor, A.W., Elsevier, 2010, 3rd Edition.
2. Introduction to bearings, Majumdar B.C, S. Chand & Co., Wheeler publishing, 1999.



Reference Books:

1. Fluid film lubrication theory and design, Andras Z. Szeri, Cambridge University press, 1998.
2. Tribology in Machine Design, Stolarski TA, Butterworth Heinemann, 2000.
3. Friction, Wear, Lubrication: A textbook in Tribology, Ludema, K.C., CRC Press, 2010.
4. Fundamentals of Machine Elements, Hamrock, B. J., Jacobson, B.O. & Schmid, S.R, McGraw-Hill Inc., 1998.

Online Resources:

1. <https://archive.nptel.ac.in/courses/112/102/112102014/>



Course Code: ME3511	Alternative Fuels and Energy Systems	3-0-0	Credits 03
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Pre-requisites: ME2091: Applied Thermal Engineering

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

CO1	Categorize, interpret and understand the essential properties of fuels for IC engines.
CO2	Identify the need for alternate fuels and characterize prospective alternate fuels.
CO3	Evaluate the storage and dispensing facility requirements.
CO4	Analyze the implement limitations with regard to performance, emission and materials compatibility.
CO5	Design Procedure for Emission Measurement and Test.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Estimate of petroleum reserve, Need for alternate fuel, Availability and comparative properties, of alternate fuels, CNG, LPG, Alcohol, Vegetable oil and Bio-gas.

CNG and LPG: Availability, Properties, Modifications required in SI and CI engines, Performance and emission characteristics, Storage, Handling and dispensing, Safety aspects, Alcohol, Manufacture of alcohol, properties, Blending of methanol and ethanol, Engine design modifications required and effects of design parameters, Performance and emission characteristics, Durability, Types of vegetable oils for engine application, Extraction process, Biogas, Properties, Engine performance and emission characteristics.

Hydrogen and Fuel Cells: Production methods, Properties, Performance and emission characteristics, Storage and handling, Safety aspects, Working principle, Classification, Description of fuel cell systems, Fuel cell components, Properties of fuel cell, General performance characteristics, Emission characteristics, Merits and demerits, Vehicle design and layout aspects.

Emissions from SI & CI Engines and its Control: Emission formation in S.I. engines, Hydrocarbons, Carbon monoxide, Nitric oxide, Lead particulates, Polynuclear aromatic hydro carbon emission, Effects of design and operating variables on emission formation in spark ignition engines, Controlling of pollutant formation in engines, Thermal reactors, Catalytic converters, Charcoal canister control for evaporative emission, Positive crank case ventilation system for UBHC emission reduction, Chemical delay, Intermediate compound formation, Pollutant formation on incomplete combustion, Effect of operating variables on



pollutant formation, Controlling of emissions, Driving behavior, Fumigation, Exhaust gas recirculation, Air injection, Cetane number effect.

Emission Measurement and Test Procedure: Measurement of exhaust gases by NDIR, Dilution tunnel technique for particulate measurement, Procedures on engine and chassis constant volume sampling procedures.

Text Books:

1. Internal Combustion Engines, Ganesan.V, Tata McGraw Hill.
2. Automotive Emission Control, Crouse. W.M, Anglin. A.L, McGraw Hill.

Reference Books:

1. Engine Emissions & pollutant formation, G.S, Patterson. D.J, Plenum Press.
2. Alternative Fuel: Emission, Economic and Performance, Maxwell et al, SAE



Course Code: ME3521	Environmental Pollution and Control Systems	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Understand types of pollutions, causes effects and remedial measures.
CO2	Evaluate Water quality standards and operations for water treatment
CO3	Design process for Sewage and sewerage treatment
CO4	Analyse types of air pollutants, their sources and impacts, meteorology
CO5	Analyse permissible limits of noise pollution, impacts of noise.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Environmental overview: types of pollutions, causes effects and remedial measures and waste management.

Water quality standards: basic unit processes and operations for water treatment. Drinking and industrial water standards, water requirements, basic unit operations and unit processes for surface water treatment.

Sewage and sewerage treatment: quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards, sludge disposal.

Air pollution: types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards.

Noise pollution: permissible limits of noise pollution, impacts of noise, measurement of noise and control of noise pollution.

Text Books:

1. Introduction to Environmental Engineering, Mackenzie L. Davis & David A. Cornwell, WCB/McGraw Hill, 3rd Edition.
2. Introduction to Environmental Engineering and Science, Gilbert M. Masters, Stanford University, Printice Hall, 2nd Edition.

Reference Books:

1. Work design, Stephan Konz, Kansas State University, Grid Publishing Inc., Colombus, Ohio



2. Environmental Pollution Control Engineering, C. S. Rao, New age International (P) Limited, Publishers, India.



Course Code: ME3531	Automobile Engineering	3-0-0	Credits 03
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Pre-requisites: ME2181: IC Engines and Gas Turbines

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

CO1	Understand the basic lay-out of an automobile.
CO2	Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
CO3	Understand the principles of transmission, suspension, steering and braking systems.
CO4	Understand automotive restraint system.
CO5	Study latest developments in automobiles.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Overview of the course, Examination and Evaluation patterns, History of Automobiles, Classification of Automobiles.

Power Plant: Classification, Engine Terminology, Types of Cycles, working principle of an IC engine, advanced classification of Engines- Multi cylinder engines, Engine balance, firing order.

Fuel System, Ignition System and Electrical system: Fuel tank, fuel filter, fuel pump, air cleaner/filter, carburetor, direct injection of petrol engines. Compression Ignition engines, Fuel Injection System- air & solid injection system, Pressure charging of engines, super charging and turbo charging, Components of Ignition systems, battery ignition system, magneto ignition system, electronic ignition and ignition timing. Main electrical circuits, generating & stator circuit, lighting system, indicating devices, warning lights, speedometer.

Lubricating system and cooling systems: Functions & properties of lubricants, methods of lubrication-splash type, pressure type, dry sump, and wet sump & mist lubrication. Oil filters, oil pumps, oil coolers. Characteristics of an effective cooling system, types of cooling system, radiator, thermostat, air cooling & water cooling.

Chassis: Systems in an automobile, body, chassis frame, parts of the automobile body, terminology, automobile frames, functions, constructions, sub frames, materials, and defects in frames.

Transmission system: axles, clutches, propeller shafts and differential: Types of gear boxes, automatic transmission, electronic transmission control, functions and types of front



and rear axles, types and functions of the clutches, design considerations of Hotchkiss drive torque tube drive, function and parts of differential and traction control.

Steering System: functions of steering mechanism, steering gear box types, steering geometry

Braking and suspension system: functions and types of brakes, operation and principle of brakes, constructional and operational classification, and parking brake. Types of springs shock absorbers, objectives and types of suspension system, rear axle suspension, electronic control, and proactive suspension system.

Automotive air conditioning: 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.

Automotive Restraint Systems: Seat belt, automatic seat belt tightener system, collapsible steering column, and air bags.

Text Books:

1. Automotive Mechanics Crouse, W.H., and Anglin, D.L., Tata McGraw Hill, New Delhi, 2005.
2. Automotive Mechanics, Heitner, J., Affiliated Southwest Press, New Delhi, 2000.

Reference Books:

1. Automobile Engineering, Narang, G.B., Khanna Publishers, New Delhi, 2001.
2. Automobile Engineering, Kamaraju Ramakrishna, PHI Learning pvt. Ltd., New delhi-2012.



Departmental Elective Courses

Departmental Elective (DE-3) Courses

Course Code: ME3541	Advanced Welding Technology	3-0-0	Credits 03
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Pre-requisites: ME2071: Manufacturing Science-I

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

CO1	Understand solid state welding processes such as friction stir welding and explosive welding and their applications
CO2	Apply laser beam welding processes to join metals
CO3	Analyze the welded joints fabricated through hybrid welding process
CO4	Examine weldability of cast iron, steel and Aluminum alloys.
CO5	Analyze the welded joint fabricated through cold metal transfer welding process

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Solid state welding processes: Classification of solid state welding processes, Review of Friction stir welding, Selection of tool design, Fixture design, modification of tool and features, modeling of friction stir welding, submerged friction stir welding. Friction stir processing, Process variables, Surface modification by friction stir processing, Production of composite by friction stir processing. Adhesive bonding, vacuum brazing,

Explosive welding: Process description, process parameters, joint design, advantages and limitations applications.

Laser Beam welding (LBW): Laser Beam welding, process parameters, and Laser Beam welding of steels. Power sources in Arc Welding, Hybrid welding processes: GMAW and Laser welding, process, advantages and Limitations, Carbon Arc welding, GTAW and Laser beam welding, Cold Metal Transfer welding process, advantages, limitations and applications.



Weldability studies and welding of dissimilar materials: Aluminum to steel, Aluminum to copper. Ultrasonic welding, ultrasonic spot welding, line welding, continuous seam welding, Resistance spot welding, Heat input and Efficiency Calculation, welding of plastic and Induction welding of plastics, process description, application, advantages and limitations.

Text Books:

1. Modern Welding Technology, Nadkarni S.V., Oxford IBH Publishers, 2015.
2. Welding Engineering and Technology, Parmar R. S., Khanna Publishers, 2014.

Reference Books:

1. Metal Hand Book, Vol 06, Welding, Brazing and Soldering, ASM International Hand book Metals Park, D. L. Olson, T. A. Siewert, Ohio USA, 2015.



Course Code: ME3551	Total Quality Management	3-0-0	Credits 03
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Pre-requisites: NIL

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

CO1	Understand quality management philosophies, techniques, and frameworks
CO2	Adopt TQM methodologies for continuous quality improvement
CO3	Identify the areas of improvement through measurement of cost of poor quality, effectiveness and efficiency of processes
CO4	Apply TQM process and concepts to enhance the performance of systems
CO5	Understand the implications of quality management standards and systems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Definition of Quality, Dimensions of Quality, Definition of Total quality management, Quality Planning, Quality costs - Analysis, Techniques for Quality Costs, and Basic concepts of Total Quality Management.

Historical Review: Quality Council. Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation, Benefits of TQM, Characteristics of successful quality leader, Contributions of Gurus of TQM, Case studies.

TQM Principles: Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality. Customer Retention, Employee Involvement - Motivation, Empowerment teams, Continuous Process Improvement - Juran Trilogy, PDSA Cycle, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure, Case studies.

TQM Tools: Benchmarking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Taguchi Quality Philosophy- Robust Design Concept, Orthogonal Arrays, Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA - Stages of FMEA, The seven tools of quality, Process capability, Concept of six sigma, New seven management tools, Case studies.



Quality Systems: Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 - Concept, Requirements and Benefits, Case Studies

Text Books:

1. Total Quality Management, Dale H. Besterfield, Pearson Education, Delhi, 2006.
2. Total Quality Management, Subburaj Ramasamy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2005.

Reference Books:

1. Quality Management - Concepts and Tasks, Narayana V and Sreenivasan N.S., New Age International, Delhi, 1996.



Course Code: ME3561	Design for Manufacturing and Assembly	2-1-0	Credits 03
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Pre-requisites: ME2071 & ME2161: Manufacturing science I and II

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

CO1	Utilize Design-for-Manufacturing concepts for effective product development
CO2	Design Manual, Automatic and Robot Assembly.
CO3	Estimate the cost of dies, molds and machined components based on die life.
CO4	Formulate appropriate design rules for forging, sheet metal forming, machining and powder metallurgy processes.
CO5	Propose manual and automated assembly sequences using appropriate design rules.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to DFM, DFMA: How Does DFMA Work, Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design, Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, and Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

Design for Machining and Injection Molding: Machining Using Single-Point & Multi point cutting tools, Choice of Work Material, Shape of Work Material, Machining Basic Component Shapes, Cost Estimating for Machined Components, Injection Molding Materials, The Molding Cycle, Injection Molding Systems, Molding Machine Size, Molding Cycle Time, Estimation of the Optimum Number of Cavities, Design Guidelines.

Design for Sheet Metal working & Die Casting: Dedicated Dies and Press-working, Press Selection, Turret Press working, Press Brake Operations, Design Rules, The Die Casting Cycle, Auxiliary Equipment for Automation, Determination of the Optimum Number of Cavities, Determination of Appropriate Machine Size, Die Casting Cycle Time Estimation, Die Cost Estimation, Design Principles.



Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, and single station assembly lines.

Text Books:

1. Assembly Automation and Product Design, Geoffrey Boothroyd, Marcel Dekker Inc., NY, 3rd Edition, 2010.
2. Process selection: from design to manufacture, K.G.Swift and J.D.Booker, London: Arnold, 1997.
3. Product design for manufacture and assembly, Boothroyd, G., Dewhurst, P and Knight, W, New York: Marcel Dekkar, 1994.
4. Design for Manufacturing: A Structured Approach, Dufresne, Olivier, and Robert J. Schmidt., 2024.
5. Manufacturing Processes for Design Professionals, R. Thompson., 2024.
6. Introduction to Manufacturing Processes, J. A. Schey, 2024.

Reference Books:

1. Hand Book of Product Design, Geoffrey Boothroyd, Marcel Dekker Inc., NY, 1992.
2. Engineering Design for Manufacture and Assembly, White, M. Tim, and Anthony D. Kelly., 2024.
3. Design for Manufacturing and Assembly: A Practical Guide to Design for Manufacturing, D. M. Anderson and P. G. Schmid, 2024.



Course Code: ME3571	Mechanics of Composite Materials	3-0-0	Credits 03
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Pre-Requisites: ME2101: Mechanics of Solids

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

CO1	Understand the industrial need for composite materials.
CO2	Identify suitable processes to develop fiber reinforced composite materials.
CO3	Apply the micro and macro mechanics for fiber reinforced composite materials.
CO4	Develop governing equation for Bending, Buckling, and Vibration of Laminated plates.
CO5	Design the composite structures with the help of computers.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Composite materials, characteristics, classification, advantages and typical problems. Unidirectional Lamina: Introduction, longitudinal strength and stiffness, transverse strength and stiffness, failure modes, thermal expansion and transport properties.

Short Fibre Composites: Theories of stress transfer, modulus and strength of short fibre composites.

Analysis of an Orthotropic Lamina: Hook's law, stress-strain relation for lamina with an arbitrary orientation, strength of a lamina subjected to biaxial stress field.

Analysis of Laminated Composites: Classical lamination theory, thermal stress in laminates.

Special Design Considerations: Analysis after initial failure, inter-laminar stress, free edge effect, design of joints, elementary fracture mechanics concepts related to composite materials.

Experimental Characterization: Uni-axial tension test, compression test, inplane shear test, three- and four-point bending test, determination of interlaminar shear strength.

Text Books:

1. Analysis and Performance of Fibre Composites, Agarwal, B.D. and Broutman, L.J., 2006 John Wiley & Sons, 2006, 3rd Edition.
2. Mechanics of Composite Materials, Jones, R.M., Taylor & Francis. 1998.



3. Fundamental Principles of Fibre Reinforced Composites, Ashbee, K.H.G. and Ashbee, H.G., CRC Press., 1993, 2nd Edition.
4. Composite materials, Chawla, K.K., Springer, New York, 1998.

Reference Books:

1. Engineering Mechanics of Composite Materials, Daniel, I.M. and Ishai, O., Oxford University Press, 2007, 2nd Edition.
2. Mechanics of Composite Materials, Christensen, R.M., Dover Publications. 2005.
3. Mechanics of Composite Materials, Kaw, A. K., CRC Press. 2005, 2nd Edition.
4. Composite materials: Engineering and Science, Mathews F.L. and Rawlings R.D., Chapman and Hall, London, England, 1st edition, 1994.



Course Code: ME3581	Dynamics of Ground Vehicles	3-0-0	Credits 03
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Pre-Requisites: ME2151: Theory of Machines

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

CO1	Develop physical and mathematical models to predict the dynamic response of vehicles
CO2	Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response
CO3	Use dynamic analyses in the design of vehicles.
CO4	Understand the principle behind the lateral dynamics
CO5	Evaluate the longitudinal dynamics and control in an automobile

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Concept of Vibration: Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility ratio, Base excitation. Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

Tyres: Tyre axis system, tyre forces and moments, tyre marking, tyre structure, hydroplaning, wheel and rim. Rolling resistance, factors affecting rolling resistance, Longitudinal and Lateral force at various slip angles, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tyres. Various test carried on a tyre.

Vertical Dynamics: Human response to vibration, Sources of Vibration. Suspension requirements – types. State Space Representation. Design and analysis of Passive, Semi active and Active suspension using Quarter car, Bicycle Model, half car and full car vibrating model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law. Suspension optimization techniques. Air suspension system and their properties.

Longitudinal Dynamics and Control: Aerodynamic forces and moments. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of maximum acceleration, tractive effort and reaction forces for different drive vehicles. Power limited acceleration and traction limited acceleration. Estimation of CG location. Stability of vehicles resting on slope. Driveline dynamics. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.



Lateral Dynamics: Steady state handling characteristics. Steady state response to steering input – Yaw velocity gain, Lateral acceleration gain, curvature response gain. Testing of handling characteristics. Transient response characteristics. Steering dynamics. Direction control of vehicles. Roll center, Roll axis. Stability of vehicle on banked road, during turn. Effect of suspension on cornering. Minuro Plot for Lateral Transient Response.

Text Books:

1. Theory of Ground Vehicles, J. Y. Wong, Wiley-Interscience, 2008, 5th Edition.
2. Mechanical Vibrations, Singiresu S. Rao, Prentice Hall, 2010, 5th Edition.
3. Fundamentals of Vehicle Dynamics, Thomas D. Gillespie, Society of Automotive Engineers Inc, 2014.

Reference Books:

1. Vehicle Dynamics, Stability, and Control, Dean Karnopp, CRC Press, 2013, 2nd Edition.
2. Tyre and Vehicle Dynamics, Hans B Pacejka, SAE International, 2005, 2nd Edition.
3. Tyres, Suspension, and Handling, John C. Dixon, Society of Automotive Engineers Inc, 1996, 2nd Edition.
4. The Multibody Systems Approach to Vehicle Dynamics, Michael Blundell & Damian Harty, Elsevier Limited, 2004.
5. Vehicle Dynamics: Theory and Application, R. Nakhai Jazar, Springer, 2013, 2nd Edition.



Course Code: ME3591	Micro-electro Mechanical Systems	3-0-0	Credits 03
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Pre-requisites: ME2071 & ME2161-Manufacturing science I and II

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

CO1	Understand the Fundamental Principles of MEMS
CO2	Analyze and Apply MEMS Fabrication Techniques.
CO3	Evaluate Mechanical and Thermal Behavior in Microstructures.
CO4	Design and Develop MEMS Sensors and Actuators.
CO5	Explore Advanced Applications and Emerging Trends in MEMS.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Overview of MEMS – Definition and historical background, Applications and market trends; MEMS Fabrication Technologies – Photolithography, Etching techniques (wet and dry etching), Deposition techniques (CVD, PVD), Bulk and surface micromachining; Materials for MEMS.

Mechanics of MEMS: Micro-scale Mechanics – Stress, strain, and deformation in microstructures, Beam bending, torsion, and resonance in MEMS; Thermal Effects – Thermal expansion in microstructures, Heat transfer mechanisms in MEMS; Mechanical Design of MEMS – Design principles for microactuators, microsensors, and microstructures.

MEMS Sensors and Actuators: MEMS Sensors – Principles and design of pressure sensors, accelerometers, and gyroscopes, Piezoelectric, capacitive, and piezoresistive sensing techniques; MEMS Actuators – Electrostatic, thermal, and magnetic actuation principles, Design and applications; Integration and Packaging – Challenges in MEMS packaging, Techniques for packaging and integration with electronics.

MEMS Signal Processing and Circuit Design: Signal Conditioning for MEMS – Amplification, filtering, and analog-to-digital conversion, Noise considerations and mitigation; Interface Circuits for MEMS – Design of interface circuits for sensors and actuators, Low-power circuit design for MEMS applications; MEMS System Integration – System-on-chip (SoC) and integration with CMOS technology, Power management in MEMS systems.

Advanced MEMS Applications and Emerging Trends: Biomedical – Lab-on-chip, drug delivery systems, and medical diagnostics; Consumer Electronics – Smartphones, gaming



devices, and wearables; Emerging Trends – Nano-electro-mechanical systems (NEMS), Microfluidics and optical MEMS, Future trends and challenges in MEMS.

Text Books:

1. Micro and Smart Systems by G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre.
2. Fundamentals of Microfabrication, Madou, M.J., CRC Press, 2002, 2nd Edition.
3. Foundations of MEMS, Chang Liu, Pearson Education Inc., 2012.
4. Microsystem Design, Stephen D Senturia, Springer Publication, 2000.

Reference Books:

1. Micro Electro Mechanical System Design, James J. Allen, 2005, CRC Press Taylor & Francis Group.
2. MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering," Hsu, T.R., John Wiley & Sons, 2008, 2nd Edition.
3. MEMS: A Practical Guide of Design, Analysis, and Applications," Gardner, J.W., and Varadan, V.K., John Wiley & Sons, 2001.
4. Introduction to Microelectromechanical Systems Engineering," Maluf, N. and Williams, K., Artech House, 2004, 2nd Edition.

Online Resources:

1. <https://nptel.ac.in/courses/108106165>
2. https://www.me.iitb.ac.in/~gandhi/me645/05L1_coursecontents_mtvn.pdf



Course Code: ME3601	Power Plant Engineering	3-0-0	Credits 03
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Pre-requisites: ME2091: Applied Thermal Engineering

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

CO1	Understand functions of the components of power plant.
CO2	Understand the working of nuclear, thermal and gas based power plants.
CO3	Evaluate the design layout and working of hydroelectric power plants.
CO4	Analyze the Energy storage and Non-conventional power generation.
CO5	Evaluate economic feasibility and its implications on power generating units.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Analysis of Steam Cycles: Introduction to the course, Power plant layout and essential feature Rankine cycle, Reheating and regeneration, Problems on Rankine Cycle, Combined cycle power generation, Binary vapour cycles.

Fuels and Combustion: Basics on fuels and combustion, Mass and energy balance of steam generator, Draught system, Enthalpy of combustion.

Steam generators, accessories and Condensers: Different types of boilers, description, working procedures, High pressure Boilers, Accessories, fluidized bed boiler. Direct Contact Condenser Surface Condensers, Effect of various parameters on condenser performance, Design of condensers, cooling towers and cooling ponds.

Hydroelectric power plant: Introduction, Hydrological Cycle and hydrographs, Design construction and operation. Nuclear power plants: Introduction, concepts of nuclear fusion and nuclear fission, types of reactors and their operation.

Energy storage: Need of storage, types of energy storage, options and limitations. Non-conventional power generation: Basics of different non-conventional power generation types, operation, limitations.

Power plant economics and other issues: Load duration curves, Power plant economics, estimation of tariff. Diesel and gas plants, Pollution and control, Greenhouse effect and control, Peak load plants.



Text Books:

1. Power plant engineering, Arora & Domkundwar, Dhanpat Rai & Sons, New Delhi, 2008.

Reference Books:

1. Power plant Technology, M.M.Ei-Wakil, , McGraw Hill Com., 1985.
2. Power plant engineering, P C Sharma, S.K. Kataria & Sons, New Delhi, 2010.



Course Code: ME3611	Design of Pumps and Turbines	3-0-0	Credits 03
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Pre-requisites: ME2081: Fluid Mechanics

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

CO1	Understand general theory of hydraulic machines
CO2	Model hydraulic turbines, Degree of Reaction & Draft tube.
CO3	Design Pump characteristics, Blade profiles, axial pumps and surge tank.
CO4	Estimate Work done & efficiency of Hydraulic Machines
CO5	Analyze reciprocating pumps and Testing of the pumping systems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

General Theory of Hydraulic Machines: Hydro turbines, Pumps, Cavitation, Application of similarity consideration to hydrodynamic machines, Characteristics, Governing, Euler equation & Impact of Jet.

Design of Turbine: Hydraulic turbine, Impulse & Reaction Turbine, Work done & efficiency Estimation, Design aspects of Pelton wheels & Francis turbine runner, Axial flow turbine, Degree of Reaction & Draft tube.

Design of Pumps: Theoretical Pump characteristics, Effect of non-uniform velocity distribution, Axial entrance velocity, Blade outlet angle, Number of blade & length of blade, Slip factor, Design of radial flow impeller, Design of suction passage, Design of blade shape, NPSH, Design of axial pumps, Design of surge tank.

Reciprocating Pump: Data required for the design of reciprocating pump and design calculations. Operation and maintenance, Installation of pumping system. Testing of the pumping systems, Various methods based on the working fluid, Drive and pump etc., Maintenance of the pumps – Prediction and correction methods, Factors affecting the maintenance and their evaluation.

Text Books:

1. Design and Performance of Centrifugal and Axial Flow Pumps and Compressors by A. Kovats, Pergamon.
2. Centrifugal and Axial Flow Pumps by A.J. Stapan off, John Wiley.



Reference Books:

1. Hydraulic machines by V. P. Vasandani, Khanna Publishers.
2. Thermal and Hydraulic machines by G. S. Sawhney, PHI Learning Pvt. Ltd.



Course Code: ME3621	Nano Fluids	3-0-0	Credits 03
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Pre-requisites: ME2081: Fluid Mechanics

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

CO1	Understand basics of nanofluids.
CO2	Measure thermophysical properties of Nanofluids
CO3	Design measurement apparatus for thermal conductivity.
CO4	Develop theoretical equations and new empirical correlations for specific heat of different nanofluids.
CO5	Analyze combined effects of thermophysical properties and turbulent flow behaviour of Nanofluids.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Introduction to nanofluids, nanostructure materials, base fluids, dispersion, sonication and stable suspension. Various types of nanofluids-volumetric concentration.

Thermophysical properties: Density; principles of measurement and apparatus. Theoretical equations and new empirical correlations to determine the density of different nanofluids. Viscosity: principles of measurement and apparatus. Andrade's and other theoretical equations and new empirical correlations to determine the viscosity of different nanofluids. Effect of volumetric concentration and temperature. Effect of subzero temperature on nanofluid viscosity.

Thermal conductivity: principles of measurement and apparatus. Hamilton-Crosser and other theoretical equations and new empirical correlations to determine the thermal conductivity of different nanofluids. Effect of volumetric concentration and temperature. Effect of Brownian motion on enhancing the thermal conductivity. Specific heat: principles of measurement and apparatus. Buongiorno's thermal equilibrium equation and other theoretical equations and new empirical correlations to determine the specific heat of different nanofluids. Effect of volumetric concentration and temperature.

Combined effects of thermophysical properties of nanofluids on the thermal diffusivity, the Prandtl number, the Reynolds number and the Nusselt number. Basic understanding of their effects on frictional loss and Heat transfer. Convective heat transfer: Single-phase fluid equations, laminar flow, entry length and fully developed friction factor and heat transfer



coefficient. Graetz number effect in the entry region. Correlations for friction factor and Nusselt number for nanofluids.

Turbulent flow: Single phase fluid fully developed flow Dittus-Boelter and Glienilski equations. Blasius and other turbulent friction factor correlations. Their comparison with nanofluids data. New correlations for turbulent friction factor and Nusselt number for nanofluids.

Principles of measurement and apparatus for the nanofluid convective heat transfer coefficient. Recent empirical relations for convection coefficient of various types of nanofluids. Effect of particle Peclet number. Effect of volumetric concentration. Application of nanofluids to various types of industrial heat exchangers. Heating capacity, mass flow, heat exchanger surface area, LMTD and pumping power for nanofluids versus conventional heat transfer fluids.

Text Books:

1. Microscale and Nanoscale Heat Transfer by C. Sobhan and G. Peterson, CRC Press, 1st Edition.
2. Handbook of Nanostructured Materials and Nanotechnology, H.S. Nalwa, I edition, Vol. I and II, American Scientific Publishers.
3. Springer Handbook of Nanotechnology, Bharat Bhushan, Springer-Verlag Publication, 1st Edition.

Reference Books:

1. Text book of Nano Science and Nano Technology, BS Murthy, P. Shankar, Universities Press.
2. Fluid Mechanics, F. M. White, McGraw-Hill, 5th Edition.
3. Heat Transfer, A. Bejan, John Wiley, 2nd Edition.

**Departmental Elective (DE-4) Courses**

Course Code: ME3631	Processing of Composite Materials	3-0-0	Credits 03
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Pre-requisites: Nil**Course Outcomes:** At the end of the course, the student will be able to

CO1	Describe the characteristics and the manufacturing principles of a composite structure.
CO2	Identify the important physical phenomena observed during composite processing.
CO3	Explain the interactions between the phenomena during composite processing.
CO4	Justify processing costs and select the best manufacturing method for a particular application.
CO5	Design process parameters for a particular material and application.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Composite Materials: Definition and Classification, Historical Development, Constituents of composites: matrix, reinforcement, and additives, Applications in Various Industries, Advantages and Disadvantages.

Properties of Composite Materials: Mechanical, thermal, electrical, and other relevant properties, Matrix Materials (Thermoplastics, Thermosets, Metals), Reinforcement Types (Fibers, Particulates, Nanomaterials), Material Selection Criteria, Influence of matrix and reinforcement on properties, Testing and characterization techniques

Processing Techniques

Overview of Manufacturing Processes: Hand Lay-up, Spray-up, Filament Winding, Resin Transfer Molding (RTM), Vacuum Infusion, 3D Printing. Process Parameters and Their Effects on Properties.

Polymer Matrix Composites (PMCs): Types of polymer matrices: thermosets vs. thermoplastics,



Reinforcement materials: Fibers (glass, carbon, aramid), particulates Fabrication techniques specific to PMCs Performance Evaluation, Factors Affecting Mechanical Properties, Fatigue Behavior and Fracture Mechanics, Environmental Resistance (Moisture, Temperature Effects).

Ceramic Matrix Composites (CMCs) and Metal Matrix Composites (MMCs): Types of ceramic and metal matrices used in composites, Reinforcement materials: whiskers, fibers, particles, Processing challenges and techniques specific to CMCs and MMCs

Carbon Fiber/Carbon Matrix Composites: Processing of Carbon/Carbon Composites, Oxidation protection of Carbon/Carbon Composites, Properties of Carbon/Carbon Composites, and application of Carbon/Carbon Composites.

Multi-filamentary Superconducting Composites: The Problem of Flux Pinning, Types of Super Conductor, Processing & structure of Multi filamentary superconducting composites. Applications of multi-filamentary superconducting composites.

Text Books:

1. Introduction to Composite Materials Design, E. J. Barbero
2. Composite Materials: Fabrication Handbook, John Wanberg
3. Composite Materials: Science and Engineering, Debosree Dutta et al.
4. Introduction to Composite Material, Anthony R. Bunsell and J. Renard.

Reference Books:

1. Fundamentals of Composite Materials, A. K. Bunsell and J. Renard.
2. Composite Materials: Engineering and Science, Robert M. Jones.
3. Mechanical Properties of Composite Materials, D. Hull and T.W. Clyne.
4. Composite Materials Handbook (MIL-HDBK-17) – A comprehensive reference for engineers.
5. Materials Science of Polymers for Engineers, Larry H. Van Vlack.



Course Code: ME3641	Artificial Intelligence in Mechanical Engineering	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Understanding of Artificial Intelligence Concepts and Intelligent Agents
CO2	Competence in Problem Solving Using Search Strategies and CSP
CO3	Understand Machine Learning Methods and Data Analysis
CO4	Understand Convolutional Neural Networks (CNNs) and Their Applications
CO5	Understand Data-Driven Optimization and AI Applications in Manufacturing

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to AI: Definition – Future of Artificial Intelligence –Characteristic of Intelligent Agents – Typical Intelligent Agents –Problem Solving Approach to Typical AI problems. Problem solving by Searching: Uninformed and informed strategies and implementation; Path planning; Constraint Satisfaction Problems (CSP).

Machine learning methods: Holistic view of learning models, Classification of learning techniques, Machine learning methods; Learning first-principles knowledge from data: Approaches to analyze manufacturing data, Automation of model selection and hyper parameter search. Physics-informed machine learning, Regression-based approaches, Techniques based on mathematical programming.

Data-driven optimization algorithms: Algorithmic approaches for data-driven optimization, Applications to large-scale mechanical systems, Extensions to other classes of problems.

AI for Mechanical system monitoring: Data acquisition systems, Feature engineering and machine learning, Signal decomposition methods, Deep learning, Transfer learning. Application of AI for Predictive Maintenance, Anomaly Detection, Design Optimization.



Text Books:

1. Artificial Intelligence: A Modern Approach, S. Russell and P. Norvig, Prentice Hall.
2. Artificial Intelligence: A Systems Approach (Computer Science), M. Tim Jones, Jones and Bartlett Publishers, Inc.; 2008, 1st Edition.

Reference Books:

1. The Quest for Artificial Intelligence, Nils J. Nilsson, Cambridge University Press, 2009.
2. Python GUI programming Cookbook -Burkhard A Meier, PacktPublication, 2nd Edition.
3. Head first Python: A brain-friendly guide. "O'Reilly Media, Inc.". Barry, P., 2016.
4. Learning python: Powerful object-oriented programming. Lutz, M., 2013, "O'Reilly Media, Inc.".



Course Code: ME3651	Smart Materials for Mechatronics Applications	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Define and describe the key characteristics of smart materials
CO2	Understand the fundamental principles of the piezoelectric effect and identify common piezoelectric materials.
CO3	Understand mechanisms and properties of the shape memory effect in both alloys (such as NiTi and Cu-based) and polymers.
CO4	Understand the Magnetostrictive Materials, Electroactive Polymers and their applications in Mechatronic Systems.
CO5	Discuss potential future applications of multifunctional and adaptive materials and nanomaterials.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Smart Materials: Overview of Smart Materials-Definition and characteristics, Types of smart materials, Historical development and advancements; Fundamentals of Material Science-Structure-property relationships, Basic principles of material science relevant to smart materials; Applications.

Piezoelectric Materials: Piezoelectric Effect-Basic principles and mathematical descriptions, Common piezoelectric materials (PZT, PVDF, etc.); Design and Implementation.

Shape Memory Alloys and Polymers: Shape Memory Effect-Mechanisms and properties, Types of shape memory alloys (NiTi, Cu-based, etc.), Shape memory polymers; Applications in biomedical devices, robotics, and practical examples; Design and Implementation-Integration into mechatronic systems, Design considerations and challenges.

Magnetostrictive Materials and Electroactive Polymers: Magnetostrictive Materials-Principles and properties, Common materials (Terfenol-D, Galfenol, etc.); Electroactive Polymers (EAPs)-Types and characteristics, Mechanisms of action.

Advanced materials and Future Trends: Multifunctional and Adaptive Materials-Overview and characteristics, Examples of multifunctional materials; Nanomaterials in Mechatronics-



Types and properties; Future Trends in Smart Materials-Emerging technologies and innovations, Potential future applications.

Text Books:

1. Smart Material Systems and MEMS: Design and Development Methodologies, Varadan, V. K., Vinoy, K. J., & Gopalakrishnan, S., 2006.
2. Piezoelectric Sensors: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers. Gauschi, G., Springer, 2002.
3. Shape Memory Alloy Engineering: For Aerospace, Structural and Biomedical Applications, Concilio, A., & Lecce, L., Elsevier, 2014.
4. Magnetostrictive Materials for Sensor and Actuator Applications, Fallahi, M., Smith, S. T., & Stanley, H. W., Springer, 2006.
5. Multifunctional Materials for Tribological Applications, Wood, R. J. K., Springer, 2015.

Reference Books:

1. Smart Materials and Structures, Gandhi, M. V., & Thompson, B. S., Springer, 1992.
2. Piezoelectric Actuators: Control Applications of Smart Materials, Uchino, K., Springer, 2010.
3. Intelligent Materials and Mechatronics, Guohui Yang, 2013.
4. Nanomaterials in Energy and Environmental Applications, He, J., Springer, 2016.



Course Code: ME3661	Control Systems	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Analyze the mathematical model of the control system.
CO2	Solve to get a time domain response.
CO3	Analyze stability of the system.
CO4	Use bode plot for frequency domain analysis.
CO5	Analyze the control system in state space.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Control System: Introduction to control system block diagram. Importance of Control Systems. Components of control. Explanation with the help of the liquid level control system. Significance of actuators and sensors. Types of actuators, Types of sensors. Open loop control and closed loop control. Use of relays, switches and contactors for simple and sequential control systems.

Control system representation: Mathematical representation of simple mechanical, electrical, thermal, hydraulic systems. Block diagram representation and reduction. Signal flow graph. Transfer function of these systems. Pole zero concepts.

Time domain analysis: Time response of first order, second order systems. Analysis of steady state error, Type of system and steady state error, Time response specifications. Effect of parameter variation on open loop and closed loop system response, sensitivity. Effect of feedback on system response, stability and disturbance.

Stability: Concept of stability, Effect of pole zero location on stability, Routh- Hurwitz criterion. Root Locus method for analysis of gain margin, phase margin and stability.

Control system analysis in frequency domain: Concept of frequency domain behavior, Bode Plot for analyzing systems in frequency domain. Frequency domain performance specifications. Correlation between time domain and frequency domain specification. Nyquist Analysis.

State Space Approach: Representation of system in state space, Converting transfer function model into state space model. Non uniqueness of state space model, Canonical



representation, Eigenvalues, Solution of state equations, Concept of State feedback control, controllability, Observability.

Text Books:

1. Control System Engineering, Nagrath & M. Gopal, Anshan, 2008.
2. Control System Engineering, Norman S. Nice, Wiley, 2008.

Reference Books:

1. Control Systems Theory & Applications, Smarajit Ghosh, Pearson Education, 2007.
2. Modern Control Engineering, Katsuhiko Ogata, Prentice Hall, 2010.
3. Control System Engineering, Norman S. Nise, Wiley, 2014.



Course Code: ME3671	Product Design and Development	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Apply product design strategies for the development of innovative products
CO2	Develop new concepts for product design by adopting various processes.
CO3	Develop new product models by applying the concepts of product design theory and robust design.
CO4	Apply embodiment principles in product development process.
CO5	Develop products by considering the social, environmental and ethical concerns.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Introduction to product design, Significance of product design, product design and development process, sequential Engineering design method, the challenges of product development, Development Process and Organizations-Generic Development Process, Concept Development, Adapting the generic PD process flows, AMF development Process, Product Development Organizations, The AMF Organization.

Product Planning and Identifying Customer Needs: Product Planning process, interpret raw data in terms of customers need, organize needs in hierarchy and establish the relative importance of needs, review of the process.

Product Specifications: Establish target specifications, setting final specifications Concept Generation-Activities of concept generation, clarifying problem, search both internally and externally, explore the output.

Concept Selection: Overview, concept screening and concept scoring, methods of selection.

Concept Testing-Elements of testing: qualitative and quantitative methods including survey, measurement of customers' response. Product Architecture-Modular and Integral architecture, implications, establishing the architecture, Delayed differentiation, Platform Planning.



Industrial Design-Assessing need for industrial design, Impact of industrial Design, industrial design process, management of industrial design process, assessing quality of industrial design.

Embodiment Design: Design for Manufacturing, prototyping. Robust Design, Design for Environment Intellectual Property and Environmental Guidelines-Intellectual Property: Elements and outline, patenting procedures, claim procedure, Environmental regulations from government, ISO system.

Text Books:

1. Product Design and Development Ulrich K. T, and Eppinger S. D McGraw Hill.
2. Design Otto K, and Wood K Pearson.
3. Engineering of creativity: introduction to TRIZ methodology of inventive Problem Solving, Semyon D. Savransky CRC Press.

Reference Books:

1. Mechanical Design Process David G Ullman McGraw Hill.



Course Code: ME3681	Mechanical Vibrations	3-0-0	Credits 03
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Pre-requisites: ME2151: Theory of Machines

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

CO1	Develop schematic models for physical systems and formulate governing equations of motion.
CO2	Analyse rotating and reciprocating systems and compute critical speeds.
CO3	Analyse and design machine supporting structures, vibration isolators and absorbers.
CO4	Calculate free and forced vibration responses of multi degree freedom systems using modal analysis.
CO5	Analyse the exact and approximate solutions of continuous systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models.

SDF systems: Formulation of equation of motion: Newton -Euler method, De Alembert's method, Energy method, Undamped Free vibration response and Damped Free vibration response, Case studies on formulation and response calculation.

Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration,

Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion. Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates,



Response to initial conditions, free vibration response case studies, Forced vibration response, undamped vibration absorbers, Case studies on undamped vibration absorbers.

Multi degree of freedom systems: Introduction, Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, orthogonality of model vectors, normalization of model vectors, decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis.

Continuous systems: Introduction to continuous systems, Exact and approximate solutions, free vibrations of strings, bars and beams.

Text Books:

1. Elements of Vibration analysis, L. Meirovich, Tata Mc-Grawhill, 2007, 2nd Edition.
2. Mechanical Vibrations, Singiresu S Rao, Pearson education, 2011, 4th Edition.
3. Theory of Vibration, W.T., Thompson, CBS Publishers.

Reference Books:

1. Vibration: Fundamentals and Practice, Clarence W. de Silva, CRC Press LLC, 2000.



Course Code: ME3691	Computational Fluid Dynamics	3-0-0	Credits 03
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Pre-requisites: ME2081: Fluid Mechanics and ME3251: Heat Transfer

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

CO1	Explain the differential equations for flow phenomena and numerical methods for their solution.
CO2	Critically analyze different mathematical models and computational methods for fluid flow and heat transfer simulations.
CO3	Solve computational problems related to fluid flows and heat transfer.
CO4	Analyze the accuracy of a numerical solution by comparison to known solutions of simple test problems and by mesh refinement studies.
CO5	Evaluate forces in both internal and external flows.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods

Governing equations of fluid dynamics: Models of the flow, the substantial derivative, Physical meaning of the divergence of velocity, the continuity equation, the momentum equation, the energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching.

Mathematical behaviour of partial differential equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations.

Basic aspects of discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform, and unequally spaced grid points.

Grids with appropriate transformation: General transformation of the equations, Metrics and Jacobians, the transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids.



Parabolic partial differential equations: Finite difference formulations, Explicit methods - FTCS, Richardson and DuFort-Frankel methods, Implicit methods - Laxonon, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization.

Stability analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, artificial dissipation, and dispersion.

Elliptic equations: Finite difference formulation, solution algorithms: Jacobi-iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, And alternative direction implicit methods.

Hyperbolic equations: Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, TVD formulations, entropy condition, first-order and second-order TVD schemes.

Scalar representation of Navier-Stokes equations: Equations of fluid motion, numerical algorithms: FTCS explicit, FTBCS explicit, Dufort-Frankel explicit, McCormack explicit and implicit, BTCS and BTBCS implicit algorithms, applications.

Grid generation: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation

Finite volume method for unstructured grids: Advantages, Cell Centered and Nodal Point Approaches, Solution of Generic Equation with tetrahedral Elements, 2-D Heat conduction with Triangular Elements.

Text Books:

1. Computational Fluid Dynamics, Anderson, J.D. (Jr), McGraw-Hill Book Company, 1995.
2. Computational Fluid Dynamics, Hoffman, K.A., and Chiang, S.T., Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.

Reference Books:

1. Computational Fluid Dynamics, Chung, T.J., Cambridge University Press, 2003.
2. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., McGraw Hill Book Company, 2002



Course Code: ME3701	Refrigeration and Air-Conditioning	3-0-0	Credits 03
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Pre-requisites: ME2091: Applied Thermal Engineering.

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

CO1	Understand the principles and applications of refrigeration systems.
CO2	Understand vapour compression refrigeration system and identify methods for performance improvement.
CO3	Study the working principles of air conditioning systems and load calculations.
CO4	Understand and design air conditioning systems.
CO5	Understand advanced refrigeration and Air-Conditioning technologies.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Fundamentals of Refrigeration: Introduction to Refrigeration, Basic Concepts, And Refrigerants

Refrigeration Systems and Cycles: Vapor Compression Refrigeration Cycle, Other Refrigeration Cycles, Components of Refrigeration Systems.

Air-Conditioning Systems and Load Calculations: Introduction to Air-Conditioning, Cooling and Heating Load Calculations, Air-Conditioning Systems.

Design of Air-Conditioning Systems: Air Distribution Systems, Duct design: Methods, materials, and sizing, Air handling units (AHU): Components and selection, Fans and blowers: Types, performance, and selection. Ventilation Systems, Design of ventilation systems: Natural and mechanical, Controls and Instrumentation. Energy Efficiency and Conservation, Green building standards and codes (LEED, ASHRAE standards).

Modern Developments and Environmental Considerations: Advanced Refrigeration Technologies, Sustainable Air-Conditioning Technologies, Environmental Impact and Regulations. Eco-friendly refrigerants and alternatives. Case Studies and Practical Applications. Recent trends and future directions in refrigeration and air-conditioning.

Text Books:

1. Principles of Refrigeration" by Roy J. Dossat
2. Refrigeration and Air Conditioning Technology by William C. Whitman, William M. Johnson, and John A. Tomczyk.



Reference Books:

1. ASHRAE Handbook - HVAC Systems and Equipment, ASHRAE.
2. Modern Refrigeration and Air Conditioning by Andrew D. Althouse, Carl H. Turnquist, and Alfred F. Bracciano.
3. Heat Pumps, David Sand.



Course Code: ME3711	Bio-Fluid Mechanics	3-0-0	Credits 03
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Pre-requisites: ME2081: Fluid Mechanics

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

CO1	Demonstrate knowledge of the role of biofluid mechanics.
CO2	Define and describe relevant fluid mechanics principles such as the conservation laws.
CO3	Understand the blood rheology and mechanics of circulation
CO4	Analyse the arterial wave propagation, flow through pulmonary and musculoskeletal system.
CO5	Understand the computational biofluid mechanics.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Overview of basic anatomy and physiology from fluid flow perspective.

Basic equations and constitutive models: mass and momentum conservation, models for non-Newtonian fluids.

Blood rheology and mechanics of circulation: composition, structure and flow properties of blood, structure, flow and pressure characteristics of the blood flow in cardio-vascular system, flow of non-Newtonian fluids in elastic tubes.

Arterial wave propagation: oscillatory and pulsatile flow, pulse waves, behaviour at bifurcations, wave propagation in flexible tubes.

Flow through the pulmonary system: structure and function of pulmonary system, fluid exchange processes, fluid mechanics of breathing.

Flow and lubrication in musculoskeletal system: hemodynamic of red blood cells, synovial fluid in joints.

Flow through the porous media: oxygen diffusion from blood to tissues, flow in ocular and renal system.

Computational biofluid mechanics: computational methods for flow and wave propagation through elastic tubes, flow through porous media

Text Books:

1. Biomechanics: Circulation, Fung, Y. C., Springer-Verlag., 2010.



2. Fluid Mechanics in the Human Circulation, Chandran, K. B., Yoganathan, A., and Rittgers, S., Pearson Education., 2005.
3. An Introduction to Biomechanics, Humphrey, J. D., and Delange, S. L., Springer-Verlag., 2004.
4. Basic Transport Phenomena in Biomedical Engineering, Fournier, R. L. L., CRC press, 2011, 3rd Edition.

Reference Books:

1. Biofluid Mechanics, Mazumdar, J. N., World Scientific., 1992.
2. Fluid Mechanics of Large Blood Vessels, Pedley, T. J., Cambridge University Press., 2008.
3. Caro, C. G., Pedley, T. J., Schroter, R. C., Seed, W. A., "Mechanics of the Circulation", Cambridge University Press., 2012.



Departmental Elective (DE-5) Courses

Course Code: ME3721	Reverse Engineering	3-0-0	Credits 03
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Pre-requisites: NIL

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

CO1	Apply the fundamental concepts and principles of reverse engineering in product design and development.
CO2	Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
CO3	Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
CO4	Apply various data analyses processes.
CO5	Analyse the various legal aspect and applications of reverse engineering in product design and development.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Historical Background, Industrial Evolution, Reinvention of Engineering, Marvels from Nature, Reverse Engineering in Modern Industries, Reverse, Engineering vs. Machine Design, Motivation and Challenge, Analysis and Verification, Accreditation, Part Criticality, Applications of Reverse Engineering.

Geometrical Form: Surface and Solid Model Reconstruction, scanning Instruments and Technology, Principles of Imaging, Cross-Sectional Scanning, Digital Data, Computational Graphics and Modeling, Data Refinement and Exchangeability, Dimensional Measurement, Case Studies, Part Tolerance, Prototyping, Additive Prototyping, Technologies, Subtractive Prototyping Processes, Rapid Injection Molding, Steps of Geometric Modeling.

Material Characteristics and Analysis: Alloy Structure Equivalency, Phase Formation and Identification, Mechanical Strength, Hardness, Part Durability and Life Limitation, Part Failure Analysis, Fatigue, Creep and Stress Rupture, Environmentally, Induced Failure.



Material Identification and Process Verification: Material Specification, Composition Determination, Microstructure Analysis, Manufacturing Process Verification.

Data Process and Analysis: Statistical Analysis, Data Analysis, Reliability and the Theory of Interference, Weibull Analysis, Data Conformity and Acceptance, Data Report, Part Performance and System Compatibility Performance Criteria, Methodology of Performance Evaluation, System Compatibility.

Acceptance and Legality: Legality of Reverse Engineering, Legal Definition of Reverse Engineering, Legal Precedents on Reverse Engineering, Patent, Copyrights, Copyright Codes, Legal Precedents on Copyrights, Trade Secret, Case Study of Reverse Engineering a Trade Secret, Third-Party Materials.

Text Books:

1. Reverse Engineering: Technology of Reinvention, Wego Wang, ISBN-13: 978-1439806302, CRC Press
2. Product Design: Techniques in Reverse Engineering and New Product Development, Kevin Otto, ISBN-13: 9788177588217, Dorling Kindersley

Reference Books:

1. Reverse Engineering: Mechanisms, Structures, Systems & Materials, Robert Messler, McGraw Hill Education, ISBN: 9780071825160
2. Reverse Engineering: An Industrial Perspective, Raja, Vinesh, Fernandes, Kiran J., ISBN 978-1-84628-856-2, Springer.



Course Code: ME3731	Additive Manufacturing	3-0-0	Credits 03
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Pre-requisites: NIL

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

CO1	Understand the Fundamentals of Additive Manufacturing (AM).
CO2	Explore Materials Used in Additive Manufacturing.
CO3	Analyze Liquid State-Based 3D Printing Processes.
CO4	Examine Solid State-Based 3D Printing Processes.
CO5	Evaluate Powder-Based and Directed Energy Deposition Processes.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM.

Materials for AM: Atomic Structure and Bonding, Nature of Polymers, Thermoplastics and Thermosetting Polymers, Types of Polymerizations, Properties of Polymers, Degradation of Polymers, Metal and Ceramic Powders, Composites, Functionally Graded Materials (FGM's).

Liquid state-based 3D printing Process: Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, Micro-stereolithography, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies.

Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies. Solid state-based 3D printing Processes: Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies.

Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration. Friction stir additive manufacturing: process, parameters, advantages, limitations and applications.



Additive friction stir deposition process: principle, parameters, applications, functionally graded additive manufacturing components, Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. Wire Arc Additive Manufacturing: Process, parameters, applications, advantages and disadvantages, case studies.

Powder Based 3D printing Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

Directed Energy Deposition Processes: Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes, case studies, Binder Jetting AM Process: process, applications.

Text Books:

1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2015, 2nd Edition.
2. 3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2015, 4th Edition.

Reference Books:

1. Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venunod and Weiyin Ma, Springer, 2004.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
3. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006.
4. Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020.
5. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.



Course Code: ME3741	Modeling and Simulation of Manufacturing Systems	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Explain the concept of modelling and simulation of manufacturing systems.
CO2	Familiarize the manufacturing simulation languages.
CO3	Describe the various approaches to analyse the output data.
CO4	Impart the knowledge applications of simulation.
CO5	Explain Markov chain models and others.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to System and simulation: Concept of system and elements of system, Discrete and continuous system, Models of system and Principles of modeling and simulation, Monte carlo simulation, Types of simulation, Steps in simulation model, Advantages, limitations and applications of simulation, Applications of simulation in manufacturing system.

Review of statistics and probability: Types of discrete and continuous probability distributions such as Geometric, Poisson, Uniform, Normal, Exponential distributions with examples.

Random numbers: Need for RNs, Technique for Random number generation such as Mid product method, Mid square method, and Linear congruential method with examples.

Test for Random numbers: Uniformity - Chi square test or Kolmogorov Smirnov test, Independency- Auto correlation test.

Random Variate generation: Technique for Random variate generation such as Inverse transforms technique or Rejection method

Analysis of simulation data: Input data analysis, Verification and validation of simulation models, Output data analysis.



Simulation languages: History of simulation languages, Comparison and selection of simulation languages.

Design and evaluation of simulation experiments: Development and analysis of simulation models using simulation language with different manufacturing systems.

Queueing models: An introduction, M/M/1 and M/M/m Models with examples, Open Queueing and Closed queueing network with examples.

Markov chain models and others: Discrete time markov chain with examples, Continues time markov chain with examples, stochastic process in manufacturing, Game theory.

Text Books:

1. Discrete Event System Simulation, J.Banks, J.S. Carson, B. L. Nelson and D.M. Nicol, PHI, New Delhi, 2009.
2. Simulation Modeling and Analysis, A.M. Law and W.D.Kelton, Tata McGraw Hill Ltd, New Delhi, 2008.

Reference Books:

1. Performance Modeling of Automated Manufacturing Systems, N. Viswanadham and Y. Narahari, PHI, New Delhi, 2007.



Course Code: ME3751	Condition Monitoring	2-1-0	Credits 03
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Pre-requisites: ME2151: Theory of Machines

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

CO1	Understand effective maintenance schemes in industries.
CO2	Diagnose the mechanical systems by applying vibration monitoring techniques.
CO3	Apply oil analysis technique to diagnose the wear debris.
CO4	Identify nonconventional methods for machine diagnoses.
CO5	Develop modern technologies for effective plant maintenance.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Failures - System, component and services failures - classification and its causes, Maintenance Schemes - objectives - types and economic benefits, break down, preventive and predictive monitoring.

Vibration Monitoring - causes and effects of vibration, review of mechanical vibration concepts - free and forced vibrations, vibration signature of active systems - measurement of amplitude, frequency and phase.

Vibration monitoring equipment- vibration sensors (contact and non-contact type) -factors affecting the choice of sensors, signal conditioners, recording and display elements, vibration meter and analyzers, measurement of overall vibration levels.

Contaminant analysis: Contaminants in used lubricating oils - monitoring techniques (wear debris) - SOAP technique, Ferrography, X-ray spectrometry, Particle classification. Temperature Monitoring - Various techniques - thermograph, pyrometers, indicating paint and NDT methods.

Special Techniques: Ultrasonic measurement method, shock pulse measurement, Kurtosis, Acoustic Emission mentoring, critical speed analysis, shaft orbit analysis, Cepstrum analysis. Non-destructive techniques, Structural health monitoring weldments for surface and subsurface cracks

Text Books:

1. Vibration Condition Monitoring, Rao J. S., Narosa Publishing House, 2000, 2nd Edition.



2. Fault Diagnosis Application, Isermann R., Springer-Verlag Berlin, 2011.
3. Hand book of Condition Monitoring, Allan Davis, Chapman and Hall, 2000.

Reference Books:

1. Instrumentation, Measurement and Analysis, Choudary K K., Tata McGraw Hill, 2012
2. Mechanical Faults Diagnosis, Collacott, R. A., Chapman and Hall, London, 1990.



Course Code: ME3761	Theory of Plasticity	2-1-0	Credits 03
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Pre-requisites: ME2071: Manufacturing Science-I

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

CO1	Explain the fundamental concepts of plasticity theory, including stress-strain relationships, yield criteria, and flow rules.
CO2	Apply various yield criteria (e.g., von Mises, Tresca, Drucker-Prager) to determine the onset of plastic deformation in materials.
CO3	Apply hardening models, including isotropic, kinematic, and combined hardening, to analyze material behavior under different loading conditions.
CO4	Skilful at using computational methods and finite element analysis (FEA) to solve nonlinear plasticity problems and analyze material behaviour.
CO5	Apply plasticity theory to analyze and solve real-world engineering problems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Overview of Plasticity Theory-Definition and scope of plasticity, Historical development and significance, Fundamental Concepts-Differences between elastic and plastic deformation, Basic principles of plasticity theory; Constitutive Relationships-Stress-strain relationships in plasticity, Basic assumptions in plasticity theory; Material Behavior Beyond Elastic Limits-Plastic flow and deformation mechanisms, Examples of materials exhibiting plastic behaviour.

Mathematical Foundations and Yield Criteria: Stress and Strain Tensors-Definition and components of stress and strain tensors, Tensor algebra and calculus; Yield Criteria-von Mises Yield Criterion, Tresca Yield Criterion, Drucker-Prager Criterion, Mohr-Coulomb Criterion; Plastic Potential Functions-Concept of plastic potential, Examples of plastic potential functions

Flow Rules and Hardening Models: Flow Rules-Associative vs. non-associative flow rules Flow rule formulations; Hardening Theories-Isotropic Hardening-Definitions and models; Kinematic Hardening-Definitions and models; Combined Hardening-Interaction of isotropic and kinematic hardening; Mathematical Formulation of Hardening Models-Derivation and application of hardening models, Examples and practical considerations.



Computational Methods in Plasticity: Incremental Plasticity Theory-Incremental theory formulation, Algorithmic procedures and numerical methods; Solution Techniques-Solution algorithms for nonlinear plasticity problems, Practical considerations and limitations.

Applications: Plastic collapse analysis of structures, Metal forming processes; Recent developments in plasticity theory, Multiscale and micromechanics approaches; Case Studies-Real-world examples and problem-solving, Experimental validation of plasticity theory.

Text Books:

1. Theory of Plasticity, J. Chakrabarty, Butterworth-Heinemann, 2006, 3rd Edition.
2. Plasticity Theory, J. Lubliner, Dover Publishing, 2008.
3. Fundamentals of the theory of plasticity, L. M. Kachanov, Dover Publishing, 1990.
4. Plasticity: Fundamentals and applications, P. M. Dixit and U. S. Dixit, CRC Press; 2014.

Reference Books:

1. Theory of Plasticity, R. Hill, Oxford University Press, 1998.
2. Theory of Engineering Plasticity, R Narayanasamy and R Ponalagusamy, Ahuja Book Company, 2000.
3. Nonlinear Solid Mechanics, D. Bigoni, Cambridge University Press, 2012.



Course Code: ME3771	Design of Transmission Elements	3-0-0	Credits 03
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Pre-requisites: ME3221: Design of Machine Members

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

CO1	Design the required size of shaft, key and coupling for the given application.
CO2	Select the appropriate gear and Design the gear for the given operating conditions.
CO3	Design the flexible elements required to transmit the desired power.
CO4	Identify the suitable breaks and clutches.
CO5	Design the suitable size of I.C. engine parts, clutch and brake.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Design of Shafts, Keys and Couplings: Types of loading on shafts, Causes of stress concentration in shafts, Design of shafts based on strength, Design of shafts based on rigidity, Use of fatigue and stress concentration factors in Shaft Design, Practical examples, Purpose of Key, Different types of keys, Design - square and flat keys, Kennedy keys and splines, Purpose of shaft couplings, Different types of couplings, Design of rigid couplings - muff coupling, split muff coupling and flanged coupling, Design of Flexible couplings - bushed-pin flexible coupling, Oldhams coupling and Universal coupling.

Design of Gears: Classification of Gears, Law of gearing, Terminology of spur gear, Standard Systems of gear tooth, Interference and undercutting, backlash, Stresses produced in a gear tooth, Concept of uniform strength beam, Shape of uniform strength cantilever beam with point load at its free end, Lewis equation, Design of spur gear tooth based on strength, Checking the design under dynamic loading conditions and wear loading conditions, Terminology and Force analysis - Helical gears, Worm gears and Bevel gears (self-study)

Design of Flexible Elements: Belts and their construction, Flat belts versus V- belts, Open and cross belt arrangement, Ratio of belt tensions, Centrifugal tension, Effect of centrifugal tension, Design of flat belts and V-belts, Selection of wire rope and Pulleys, Introduction to Chain drive - its merits and demerits, Constructional features of a chain drive.

Design of Brakes and Clutches: Different types of brakes, Concept of self-energizing and self-locking of brakes, Practical examples, Design of band brakes, block brakes and internal expanding brakes, Necessity of a clutch in an automobile, Types of clutch, friction materials and its properties, Design of single plate, multi-plate and cone clutches based on uniform pressure and uniform wear theories.



Design of I.C. Engine parts: Design of engine parts such as Piston, Connecting rod and Crank shaft.

Text Books:

1. Mechanical Engineering Design, Richard G. Budynas, J Keith Nisbett, Shigley's McGraw Hill, 2011, 9th Edition.
2. Machine design an integrated approach, Robert L Norton, Pearson Education, 2009, 2nd Edition.

Reference Books:

1. Design of Machine Elements, V B Bhandari, Tata McGraw Hill Education Private Limited, 2012, 3rd Edition.
2. Machine Design, Black and Adams, McGraw Hill and Co, New Delhi, 2002.



Course Code: ME3781	Introduction to CFD Tools	3-0-0	Credits 03
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Pre-requisites: ME2081: Fluid Mechanics

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

CO1	Understand the basic principle of CFD and its applications.
CO2	Analyse the numerical approximations in CFD.
CO3	Understand the turbulence and its effects on fluid flow.
CO4	Understand the heat transfer modes in CFD
CO5	Simulate the CFD models.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to CFD: Overview of CFD and its applications, Basic principles of fluid dynamics, governing equations of fluid flow (Navier-Stokes equations), Discretization methods: Finite difference, finite volume, and finite element methods, Introduction to CFD software and tools.

Numerical Methods in CFD: Numerical approximation and error analysis, Stability and convergence criteria, Solution techniques for linear and non-linear algebraic equations, Time-stepping methods for unsteady flows, Grid generation and mesh quality

Turbulence Modeling: Introduction to turbulence and its effects on fluid flow, Reynolds-Averaged Navier-Stokes (RANS) equations, Turbulence models: k- ϵ , k- ω , and LES (Large Eddy Simulation), Application of turbulence models in CFD simulations.

Heat Transfer in CFD: Conduction, convection, and radiation heat transfer, Heat transfer equations and their numerical solution, Coupled heat and fluid flow problems, Application of CFD in heat exchangers, electronic cooling, and HVAC systems.

Practical Applications of CFD: Case studies in automotive, aerospace, and energy sectors, Best practices in CFD simulations, Verification and validation of CFD results, advanced topics: Multiphase flow, reacting flows, and optimization using CFD

Text Books:

1. Computational Fluid Dynamics: The Basics with Applications" by John D. Anderson, McGraw-Hill, 1995, 1st Edition.
2. Numerical Heat Transfer and Fluid Flow" by Suhas V. Patankar, Hemisphere Publishing Corporation, 1980, 1st Edition.



Reference Books:

1. Turbulence Modeling for CFD" by David C. Wilcox, DCW Industries, 2006, 3rd Edition.
2. Introduction to Computational Fluid Dynamics and Heat Transfer, Jiyuan Tu, Guan-Heng Yeoh, and Chaoqun Liu, Butterworth-Heinemann, 2012, 2nd Edition.
3. Applied Computational Fluid Dynamics Techniques, Rainald Löhner, Wiley, 2008, 2nd Edition.



Course Code: ME3791	Fuels and Combustion	3-0-0	Credits 03
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Pre-requisites: ME2091: Applied Thermal Engineering

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

CO1	Differentiate between various fuels and thermo chemistry.
CO2	Understand the chemical kinetics.
CO3	Understand mass conservation equations in 1D and 2D forms.
CO4	Understand the laminar and turbulent flames.
CO5	Understand the pollutant emissions of the fuels.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Overview of the course - Thermochemistry of Combustion-Concept of Adiabatic Flame Temperature-Numerical Problems

Chemical Kinetics: Differences between equilibrium and rate-controlled reactions Global versus Elementary Reactions. Elementary reaction rates, bimolecular reactions and collision theory, other elementary reactions, Relation between rate coefficients and equilibrium constants, Steady-state Approximation. The mechanism for Uni-molecular reactions, Chain and Chain-Branching reactions.

Introduction to species Mass Transfer: Rudiments of Mass Transfer, Mass Transfer Rate Laws, Species Conservation. The Stefan Problem, Liquid-vapor interface boundary conditions, Droplet evaporation, Numerical.

Simplified Conservation Equations for Reacting Flows: Overview-Overall Mass Conservation (Continuity) Species mass Conservation (Species Continuity) Momentum Conservation, 1-D and 2-D forms, Energy Conservation-General 1-D Form, Shvab- Zeldovich Forms, Definition of Mixture Fraction.

Laminar Premixed Flames: Physical Description, Definition, Principal characteristics, Typical Laboratory Flames. Simplified Analysis, Assumptions, Conservation Laws, Solution, Factors Influencing flame velocity and Thickness: temperature, pressure, Equivalence ratio, fuel type, Flame speed Correlations for Selected fuels, Quenching, Flammability, and Ignition Flame lift-off (Blow-off) and flash back, Concept of Flame stretch-Karlovitz number, Flame Stabilization.



Introduction to Turbulent Flames: Turbulent length and time scales, Weak turbulent flames. Wrinkled Reaction Sheets, Distributed Reaction zones.

Pollutant Emissions: Effects of emissions, Quantification of Emissions, Emission Indices, Corrected concentrations, Various Specific Emission Measures-Emissions from Premixed Combustion: Oxides of Nitrogen, Carbon Monoxide, Unburned Hydrocarbons, and Catalytic after- treatment, Particulate Matter. Emissions from non-Premixed Combustion: Oxides of Nitrogen, Unburned Hydrocarbons and Carbon Monoxide, Particulate Matter and Oxides of Sulphur,

Text Books:

1. Combustion, Stephen, R. Turns., McGraw Hill, 2005.
2. Introduction to Combustion, Mishra, D.P., Prentice Hall, 2009.
3. Fuels and Combustion, Sharma, S. P., Tata McGraw Hill, New Delhi, 2001.

Reference Books:

1. Internal Combustion Engine Fundamentals, John B. Heywood, McGraw Hill Co. 1988.
2. Combustion: Physical and Chemical Fundamentals, Modelling and Simulation, Experiments, Warnatz, Ulrich Maas and Robert W. Dibble Pollutant Formation, 1999.



Course Code: ME3801	Energy Conservation Management	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Outline energy scenario, audit and management.
CO2	Apply energy conservation policy, regulations in industrial practices. Evaluate energy economics.
CO3	Identify opportunities for rational use of energy.
CO4	Analyse the thermal systems for energy efficiency.
CO5	Analyse electrical systems for energy conservation.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Energy scenario, various forms of energy, energy management and its importance, recent trends in energy conservation.

Energy Auditing and Instrumentation: Definition, methodology, analysis of past trends (plan data), closing the energy balance, laws of thermodynamics, measuring instruments, portable and online instruments.

Energy Economics: Simple payback period, time value of money, IRR NPV, life cycle costing, cost of saved energy, cost of energy generated.

Monitoring and Targeting: Defining monitoring and targeting, elements of monitoring and targeting, data and information, analysis techniques, energy consumption, production, cumulative sum of differences.

Energy Efficiency in Thermal Utilities: Boilers, steam system, furnaces insulation and refractories, FBC boilers, cogeneration, waste heat recovery.

Energy Efficiency in electrical Utilities: Electrical systems, electric motors, compressed air system, HVAC and refrigeration systems, fans and blowers, pumps and pumping systems, cooling towers, lighting system, diesel generating system.



Text Books:

1. Industrial Energy Management and Utilization, Witte, L.C., Schmidt, P.S., Brown, D.R., Hemisphere Publishing Corporation. Springer-Verlag, 1988.
2. Energy: Management, Supply and Conservation, Clive Beggs, Routledge, 2012.

Reference Books:

1. Guide to Energy Management, Capehart, B.L., Turner, W.C., Kennedy, W.J., Fairmont Press, 2011, 7th Edition.
2. Energy Management Handbook, Turner, W.C. and Doty, S., Fairmont Press., 2009, 7th Edition.
3. Handbook of Energy Efficiency and Renewable Energy, Kreith, F. and Yogi Goswami, D., CRC Press., 2007.



Basket-6 (DE-6):

Course Code: ME4811	Materials Characterization	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Understanding of various materials testing methods
CO2	Understand properties of materials through tribological performance tests
CO3	Interpret surface morphology and microstructure analyses
CO4	Perform microstructure and phase analysis
CO5	Interpret the results to determine material thermal stability

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Materials testing: Tensile test, hardness test, impact test, fracture/fatigue/creep test, Universal testing machine (UTM), contact angle measurement, surface energy, tribological performance: wear and friction test, corrosion test (electrochemical analysis), surface reflectivity test, surface tension measurement, Scratch testing (tractional coefficient).

Surface morphology, topography, and elemental analysis: Optical profilometer (contact and non-contact measurement), Field emission scanning electron microscopy (FESEM), energy-dispersive X-ray spectroscopy (EDS/EDX/EDAX), Secondary ion mass spectrometry (SIMS), atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), Optical emission spectroscopy (OES).

Microstructure and phase analysis: Optical microscope (metallurgical property), X-ray diffraction (XRD), transmission electron microscopy (TEM), electron backscatter diffraction (EBSD), Raman spectroscopy, Fourier-transform infrared spectroscopy (FTIR), UV-vis analysis.

Thermal analysis: Scanning tunneling microscopy (STM), differential thermal analysis (DTA), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), thermomechanical analysis (TMA), dynamic mechanical analysis (DMA/DMTA).



Text Books:

1. B. Fultz and J. M. Howe, Transmission Electron Microscopy and Diffractometry of Materials, Springer 2008.
2. ASTM handbook, vol. 3, 1997
3. ASM hand book Materials characterization, Vol 10, 1998
4. C. R. Brundle, C. A. Evans Jr., S. Wilson, Encyclopedia of Materials Characterization, ButterworthHeinemann, 1992.

Reference Books:

1. R. W. Cahn, and E. Lifshin, Concise Encyclopedia of Materials Characterization, Pergamon, 1993.
2. E. N. Kaufmann, Materials characterization, Wiley Interscience, 2003.
3. B. D. Cullitey, Elements of X-ray diffraction, Addison-Wesely, 1968.
4. E. Lifshin, X Ray Characterization of Materials, Wiley-Vch 1999



Course Code: ME4821	Precision Manufacturing	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Understand the concept of accuracy and precision
CO2	Apply fits and tolerances for parts and assemblies as per ISO standards.
CO3	Evaluate the machine tool and part accuracies.
CO4	Estimate the error during machining.
CO5	Estimate the surface quality of machined components

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Accuracy and Precision: Introduction - Accuracy and precision – Need – application of precision machining- alignment testing of machine tools, accuracy of numerical control system, specification of accuracy of parts and assemblies.

Tolerance and fits: Tolerance and fits, hole and shaft basis system, types of fits- Types of assemblies-probability of clearance and interference fits in transitional fits.

Concept of part and machine tool accuracy: Specification of accuracy of parts and assemblies, accuracy of machine tools, alignment testing of machine tools.

Errors during machining: Errors due to compliance of machine-fixtured-tool-work piece (MFTW) System, theory of location, location errors, errors due to geometric inaccuracy of machine tool, errors due to tool wear, errors due to thermal effects, errors due to clamping. Statistical methods of accuracy analysis.

Surface roughness: Definition and measurement, surface roughness indicators (CLA, RMS, etc.,) and their comparison, influence of machining conditions, methods of obtaining high quality surfaces, Lapping, Honing, Super finishing and Burnishing processes.

Text Books:

1. Precision Engineering in Manufacturing, R.L.Murty, New Age International Publishers, 1996.



2. Fundamentals of Process Engineering, V.Kovan, Foreign Languages Publishing House, Moscow, 1975.

Reference Books:

1. Process Engineering for Manufacture, Eary and Johnson, Prentice Hall, 1962.
2. Dimensional control in Precision Manufacturing, J.L.Gadjala, McGraw Hill Publishers, 2012.



Course Code: ME4831	Advances in Robotics and Artificial Intelligence	2-1-0	Credits 03
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Pre-requisites: ME1031: Engineering Mechanics

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

CO1	Understand the technologies used in advanced robots.
CO2	Understand the Industry 4.0 and Internet of Robotic things (IORT)
CO3	Understand the technology used in Natural Language processing.
CO4	Study NLP techniques and understand its utility in industrial applications.
CO5	Apply automated reasoning in AI based programming.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Humanoid Robotics Technology and Social Robots: Sensors in Humanoid Robot, Control of Humanoid Robot, actuation types for humanoid Robot, System Integration in Humanoid Robot, Social Robot, Need of Social Robots, Assistive and Social Robots in the Healthcare Sector and other, Case study On Humanoid Robot.

Swarm Robotics: Characteristics, Swarm Robotics and Multi-Robotic Systems, Experimental Platforms in Swarm Robotics, Tasks in Swarm Robotics, Swarm Robots used in Real world applications, Smart Robots, Smart Robots applications, Robotics for Warfare Applications.

Human Robot Interaction (HRI): Definition, History, Need of HRI, Ethical Issues for HRI, Multi-Modal Perception, Social, Service, and Assistive Robotics, HRI Architecture, Collaborative Robots, Definition, Types of Collaboration, Applications of collaborative robots, collaborative Robot Technology.

Industry 4.0 and Internet of Robotic things (IORT): Introduction, Internet of Things and Robotics, Applications and developments of the Internet of Robotic Things.

Natural Language Processing: Introduction, Classical Approaches to Natural Language Processing, Text Preprocessing, Lexical Analysis, Syntactic Parsing, Semantic Analysis, Natural Language Generation, Applications.

Logics for AI and Automated Reasoning: What is Automated Reasoning, methods of Reasoning, reasoning types, use of Automated reasoning in AI, Reasoning and its types, applications for Automated Reasoning, Mathematical consideration.



Text Books:

1. Advanced Robotics (Design & Applications), Sabrie Soloman, Khanna Book Publishing Co., 2023.
2. A Classical Approach to Artificial Intelligence, M.C. Trivedi, Khanna Book Publishing, 2023.
3. Artificial Intelligence, Luger Pearson, 2008, 5th Edition.
4. A Handbook on Natural Language Processing, Ralf Herbrick, Thore Graepel, CRC Press, 2010, 2nd Edition.

Reference Books:

1. Robotics Process Automation, S. Mukherjee, Khanna Book Publishing, 2021.
2. Data Science with AI, ML, DL, Dr. Rajiv Chopra, Khanna Book Publishing, 2023.
3. Humanoid Robot: Design and Fuzzy Logic Control Technique for Its Intelligent Behaviors, Elmer P. Dadios, 2012.
4. An Introduction to Swarm Robotics, Iñaki Navarro and Fernando Matía, ISRN, Robotics, 2013.
5. Automation and Collaborative Robotics, Springer Publication, 2020.
6. Designing for collaborative robotics, Jeff Faneuff, Jonathan Follett, O'Reilly Media, 2016.
7. Human-Robot Interaction, David Feil-Seifer, 2010.
8. Automated Reasoning for Explainable Artificial Intelligence, Maria Paola Bonacina, 2018.
9. Explainable Artificial Intelligence (XAI), David Gunning, 2017.



Course Code: ME4841	Data Modelling and Visualization	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Understand and Apply Entity-Relationship (ER) Modeling.
CO2	Master Data Visualization Fundamentals.
CO3	Utilize Advanced Visualization Techniques.
CO4	Conduct Visual Analytics for Complex Data
CO5	Implement and Evaluate Visualization Tools and Techniques.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction Data Modeling: Entity Relationship Model: Types of Attributes, Relationship, Structural Constraints – Relational Model, Relational model Constraints - Mapping ER model to a relational schema – Integrity constraint.

Introduction to Data Visualization: Overview of data visualization - Data Abstraction - Analysis: Four Levels for Validation- Task Abstraction - Analysis: Four Levels for Validation.

Visualization Techniques: Scalar and point techniques Color Maps Contouring Height Plots – Vector visualization techniques Vector Properties Vector Glyphs Vector Color Coding Stream Objects.

Visual Analytics: Visual Variables- Networks and Trees - Map Color and Other Channels- Manipulate View Arrange Tables Geo Spatial Data Reduce Items and Attributes.

Types of Visual Analysis: Time- Series data visualization -Text data visualization- Multivariate data visualization and case studies.

Visualization Tools and Techniques: Introduction to data visualization tools- Tableau - Visualization using R- Dashboard creation using visualization tools for the use cases: Finance-marketing-insurance- healthcare etc.

Text Books:

1. Visualization Analysis and Design, Tamara Munzer, CRC Press 2014 Alexandru Telea, Data Visualization Principles and Practice CRC Press 2014.
2. Java SE8 for Programmers, Paul J. Deitel, Harvey Deitel, (Deitel Developer Series), 2014, 3rd Edition.



Reference Books:

1. Introduction to Java programming-comprehensive version, Y. Daniel Liang, - Pearson Ltd. 2015, 10th Edition.
2. Paul Deitel Harvey Deitel, Java, How to Program, Prentice Hall; 2011, 9th Edition.
3. BIG JAVA, Cay Horstmann, John Wiley Sons, 2009, 4th Edition.
4. Professional Java for Web Applications, Nicholas S. Williams, Wrox Press, 2014.



Course Code: ME4851	Artificial Intelligence and Machine Learning for Mechanical Systems	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Analyze Mechanical Systems in the Context of Industry 4.0
CO2	Apply Statistical Methods for Data Analysis
CO3	Implement and Evaluate AI Techniques
CO4	Utilize Machine Learning for Mechanical Systems
CO5	Develop and Integrate Systems Using Raspberry Pi

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Mechanical Systems: Evolution in the context of Industry 4.0, Key issues: Adaptability, Intelligence, Autonomy, Safety, Sustainability, Interoperability, Flexibility of Mechanical Systems.

Introduction of Statistics; Descriptive statistics: Central tendency measures, Dispersion measures, data distributions, centre limit theorem, sampling, sampling methods; Inferential Statistics: Hypothesis testing, confidence level, degree of freedom, P-value, Chi-square test, ANOVA, Correlation V's Regression, Uses of Correlation and regression.

Artificial Intelligence: Brief review of AI history, Problem formulation: Graph structure, Graph implementation, state space representation, search graph and search tree, Search Algorithms: random search, Depth-first, breadth-first search and uniform-cost search. Heuristic: Best first search, A* and AO* algorithm, generalization of search problems. Ontology; Fuzzy; Meta-heuristics.

Machine Learning: Overview of supervised and unsupervised learning; Supervised Learning: Linear Regression, Non-linear Regression Model evaluation methods, Logistic Regression, Neural Networks; Unsupervised Learning: K-means clustering, Cmeans Clustering. Convolutional Neural Networks (CNN), Pooling, Padding Operations, Interpretability in CNNs, Limitations in CNN. Cases with respect to different mechanical systems.

Introduction to Raspberry Pi: Installation of Raspbian OS on Raspberry Pi; Controlling LED using Raspberry Pi; Integrating IR Sensor with Raspberry Pi; Controlling LED with IR Sensor; Integrating Temperature and amp; Humidity Sensor with Raspberry Pi read Current



Environment Values, Collecting the sensor data using Raspberry Pi; Matlab toolboxes - Simulink, Mechanical Systems implementation: From features to software components, Mapping software components to ECUs.

Text Books:

1. Cyber-Physical Systems, Rajkumar, Dionisio De Niz, and Mark Klein, Wesley Professional.
2. Principles of Cyber-Physical Systems, Rajeev Alur, MIT Press, 2015.
3. A Comprehensive guide to AI and Expert Systems, Robert Levine et al., McGraw Hill Inc, 1986.

Reference Books:

1. Introduction to Embedded Systems: A Cyber-Physical Systems Approach, E. A. Lee and S. A. Seshia, 2011.
2. Introduction to Discrete Event Systems, C. Cassandras, S. Lafortune, Springer 2007.
3. Formal methods for real-time computing, Constance Heitmeyer and Dino Mandrioli, Wiley publisher, 1996.
4. Design of Experiments, Montgomery Douglas, 2017. John Wiley and Sons, Inc.



Course Code: ME4861	Rotor Dynamics	2-1-0	Credits 03
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Pre-requisites: ME2151: Theory of Machines

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

CO1	Model the Rotor bearing systems and formulate the governing equations.
CO2	Understand the role of damping, gyroscopic, centrifugal, stiffness and inertial effects on rotors.
CO3	Compute the critical speeds and stability limits for rotors under axial, transverse and torsional modes.
CO4	Analyse the rotor bearing systems using transfer matrix method and Finite Element Method.
CO5	Compute the transient response of rotors.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Introduction to rotor dynamics & smart rotor systems, Review of momentum principles, Hamilton's principle and Lagrange's equations, Rotating and reciprocating unbalances, Classification of Discrete and continuous systems, Review of free and forced vibrations of single and multi-degree of freedom systems.

Linear Rotor Dynamics: Equation of motion, Rotating systems, Complex coordinate representation, Undamped Jeffcott Rotor - Free whirling, Unbalance response, Shaft Bow Jeffcott Rotor with viscous damping - Free whirling, Unbalance response, Shaft Bow with structural damping - Free whirling, Unbalance response, frequency dependent loss factors with non-synchronous damping, Effect of Bearing Compliance, Stability in supercritical region.

Modelling with Four Degrees of Freedom: Generalised coordinates and equations of motion in real and complex coordinates, Static and couple unbalance and their effects, uncoupled gyroscopic systems, Free whirling of coupled undamped systems, Unbalance response and Shaft bow. Model uncoupling of gyroscopic systems, Configuration and state space approaches. Disc gyroscopic, synchronous and nonsynchronous whirl, forward and backward whirl.

Discrete multi-degree of freedom: Introduction, transfer matrix approach for undamped systems, Damped systems, the finite element method for rotors, Beam elements, spring



elements, Mass elements, Assembly and constraints, damping matrices, Choice of coordinates: fixed Vs Rotating and Real Vs Complex coordinates, Computation of critical speeds, Computation of unbalance response. Campbell and root locus diagrams, Reduction of DOF: Nodal reduction, model reduction and component mode synthesis.

Transmission Shafts: Modelling of rotors as continuous systems, Euler-Bernoulli and Timoshenko beam models, Dynamic stiffness, Analytical and approximate solutions.

Anisotropy of rotors and supports: Isotropic rotors on Anisotropic supports - Influence of damping, non-isotropic rotors on isotropic supports.

Torsional and Axial Dynamics: Free and forced Torsional vibrations and critical speeds, Axial Vibration of rotors.

Rotor-Bearing Interaction: Rigid body and flexural modes, Linearization of bearing Characteristics, rolling element bearings, Fluid film bearings, Magnetic bearings, bearing alignment in multi rotor bearings.

Instability in Rotors, Balancing Condition monitoring of rotors: Common faults and vibration signatures, Condition based monitoring.

Text Books:

1. Dynamics of Rotating Systems, Giancarlo Genta, Springer, 2009.
2. Rotor Dynamics, Rao, J.S., New Age International, 2003, 3rd Edition.
3. Rotating Machinery Vibrations, Maurice L. Adams, Jr., Marcel Dekker, Inc., New York, 2001.

Reference Books:

1. Vibration Analysis of Rotors, Chong-Won Lee, Kluwer Academic Publishers, London, 1995.
2. Rotor dynamics, Muszynska A, Taylor & Francis, New York, 2005.
3. Dynamics of Rotor-Bearing Systems, Goodwin M J, Unwin Hyman, Sydney, 1989.



Course Code: ME4871	Jet Propulsion and Rocketry	2-1-0	Credits 03
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Pre-requisites: ME2091: Applied Thermal Engineering

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

CO1	Understand the applications of jet and rocket propulsion and their energy requirements
CO2	Identify propellants available and factors influencing their burn rate and performance
CO3	Classify nozzles and their requirements for the development of thrust and impulse.
CO4	Understand the principles of rocket propulsion, staging and boosting.
CO5	Evaluate burn rate, propulsive power, thrust and energy requirements in ideal cases of propulsion devices.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Motion in Space-Requirements of Orbit: Introduction, Motion of Bodies in Space and Laws of Motion; Parameters describing Motion of Bodies, Newton's laws of Motion, Universal Law of Gravitational Force, Gravitational Field; Requirements for Motion in Space, Geosynchronous and Geostationary Orbits, Eccentricity and Inclination of Orbits, Energy and Velocity Requirements to reach a Particular Orbit; Escape Velocity, Freely Falling Bodies, Means of Providing the Required Velocities, small problems.

Theory of Rocket Propulsion: Illustration by an Example of Motion of Sled Initially at Rest, Motion of Giant Squid in Deep Seas; Rocket Principle and the Rocket Equation, Mass Ratio of a Rocket, Desirable Parameters of a Rocket, Propulsive Efficiency of a Rocket, Performance Parameters of a Rocket, Staging and Clustering of Rockets, Classification of Rockets, problems.

Rocket Nozzle and Performance: Expansion of gas from a high pressure chamber, Shape of the Nozzle, Nozzle area Ratio, Performance loss in a conical Nozzle, Flow Separation in Nozzles Contour or Bell Nozzles, Unconventional Nozzles Mass Flow rates and characteristic Velocity, thrust developed by a Rocket; Thrust Coefficient Efficiencies, Specific Impulse and Correlation with C^* and CF General Trends.



Chemical Propellants: Small Values of Molecular Mass and Specific Heat Ratio, Energy Release during Combustion of Propellants, Criterion for Choice of Propellants, Solid Propellants, Liquid Propellants, Hybrid Propellants.

Solid Propellant Rockets: Mechanism of Burning and Burn Rate, Choice of Index n for Stable Operation of Solid Propellant Rockets, Propellant Grain Configuration, Ignition of Solid Propellant Rockets, Pressure Decay in the chamber after propellant Burns Out, Action time and Burn Time, Factors influencing Burn Rate Components of a Solid Propellant Rocket.

Liquid Propellant Rockets: Propellant Feed system, Thrust Chamber, Performance and Choice of Feed System Cycle, Turbo-pumps, Gas requirements for draining of propellants from storage tanks, draining under microgravity conditions, Complexity of Liquid Propellant Rockets and simulation, Trends in the development of liquid propellant rockets.

Liquid Monopropellant rockets: Hydrazine, Monopropellant rockets, Catalyst bed loading, Performance and applications.

Hybrid Rockets: Working Principle, Choice of Fuels and Oxidizers, Future of Hybrid Rockets.

Combustion Instability: Bulk and wave modes of Combustion Instability, Analysis procedure for bulk mode of combustion, Instability in liquid propellant rockets, Bulk mode of combustion instability in solid Propellant Rockets, Wave mode of combustion instability, Wave mode instability in solid propellant rockets, Evaluation of the growth constant of solid propellant using T burner, Conversion of growth constant derived from T burner for application in a solid propellant rocket, Wave mode instability in liquid propellant rockets, Non-linear combustion instability, Process induced combustion instability, Pogo instability due to interaction of propulsion and structure, Combustion Instability: Suppression and Control.

Text Books:

1. Barrere, M., Rocket Propulsion, Elsevier Pub. Co., 1990.
2. Sutton, G. P., Rocket Propulsion Elements, John Wiley, New York, 1993.
3. Ramamurthi K., Rocket Propulsion, Macmillan Publishers India Ltd., 2010.

Reference Books:

1. Feedesiev, V. I. and Siniarev, G. B., Introduction to Rocket Technology, Academic Press, New York, 2000.
2. Sarvanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, H., Gas Turbine Theory, 6th Edition, Pearson Prentice Hall, 2008.



Course Code: ME4881	Heating, Ventilation & Air-Conditioning (HVAC)	2-1-0	Credits 03
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Pre-requisites: ME2091: Applied Thermal Engineering

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

CO1	Understand the fundamentals of Psychrometry.
CO2	Apply human comfort indices and comfort chart to design indoor conditions of HVAC systems.
CO3	Estimate heating and cooling loads for buildings according to ASHRAE procedures/standards.
CO4	Perform Load Calculations for Air-Conditioning Systems
CO5	Design and evaluate complete air distribution system including fan, duct, and installation requirements for a typical HVAC system.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Brief history of air conditioning and impact of air conditioning. HVAC systems and classifications, Heat Pumps Psychrometry of Air Conditioning Processes: Thermodynamic properties of moist air, Important Psychrometry properties, Psychrometric chart; Psychrometric process in air conditioning equipment, applied Psychrometry, air conditioning processes, air washers.

Comfort Air Conditioning: Thermodynamics of human body, metabolic rate, energy balance and models, thermoregulatory mechanism. Comfort & Comfort chart, Effective temperature, Factors governing optimum effective temperature, Design consideration. Selection of outside and inside design conditions.

Heat Transfer through Building Structures: Solar radiation; basic concepts, sun-earth relationship, different angles, measurement of solar load, Periodic heat transfer through walls and roofs. Empirical methods to calculate heat transfer through walls and roofs using decrement factor and time lag method. Infiltration, stack effect, wind effect. CLTD/ETD method - Use of tables, Numerical and other methods, Heat transfer through penetration - Governing equations, SHGF/SC/CLF Tables.

Load Calculation: Types of air-conditioning systems, General consideration, internal heat gains, system heat gain, cooling and heating load estimate.



Ventilation System: Introduction- Fundamentals of good indoor air quality, need for building ventilation, Types of ventilation system, Air Inlet system. Filters heating & cooling equipment, Fans, Duct design, Grills, Diffusers for distribution of air in the workplace.

Text Books:

1. Heating Ventilating and Air Conditioning- Analysis and Design, F.C. McQuiston & J.D. Parker, John Wiley & Sons, 2001, 5th Edition.
2. Thermal Environmental Engineering, J.L. Threlkeld, Prentice-Hall, Inc., 1970, 2nd Edition.

Reference Books:

1. ASHRAE Handbooks: Fundamentals, HVAC Applications, HVAC Systems & Equipment.
2. Refrigeration & Air conditioning, R.C. Arora, PHI, 2010.



Course Code: ME4891	Engineering Acoustics	3-0-0	Credits 03
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Pre-requisites: ME2151: Theory of Machines

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

CO1	Understand wave propagation, absorption, transmission, reflection and radiation.
CO2	Formulate acoustic problems for reduction of sound levels.
CO3	Analyze and design resonant systems including pipes, mufflers, Helmholtz resonators.
CO4	Evaluate architectural acoustics reverberation time, direct echoes and acoustical amplification.
CO5	Analyze the acoustic levels and analytical predictions.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Review of vibrations, resonance and frequency, Sound pressure, power and intensity and its measurement, Concept of Monopoles, Dipoles and Quadrupoles, Sound Power measurement, Transmission loss, Longitudinal and Transverse wave equations, Spherical and cylindrical wave equation, Acoustic intensity, decibel scales, Sound wave generators.

Acoustic wave propagation: Transmission/reflection of waves in different media, radiation and reception of acoustic waves, absorption and attenuation of sound, Cavities and waveguides. Wave types in fluids and solids. Modes of vibrations in solids.

Pipes, Resonators, and Filters: Resonance in pipes, standing waves, Absorption of sound, Helmholtz resonator, acoustic impedance, acoustic filters.

Damping Attenuation and Absorption: Viscous attenuation of sound, absorption by atmosphere, attenuation in water, absorption in fluid filled pipes, damping in solids.

Architectural Acoustics: Sound in enclosures, direct and reverberant sounds, sound absorption materials, acoustic factors in architectural design, standing waves and normal modes in enclosures.

Noise Control: The auditory system, Effects of noise on humans, noise measurement and criterion, treatment at source and treatment of transmission path, Analysis and design of



mufflers for automotive applications, Noise measurement and instrumentation standards. Noise Control approaches.

Text Books:

1. Introduction to acoustics, Robert D Finch. PHI2008.
2. Engineering Acoustics: An introduction to Noise Control, Michael Moser, Michael Maser, S. Zimmermann, Springer, 2009, 2nd Edition.

Reference Books:

1. Foundations of Engineering Acoustics, Frank J Fahy, Academic Press, 2000.
2. Engineering Acoustics: An Introduction to Noise Control, Michael Moeser, Michael Maser, Springer, 2004.



Open Elective Courses

Course Code: ME2901	IC Engines and Hybrid Vehicles	3-0-0	Credits 03
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Pre-requisites: ME1051: Engineering Thermodynamics

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

CO1	Understand the internal combustion engine components and systems
CO2	Understand fuel supply and ignition systems
CO3	Understand and apply hybrid vehicle technologies.
CO4	Explain automotive transmission, suspension, and steering systems
CO5	Apply knowledge to hybrid vehicle design, testing, and future trends.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														
CO6														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Internal Combustion Engines: Overview of IC Engines; Basic Engine Components; Engine Thermodynamics and Performance; Engine Cooling Systems; Engine Lubrication Systems.

Fuel Supply and Ignition Systems: Fuel Supply Systems; Ignition Systems; Emissions and Environmental Impact; Engine Testing and Performance Evaluation.

Introduction to Hybrid Vehicles: Fundamentals of Hybrid Vehicles- Definitions and types, Components; Hybrid Vehicle Systems and Operation; Performance and Efficiency of Hybrid Vehicles; Advantages and challenges of hybrid technology.

Transmission, Suspension, and Steering Systems: Transmission Systems- Types of clutches: single plate, multi-plate, semi-centrifugal, and fluid flywheel; Gearbox Types-Sliding mesh, constant mesh, synchromesh; Transmission system Components-Propeller shaft, differential, selector mechanisms. Steering Mechanisms-Manual vs. power steering systems

Principles of steering system design and operation, Braking Systems-Types of braking systems: mechanical, hydraulic, air brakes.



Hybrid Vehicle Design, Testing, and Future Trends: Hybrid Vehicle Design Considerations, Hybrid Vehicle Testing and Diagnostics, Future Trends in Hybrid and Electric Vehicles, Practical Applications and Case Studies.

Text Books:

1. Internal Combustion Engine Fundamentals, John B. Heywood
2. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Chris Mi and M. Abul Masrur.
3. Automotive Technology: A Systems Approach, Jack Erjavec and Rob Thompson.

Reference Books:

1. Advanced Hybrid Vehicles, Michael A. McCarthy and William W. Tschudi
2. Automotive Engineering: Powertrain, Chassis System and Vehicle Body, David Crolla
3. Future Automotive Technologies, Simon Mills



Course Code: ME3911	Alternative Sources of Energy	3-0-0	Credits 03
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Pre-requisites: ME2091: Applied Thermal Engineering

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

CO1	Understand and analyze renewable energy technologies.
CO2	Assess energy storage methods and their necessities.
CO3	Design and evaluate solar energy systems.
CO4	Apply principles of wind energy conversion.
CO5	Compare energy utilization from biomass and other renewable energy sources.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														
CO6														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies.

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods.

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

Solar Thermal systems: Introduction; 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 Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

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



Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles.

Text Books:

1. Solar Energy - Principles of Thermal Collection and Storage, Sukhatme S.P. and J.K.Nayak, Tata McGraw Hill, New Delhi, 2008.
2. Non-Conventional Energy Resources, Khan B.H., Tata McGraw Hill, New Delhi, 2006.

Reference Books:

1. Solar Energy - Thermal Processes, J.A. Duffie and W.A. Beckman, John Wiley, 2001.



Course Code: ME3921	Machine Learning for Robotics	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Understand basic machine learning techniques such as regression, classification
CO2	Understand about clustering and segmentation
CO3	Model a fuzzy logic system with fuzzification and defuzzification
CO4	Understand the concepts of neural networks and neuro fuzzy networks.
CO5	Gain knowledge on Reinforcement learning

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														
CO6														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics.

Clustering and Segmentation Methods: Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K-nearest neighbour algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.

Fuzzy Logic: Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application

Neural Networks: Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics

RNN and Reinforcement Learning: Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning,



Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics

Text Books:

1. Artificial Intelligence: A Guide to Intelligent Systems, Micheal Negnevitsky, Addison Wesley, England, 2011, 3rd Edition.

Reference Books:

1. Handbook of Robotics, Bruno Siciliano, Oussama Khatib, 2016, Springer, 2nd Edition.
2. Neural Networks and Learning Machines: A Comprehensive Foundation, Simon Haykin, Pearson, delhi 2016, 3rd Edition.
3. Fuzzy Logic with Engineering Applications, Timothy J Ross, Chichester, 2011, Sussex Wiley, 4th Edition.



Course Code: ME4931	Simulation of Mechanical Systems	2-1-0	Credits 03
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Pre-requisites: ME2101: Mechanics of Solids, ME2091: Applied Thermal Engineering.

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

CO1	Model Mechanical Systems and Apply Simulation Techniques
CO2	Implement and Evaluate Numerical Methods for Mechanical Systems
CO3	Conduct and Interpret Static and Dynamic Analyses
CO4	Analyze and Simulate Vibrations and Thermal Effects
CO5	Perform Optimization, Sensitivity Analysis, and Multi-Domain Integration

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Mechanical System Simulation: Overview of simulation in mechanical engineering, Types of simulations: static, dynamic, thermal, fluid, Introduction to simulation software (MATLAB, Simulink, ANSYS, etc.)

Fundamentals of Mechanical System Modeling: Basic concepts of mechanical system modelling, System components: masses, springs, dampers, Differential equations and their role in mechanical modelling.

Numerical Methods for Mechanical Systems: Introduction to numerical methods (Euler's method, Runge-Kutta methods), Application of numerical methods to simulate mechanical systems, Error analysis and convergence.

Static and Dynamic Analysis and Simulation: Principles of static equilibrium, Methods for static analysis (Finite Element Method, FEA), Principles of dynamics: kinematics and kinetics Time-domain and frequency-domain analysis, Dynamic simulation using MATLAB/Simulink.

Vibration Analysis: Types of vibrations-free and forced vibrations, Modal analysis and response prediction, Vibration simulation with MATLAB/Simulink

Thermal Analysis of Mechanical Systems: Basics of heat transfer and thermal analysis, Modeling thermal effects in mechanical systems, Hands-on: Thermal simulation using ANSYS or similar software.



Fluid Dynamics in Mechanical Systems: Introduction to fluid dynamics and its relevance to mechanical systems, Basics of Computational Fluid Dynamics (CFD), Simulation using ANSYS Fluent or similar software.

Optimization and Sensitivity Analysis: Techniques for optimizing mechanical designs, Sensitivity analysis and its importance in simulations

Integration of Mechanical System Models: Coupling different types of simulations (e.g., mechanical and thermal), Multi-domain system simulation, Validation and Verification of Simulation Models.

Text Books:

1. Introduction to Mechatronics and Measurements systems, David G. Alciatore and Michael B. Histan.

Reference Books:

1. Mechanical Vibrations: Theory and Application to Structural Dynamics, by Douglas J. Meade.
2. Finite Element Method: A Practical Approach, Steven C. Chapra.
3. Engineering Mechanics: Dynamics, J.L. Meriam and L.G. Kraige.



Course Code: ME3941	Fundamentals of Artificial Intelligence	3-0-0	Credits 03
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Pre-requisites: Nil

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

CO1	Understanding of AI Scope, History, and Future Directions
CO2	Solve Problem and Search Strategies
CO3	Knowledge of Knowledge Representation and Reasoning
CO4	Competence in Reasoning Under Uncertainty
CO5	Understand decision-making processes and algorithms for optimal policies in sequential decision problems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Scope; History, Trends and Future Directions.

Problem Solving by Search: Production Systems and AI;

Graph-Search Strategies: Uninformed Search, Heuristic Search Techniques; Constraint Satisfaction Problems; Stochastic Search Methods;

Searching Game Trees: Minimax, Alpha-Beta Pruning. Knowledge Representation and Reasoning;

Predicate Calculus in AI: Syntax and Semantics, Expressivity, Unification, Resolution; Resolution Refutation Systems; Situation Calculus.

Reasoning under uncertainty: Notion of Uncertainty; Uncertain Knowledge and Reasoning, Probabilities; Bayesian Networks.

Planning: Planning with State Space Search; Planning Graphs; Partial Order Planning.

Decision Making: Sequential Decision Problems, Algorithms for optimal Policies.

Machine Learning: Learning from Observations: Overview of different forms of Learning, Learning Decision Trees, Computational Learning Theory, Statistical Learning Methods, Neural Networks and Connectionist Learning.



Text Books:

1. Artificial Intelligence, Patrick Henry Winston, Addison-Wesley Publishing Company, 2004, 3rd Edition.
2. Principles of Artificial Intelligence, Nils J. Nilsson, Illustrated Reprint Edition, Springer Heidelberg, 2014.

Reference Books:

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig. PHI, 2009, 3rd Edition.
2. Quest for Artificial Intelligence, Nils J. Nilsson, Cambridge University Press, 2010, 1st Edition.