III B.Tech. I Semester

S.No	Course Code	Title	L	T	P	Credits
1	23MET10	Machining Process & Metrology	3	0	0	3
2	23MET11	Thermal Engineering	3	0	0	3
3	23MET12	Dynamics of Machinery	3	0	0	3
4	23CST12	Introduction To Quantum Technologies And Applications	3	0	0	3
5	23MET13a 23MET13b 23MET13c 23MET13d 23MET13e	**Professional Elective-I** 1. Tool Design 2. Automobile Engineering 3. Mechanical Behaviour of Materials 4. Work study and Ergonomics 5. Nano Technology	3	0	0	3
6		**Open Elective-I**	3	0	0	3
7	23MEP07	Thermal Engineering Lab	0	0	3	1.5
8	23MEP08	Dynamics lab	0	0	3	1.5
9	23MEP09	**Skill Enhancement course** Machine Tools & Metrology lab	0	1	2	2
10	23ECP09	**Engineering Science** Tinkering Lab	0	0	2	1
11	23MEP10	**Evaluation of Community Service Internship** Community Service Internship/Project	-	-	-	2
		Total	15	1	10	**26**

Note:

1. A student is permitted to register for Honor's or a Minor in IV semester after the results of III Semester are declared and students may be allowed to take maximum two subjects per semester pertaining to their Minor from V Semester onwards.
2. A student shall not be permitted to take courses as Open Electives/Minor/honor's with content substantially equivalent to the courses pursued in the student's primary major.
3. A student is permitted to select a Minor program only if the institution is already offering a Major degree program in that discipline.

Open Elective – I

S.No.	Course Code	Course Name	Offered by the Dept.
1	23CET12	Green Buildings	CIVIL
2	23CET13	Construction Technology and Management	
3	23EET13	Electrical Safety Practices and Standards	EEE
4	23ECT17	Electronic Circuits	ECE
5	23CST16	Java Programming	CSE & Allied/IT
6	23AIT07	Fundamentals of Artificial Intelligence	
7	23CST30	Quantum Technologies and Applications	
8	23BST19	Mathematics for Machine Learning and AI	Mathematics
9	23BST20	Materials Characterization Techniques	Physics
10	23BST21	Chemistry of Energy Systems	Chemistry
11	23BST22	English for Competitive Examinations	Humanities
12	**23BST23**	**Entrepreneurship and New Venture Creation**	

III B.Tech. II Semester

S.No	Course Code	Title	L	T	P	Credits
1	23MET15	Heat Transfer	3	0	0	3
2	23MET16	CAD/CAM	3	0	0	3
3	23MET17	Design of Machine Members	3	0	0	3
4	23MET18a 23MET18b 23EET19 23MET18c 23MET18d	**Professional Elective-II** 1. Engineering Fracture Mechanics 2. Introduction of Turbo Machinery 3. Control Systems 4. Operations Research 5. Smart Materials	3	0	0	3
5	23MET19a 23MET19b 23MET19c 23MET19d 23MET19e 23MET19f	**Professional Elective-III** 1. Applications of Computational Fluid dynamics 2. Industrial Safety 3. Design of Automobile Transmission Systems 4. Mechanics & Manufacturing of Composite Materials 5. Introduction to hybrid and electric vehicles 6. Modern Manufacturing Methods	3	0	0	3
6		**Open Elective – II**	3	0	0	3
7	23MEP11	Heat Transfer Lab	0	0	3	1.5
8	23MEP12	CAD/CAM Lab	0	0	3	1.5
9	23MEP13	**Skill Enhancement course** 3 D Printing Lab	0	1	2	2
10	23BST28	**Audit Course** Technical paper writing and IPR	2	0	0	-
11	23MET20	**Workshop**	0	0	0	0
Total			**20**	**1**	**08**	**23**
Mandatory Industry Internship of 6-8 weeks duration during summer vacation						

Open Elective – II

S.No.	Course Code	Course Name	Offered by the Dept.
1	23CET19	Disaster Management	CIVIL
2	23CET20	Sustainability In Engineering Practices	
3	23EET18	Renewable Energy Sources	EEE
4	23ECT25	Digital Electronics	ECE
5	23CST12	Operating Systems	CSE& Allied/IT
6	23CST17	Introduction of Machine Learning	
7	23BST24	Optimization Techniques for Engineers	Mathematics
8	23BST29	Mathematical Foundation Of Quantum Technologies	
9	23BST25	Physics Of Electronic Materials And Devices	Physics
10	23BST26	Chemistry Of Polymers And Applications	Chemistry
11	23BST27	Academic Writing and Public Speaking	Humanities

COURSES OFFERED FOR HONOURS DEGREE IN MECHANICAL ENGINEERING

S. No.	Course Code	Title	L	T	P	Credits
1	23MEH01	Automotive Thermal Systems	3	0	0	3
2	23MEH02	Simulation and Modelling of Manufacturing Systems	3	0	0	3
3	23MEH03	Supply Chain Management	3	0	0	3
4	23MEH04	Advanced Mechanism Design	3	0	0	3
5	23MEH05	Bio Mechanics	3	0	0	3
6	23MEH06	Applied Project Work	0	0	6	3
Total			15	0	6	18

LIST OF MINORS OFFERED OTHER THAN MECHANICAL ENGINEERING

S.No.	Minor Title	Department offering the Minor
1	3D Printing	ME
2	Industrial Engineering	

3D PRINTING

S. No.	Course Code	Title	L	T	P	Credits
1	23MEM01	Material Science & Engineering	3	0	0	3
2	23MEM02	Additive Manufacturing	3	0	0	3
3	23MEM03	Material Characterization Techniques	3	0	0	3
4	23MEM04	3D Printing Materials and Applications	3	0	0	3
5	23MEM05	CAD/CAM	3	0	0	3
6	23MEM06	Computer Aided Machine Drawing	0	0	3	1.5
7	23MEM07	3D Printing Lab	0	0	3	1.5
Total			15	0	6	18

INDUSTRIAL ENGINEERING

S. No.	Course Code	Title	L	T	P	Credits
1	23MEM08	Production Planning & Control	3	0	0	3
2	23MEM09	Marketing Management	3	0	0	3
3	23MEM10	Supply Chain Management	3	0	0	3
4	23MEM11	Strategic Management for Competitive Advantage	3	0	0	3
5	23MEM12	Six Sigma & Lean Manufacturing	3	0	0	3
6	23MEM13	Applied Project Work	0	0	6	3
Total			15	0	6	18

III Year B.Tech. ME – I Semester

Course Code	Machining Process & Metrology	L	T	P	C
23MET10		3	0	3	3

Course objectives: The objectives of the course are to	
1	Gain knowledge on working principle of different metal cutting processes and familiarize with cutting forces, machining calculations and cutting fluids.
2	Make the student learn about principles of lathe and Drilling machines.
3	Make the student learn about principles of Grinding and Milling machines.
4	Explain the system of limits, fits & tolerances and design of gauges
5	Know the measurement of screw thread and Describe the Measurement of Displacement, Force.

Course Outcomes: On successful completion of the course, the student will be able to,		
CO1	Illustrate advanced machining processes, cutting tools and cutting fluids for a specific material and part features	**L1, L2**
CO2	Operation of various machines like lathe, drilling, grinding, slotting, shaping, milling etc	**L2**
CO3	Practical exposure on flat surface machining, milling and grinding operations.	**L1, L2**
CO4	List various measuring instruments used in metrology.	**L3**
CO5	Measure Screw Thread, Displacement and Force	**L2, L4**

UNIT I

Elementary treatment of metal cutting theory – Elements of cutting process – Geometry of single point tool and angles, chip formation and types of chips – built up edge and its effects, chip breakers. Mechanics of orthogonal cutting –Merchant's Force diagram, cutting forces – cutting speeds, feed, depth of cut, heat generation, tool life, coolants, machinability –economics of machining. cutting Tool materials and cutting fluids –types and characteristics.

UNIT II

Engine lathe – Principle of working- specification of lathe – types of lathes – work holders and tool holders –Taper turning, thread cutting operations and attachments for Lathes.

Drilling, Boring Machines, Shaping, Slotting and planning machines - Principles of working, specifications, types, Tools and tool holding devices – operations performed, machining time calculation.

UNIT III

Milling machine – Principles of working – specifications – classifications of milling machines – methods of indexing, milling cutters - machining operation, Accessories to milling machines.

Grinding machine –Theory of grinding – classification– cylindrical and surface grinding machine – Tool and cutter grinding machine – Grinding wheel specification - types of abrasives – bonds, Truing and Dressing of wheels.

Lapping, Honing and Broaching machines – comparison of grinding, lapping and honing. Principles of design of Jigs and fixtures and uses, Classification of Jigs & Fixtures – Principles of location and clamping –types.

UNIT IV

Concept of Measurement: Concept of feedback Control systems -generalized measurement system, units and standards, measuring instruments, sensitivity, readability, range of accuracy, precision, terminology and limits fits and tolerances, hole basis and shaft basis system, interchangeability.

Linear and Angular Measurement: Linear measuring instruments: Vernier instruments, micrometers, slip gauges, tool maker's microscope, Angular measurements: Sine bar, bevel protract.

Roughness measurement: - Methods of measurement of surface finish-profilograph, talysurf.

UNIT V

Screw Thread and Gear Measurement: errors in screw threads, various methods for measuring external and internal screw threads.

Coordinate Measuring Machine (CMM)-Construction and features.

Measurement of Displacement: Theory and construction of various transducers to measure displacement Piezo-electric, capacitance, transducers.

Measurement of Force: Direct method -load cells and proving rings.

Text Books:

1. Manufacturing Technology-Kalpakzian- Pearson Seventh edition. (2018)
2. R.K.Jain, Engineering Metrology,20/e,KhannaPublishers,2013.

Reference Books:

1. Production Technology by R.K. Jain and S.C. Gupta, Khanna Publishers, 17thedition.
2. Workshop Technology – Vol II, B.S.Raghu Vamshi, Dhanpat Rai & Co, 10th edition, 2013
3. Mahajan, Engineering Metrology,2/e,DhanpatRai,2013.
4. S.Bhaskar, Basic Principles-Measurments and Control Systems, Anuradha Publications, 2014.
5. D.S.Kumar, Mechanical Measurements & Control, Metropolitan Publishers, 5/e,2015.

Online Learning Resources:

- https://nptel.ac.in/courses/112/107/112107078/
- https://youtu.be/t3y_Ys3LgGM
- https://www.youtube.com/watch?v=E4VZ_rFqpG4&t=1s
- https://youtu.be/-tcaR7oSx_w
- https://youtu.be/Uybg6VDLoRQ
- https://youtu.be/Uybg6VDLoRQ
- https://youtu.be/aWQsEX1TrSI

III Year B.Tech. ME – I Semester

Course Code	THERMAL ENGINEERING	L	T	P	C
23MET11		3	0	3	3

	Course objectives: The objectives of the course are to
1	Impart the knowledge on I C Engine
2	Demonstrate fuel systems, Cooling modes and types of ignitions systems.
3	Explain the fuel and combustion systems variables and its effects.
4	Study of engine Performance and its characteristics
5	Instruct the awareness on Air compressors and exercise the problems on compressors

Course Outcomes: On successful completion of the course, the student will be able to,		
CO1	understand working of different I.C Engines and recognize basic elements and subsystems of an I.C. Engine	**L1, L2, L3**
CO2	Investigate S.I Engine fuel air requirements, evaluate fuel supply systems in an S.I Engine, create necessary cooling modes and differentiate different ignition systems.	**L2, L3, L5, L6**
CO3	Analyze the Flame Speed and Effect of Engine Variables and evaluate the abnormal combustion effects and its causes.	**L3, L5, L6**
CO4	Applying of different input parameters to analyze and create the best performance in S.I and C.I Engines and resolve the influence of normal and abnormal combustions.	**L3, L4, L5. L6**
CO5	Familiarized the working principle of various types of air compressors and solve problems related to reciprocating air compressor.	**L1, L2, L3**

UNIT-I

I.C. ENGINES : Definition of Engine and Heat Engine, I.C Engine Classification – Parts of I.C. Engines, Working of I.C. Engines, Two Stroke & Four Stroke I.C. Engines SI & CI Engines, Valve and Port Timing Diagrams.

UNIT-II

Fuel System: S.I. Engine: Fuel Supply Systems, carburetor types Air Filters, Mechanical and Electrical Fuel Pump – Filters– Gasoline Injection Systems.

Cooling & Lubrication Systems: Cooling Requirements, Air Cooling, Liquid Cooling, Thermo Siphon, Water And Forced Circulation System, Lubrication Systems-Flash, Pressurized and Mist Lubrication.

Ignition System: Function of an Ignition System, Battery coil Ignition System, Magneto Coil Ignition System, Electronic Ignition System using Contact Breaker, Electronic Ignition using Contact Triggers – Spark Advance and Retard Mechanism.

UNIT-III

Fuels and Combustion:

S I engine : Normal Combustion and Abnormal Combustion – Importance of Flame Speed and Effect of Engine Variables – Type of Abnormal Combustion, Pre-Ignition and Knocking (Explanation) – Fuel Requirements and Fuel Rating, Anti Knock Additives, Combustion Chambers.

Engines: Stages Of Combustion – Delay Period And Its Importance – Effect Of Engine

Variables – Diesel Knock– Combustion Chambers (DI And IDI), Fuel Requirements and Fuel Rating.

UNIT – IV

Testing and Performance : Parameters of Performance - Measurement of Cylinder Pressure, Fuel Consumption, Air Intake, Exhaust Gas Composition, Brake Power – Determination of Frictional Losses And Indicated Power – Performance Test – Heat Balance Sheet and Chart.

UNIT-V

Air Compressors: Reciprocating Compressors, Effect of Clearance volume in Compressors, Volumetric Efficiency, Single Stage and Multi Stage Compressors, Effect of Inter cooling and Pressure Drop in Multi - Stage Compressors, Problems Related to Reciprocating Compressors, Working principles of Roots blower, Vane type Blower, Centrifugal Compressor - Axial Flow Compressors.

TEXT BOOKS:

1. I.C. Engines / V. Ganesan- TMH fourth edition (2017)
2. Thermal Engineering / Rajput / Lakshmi Publications 11th edition (2020)
3. Internal Combustion Engine Fundamentals John B. Heywood TMH (2017)

REFERENCES:

1. IC Engines – Mathur& Sharma – DhanpathRai& Sons (2017)
2. Engineering fundamentals of IC Engines – Pulkrabek, Pearson, PHI 2nd edition (2015)
3. Thermal Engineering, Rudramoorthy – TMH First edition (2017)
4. Thermodynamics & Heat Engines, B. Yadav, Central Book Depot., Allahabad (2002)
5. Thermal Engineering / Rajput / Lakshmi Publications 11th edition (2020)

Online Learning Resources:

https://nptel.ac.in/courses/112103316

https://youtube.com/playlist?list=PLwdnzlV3ogoWV-_n1YItO933MxgPXfEiM&si=QcuZlil5MRldeTiD

https://youtu.be/FDmYCI_xYlA?si=vS1kdhqc5WCRnl21

https://youtube.com/playlist?list=PLfq4fiRrJSn5leKEZoUF-2vBkMG37iGs8&si=nZVdvgmACy-lVvSC

III Year B.Tech. ME – I Semester

Course Code	DYNAMICS OF MACHINERY	L	T	P	C
23MET12		3	0	0	3

	Course objectives: The objectives of the course are to
1	Analysis of forces acting in mechanisms
2	Effects of unbalance forces
3	Modelling and analyzing the vibration behaviour of spring mass damper system.
4	The principles in mechanisms used for governing of machines

Course Outcomes: On successful completion of the course, the student will be able to,		
CO1	Understand the gyroscopic effect on vehicles and study of friction in various machine elements.	L2, L3,L6
CO2	Examine dynamic concepts of the clutches, Brakes and dynamometer.	L2, L3,L4
CO3	Understand concepts of inertia forces and turning moment diagrams of IC engines.	L4,L5,L6
CO4	Understand the force analysis and effects of balancing in rotors and engines.	L2, L1,L5
CO5	Gain the basic knowledge on the dynamics of various governors	L6, L5,L1

UNIT I GYROSCOPIC EFFECTS AND FRICTION

Gyroscopes: Angular motion – Gyroscopic couple – Effect of gyroscopic couple an aero plane – Effect of gyroscopic couple on a naval ship – Stability of moving four wheel and two-wheel drive.
Friction: Laws of friction – Friction of screw, nuts, screw jack – Friction of journal bearing – Friction of journal pivot and collar bearing – Film friction.

UNIT – II CLUTCHES, BRAKES AND DYNAMOMETER

Clutches: Friction clutches – Single disc or plate clutch, multiple disc clutch, cone clutch and centrifugal clutch. **Brakes:** Materials for brake lining – Single, double and pivoted block – Simple and differential band brake – Internal expanding brake – Braking of a vehicle**. Dynamometers:** Prony brake and rope brake absorption dynamometers.

UNIT – III INERTIA FORCES AND TURNING MOMENT DIAGRAMS

Inertia Forces: D-Alembert's principle – Velocity, acceleration and forces of the reciprocating parts in engines – Velocity and acceleration of the piston and connecting rod – Equivalent dynamical system. **Turning Moment Diagrams:** Turning moment diagrams for steam engine, I.C. Engine and multi cylinder engine – Fluctuation of Energy – Crank effort – Coefficient of fluctuation of energy – Fly wheels – Coefficient of fluctuation of speed – Energy stored in fly wheel – Fly wheel design – Flywheel in punching press**.**

UNIT – IV BALANCING OF ROTATING AND RECIPROCATING MASSES

Rotating Masses: Balancing of single and two masses in same and different planes – Balancing of different masses in same and different planes.

Reciprocating Masses: Primary, secondary and higher balancing of reciprocating masses – Unbalanced forces and couples – Balancing of coupled locomotives – Variation of tractive force, hammer blow and swaying couple – Analytical and graphical methods.

UNIT – V GOVERNORS& MECHANICAL VIBRATIONS

Governors: Types - Watt, Porter and Proell governors – Hartnell, Hartung, Wilson-Hartnell and Pickering governors with auxiliary springs – Sensitiveness, stability, isochronous and hunting of governors – Effort and power of governor – Controlling force – Coefficient of insensitiveness.

Free Vibration: Vibratory systems – Degrees of freedom – Single degree of freedom – Free vibration – Equations of motion – Natural frequency – Types of damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts - Torsional vibration – Two and three rotor torsional systems..

Forced Vibration: Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

Textbooks:

1. S.S. Rattan, Theory of Machines, MGH Publishers,3/e,2013.
2. R.L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill, 2017.

Reference Books:

1. Thomas Bevan, Theory of machines, Pearson, 3/e,2012.
2. J.E. Shigley, The theory of machines and mechanisms, McGraw hill, 2/e, 1995.
3. R.S.Khurmi, J.K.Guptha, Theory of machines S.Chandpublications, 2005.

Online Learning Resources:

- https://nptel.ac.in/courses/112104114
- https://nptel.ac.in/courses/112101096
- https://archive.org/details/NPTEL-MechEngr-Dynamics_of_Machines
- https://www.youtube.com/watch?v=OlZXxPVpmBs
- https://www.digimat.in/nptel/courses/video/112104114/L01.html

23CST12	INTRODUCTION TO QUANTUM TECHNOLOGIES AND APPLICATIONS (Qualitative Treatment)	L	T	P	C
		3	0	0	3

Course Objectives (COBJ):

- Introduce fundamental quantum concepts like superposition and entanglement.
- Understand theoretical structure of qubits and quantum information.
- Explore conceptual challenges in building quantum computers.
- Explain principles of quantum communication and computing.
- Examine real-world applications and the future of quantum technologies.

Course Outcomes (CO):

- Explain core quantum principles in a non-mathematical manner.
- Compare classical and quantum information systems.
- Identify theoretical issues in building quantum computers.
- Discuss quantum communication and computing concepts.
- Recognize applications, industry trends, and career paths in quantum technology.

Unit 1: Introduction to Quantum Theory and Technologies

The transition from classical to quantum physics, Fundamental principles explained conceptually: Superposition, Entanglement, Uncertainty Principle, Wave-particle duality, Classical vs Quantum mechanics – theoretical comparison,Quantum states and measurement: nature of observation,Overview of quantum systems: electrons, photons, atoms,The concept of quantization: discrete energy levels,Why quantum? Strategic, scientific, and technological significance,A snapshot of quantum technologies: Computing, Communication, and Sensing,National and global quantum missions: India's Quantum Mission, EU, USA, China

Unit 2: Theoretical Structure of Quantum Information Systems

What is a qubit? Conceptual understanding using spin and polarization, Comparison: classical bits vs quantum bits, Quantum systems: trapped ions, superconducting circuits, photons (non-engineering view),Quantum coherence and decoherence – intuitive explanation, Theoretical concepts: Hilbert spaces, quantum states, operators – only interpreted in abstract,The role of entanglement and non-locality in systems, Quantum information vs classical information: principles and differences,Philosophical implications: randomness, determinism, and observer role

Unit 3: Building a Quantum Computer – Theoretical Challenges and Requirements

What is required to build a quantum computer (conceptual overview)?,Fragility of quantum systems: decoherence, noise, and control, Conditions for a functional quantum system: Isolation, Error management, Scalability, Stability, Theoretical barriers: Why maintaining entanglement is difficult,Error correction as a theoretical necessity, Quantum hardware platforms (brief conceptual comparison),Superconducting circuits, Trapped ions, Photonics, Visionvs reality: what's working and what remains elusive,The role of quantum software in managing theoretical complexities

Unit 4: Quantum Communication and Computing – Theoretical Perspective

Quantum vs Classical Information, Basics of Quantum Communication, Quantum Key Distribution (QKD),Role of Entanglement in Communication,The Idea of the Quantum Internet – Secure Global Networking,Introduction to Quantum Computing,Quantum Parallelism (Many States at Once),Classical vs Quantum Gates, Challenges: Decoherence and Error Correction,Real-World Importance and Future Potential

Unit 5: Applications, Use Cases, and the Quantum Future

Real-world application domains: Healthcare (drug discovery),Material science, Logistics and optimization, Quantum sensing and precision timing, Industrial case studies: IBM, Google, Microsoft, PsiQuantum,Ethical, societal, and policy considerations, Challenges to adoption: cost, skills, standardization,Emerging careers in quantum: roles, skillsets, and preparation pathways,Educational and research landscape – India's opportunity in the global quantum race

Textbooks:

1. Michael A. Nielsen, Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 10th Anniversary Edition, 2010.
2. Eleanor Rieffel and Wolfgang Polak, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.

3. Chris Bernhardt, *Quantum Computing for Everyone*, MIT Press, 2019.

Reference Books:

1. David McMahon, *Quantum Computing Explained*, Wiley, 2008.
2. Phillip Kaye, Raymond Laflamme, Michele Mosca, *An Introduction to Quantum Computing*, Oxford University Press, 2007.
3. Scott Aaronson, *Quantum Computing Since Democritus*, Cambridge University Press, 2013.
4. **Alastair I.M. Rae**, *Quantum Physics: A Beginner's Guide*, Oneworld Publications, Revised Edition, 2005.
5. **Eleanor G. Rieffel, Wolfgang H. Polak**, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.
6. **Leonard Susskind, Art Friedman**, *Quantum Mechanics: The Theoretical Minimum*, Basic Books, 2014.
7. **Bruce Rosenblum, Fred Kuttner**, *Quantum Enigma: Physics Encounters Consciousness*, Oxford University Press, 2nd Edition, 2011.
8. **GiulianoBenenti, GiulioCasati, GiulianoStrini**, *Principles of Quantum Computation and Information, Volume I: Basic Concepts*, World Scientific Publishing, 2004.
9. **K.B. Whaley et al.**, *Quantum Technologies and Industrial Applications: European Roadmap and Strategy Document*, Quantum Flagship, European Commission, 2020.
10. **Department of Science & Technology (DST), Government of India**, *National Mission on Quantum Technologies & Applications – Official Reports and Whitepapers*, MeitY/DST Publications, 2020 onward.

Online Learning Resources:

- IBM Quantum Experience and Qiskit Tutorials
- Coursera – Quantum Mechanics and Quantum Computation by UC Berkeley
- edX – The Quantum Internet and Quantum Computers
- YouTube – Quantum Computing for the Determined by Michael Nielsen
- Qiskit Textbook – IBM Quantum

III Year B.Tech. ME – I Semester

Course Code	TOOL DESIGN (Professional Elective-I)	L	T	P	C
23MET13a		3	0	0	3

Course objectives: The objectives of the course are to	
1	Understand the fundamentals of tool engineering and the role of tool design in manufacturing.
2	Analyze the principles of metal cutting and apply them to cutting tool design.
3	Design various jigs and fixtures using proper locating and clamping principles.
4	Evaluate and design different types of press tool dies for sheet metal operations.
5	Develop tooling and fixture strategies suitable for CNC machining systems.

Course Outcomes: On successful completion of the course, the student will be able to,		
1	Understand tool design fundamentals, select appropriate materials, and design effective tools to develop durable, precise tools for various manufacturing applications.	L2, L3,L6
2	Define Oblique and orthogonal cutting **,** Apply the mechanics of metal cutting to design basic cutting tools like single-point, milling, and broaching tools.	L1,L3,L6
3	Demonstrate basic principles of drill jigs and various fixtures and design the jigs and fixtures by applying principles of location and clamping.	L2,L3,L6
4	Calculate clearance, cutting forces, and develop designs for press tool dies (blanking, piercing, bending, and drawing).	L2,L4,L6
5	Evaluate and Develop tool holding, fixture systems, and automation features like ATC for CNC machine tools.	L1,L5,L6

UNIT I

INTRODUCTION TO TOOL DESIGN

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials- Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment.

UNIT II

DESIGN OF CUTTING TOOLS

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters.

UNIT III

DESIGN OF JIGS AND FIXTURES

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gauges – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Types of Fixtures – Vice Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures.

UNIT IV

DESIGN OF PRESS TOOL DIES

Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Centre of pressure -Strip layout – Short-run tooling for Piercing – Bending dies – Drawing dies-Design and drafting.

UNIT V

TOOL DESIGN FOR CNC MACHINE TOOLS

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools-Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

Textbooks:

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, ―Tool Design‖, Tata McGraw Hill Publishing Company Ltd., 2000.
2. E.G.Hoffman,‖ Jig and Fixture Design‖, Thomson Asia Pvt Ltd, Singapore, 2004.

Reference Books:

1. P.C.Sharma, A Text book of Production Engineering, S.Chand Publications, 1999.
2. Prakash Hiralal Joshi, ―Tooling data‖, Wheeler Publishing, 2000
3. Venkataraman K., ―Design of Jigs, Fixtures and Presstools‖, TMH, 2005.
4. Haslehurst M., ―Manufacturing Technology‖, The ELBS, 1978.

Online Learning Resources:

- https://www.iare.ac.in/sites/default/files/lecture_notes/TOOL%20DESIGN_Lecture_Notes.pdf
- https://www.cet.edu.in/noticefiles/261_MMP%20Lecture%20Notes-ilovepdf-compressed.pdf
- https://www.vssut.ac.in/lecture-notes.php?url=production-engineering
- https://nptel.ac.in/courses/112/105/112105233/
- https://www.youtube.com/watch?v=7MkX-sW97rI
- https://nptel.ac.in/courses/112/105/112105126/#

III Year B.Tech. ME – I Semester

Course Code	AUTOMOBILE ENGINEERING (Professional Elective-I)	L	T	P	C
23MET13b		3	0	0	3

Course objectives: The objectives of the course are to	
1	Impart the knowledge on I C Engine, Automobile chasis and Body
2	Demonstrate fuel systems and types of ignitions systems.
3	Explain the Principles of Steering system and Suspension system.
4	Gain knowledge wheels, Tyres and Braking system.
5	Make the students with the awareness on Automobile electrical system.

COURSE OUTCOMES On successful completion of this course the student will be able to		
CO1	Find the different parts and develop the automobile systems to analyze engine components	L1, L3,L4
CO2	Identify the working of various parts in ignition system to apply the different vehicles and design the ignition and fuel injection systems.	L3, L4,L6
CO3	Demonstrate how the steering and the suspension systems works, types of steering and suspension systems and its applications.	L2,L3,L5
CO4	Recognize the different types of wheels and breaking systems. Choose the suitable tyres and brakes for different applications.	L2, L3,L4
CO5	Utilize different electrical systems in automobiles. Apply advanced electrical circuits.create advanced Global Positioning System (GPS), Hybrid vehicle, Fuel Cell.	L1, L3,L6

UNIT I

Introduction to vehicle structure and engine components

Vehicle construction - Chassis and body - Specifications - Engine - Types - Construction - Location of engine - Cylinder arrangement - Construction details - Cylinder block - Cylinder head - Cylinder liners - Piston – piston rings - Piston pin - Connecting rod - Crankshaft - Valves. Lubrication system - Types - Oil pumps - Filters. Crankcase ventilation.

UNIT II

Ignition and fuel supply systems

Ignition system - Coil and Magneto - Spark plug - Distributor – Electronic ignition system - Fuel system - Carburetor - Fuel pumps - Fuel injection systems - Mono point and Multi point – Unit Injector – Nozzle types - Electronic Fuel Injection system (EFI) – GDI, MPFI, DTSI.

UNIT – III

Steering and suspension system

Principle of steering - Steering Geometry and wheel alignment - Steering linkages – Steering gearboxes - Power steering - front axle - Suspension system - Independent and Solid axle – coil, leaf spring and air suspensions - torsion bar - shock absorbers.

UNIT – IV

Wheels, Tyres and Braking System

Wheels and Tyres - Construction - Type and specification - Tyre wear and causes - Brakes - Needs – Classification –Drum and Disc Mechanical - Hydraulic and pneumatic - Vacuum assist – Retarders – Anti-lock Braking System(ABS).

UNIT – V

Automobile electrical systems and advances in automobile engineering

Battery-General electrical circuits- Active Suspension System (ASS) - Electronic Brake Distribution (EBD) – Electronic Stability Program(ESP), Traction Control System (TCS) - Global Positioning System (GPS), Hybrid vehicle, Fuel Cell.

Textbooks:

1. Kirpal Singh, Automobile Engineering, Vol.1&2, Standard Publications, 13/e, 2020.
2. William.H.Crouse, Automotive Mechanics, 10/e , McGraw-Hill, 2006.
3. David A. Corolla, Automotive Engineering: Powertrain, Chassis System and Vehicle Body, Butterworth-Heinemann Publishing Ltd, 2009.

Reference Books:

1. Bosch, Automotive Hand Book, 6/e, SAE Publications, 2007.
2. K. Newton and W. Steeds, The motor vehicle, 13/e, Butterworth-Heinemann Publishing Ltd, 1989.
3. Joseph Heitner, Automotive Mechanics Principles and Practices, 2/e, CBS publishing 2004.
4. Richard Stone, Jeffrey K. Ball, Automotive Engineering Fundamentals" SAE International, 2004.

Online Learning Resources:

- https://nptel.ac.in/courses/107106088
- https://nptel.ac.in/courses/107106080
- https://hindustanuniv.ac.in/assets/pdf/ug/CBCS/cbcs-automobile-2018.pdf
- https://ed.iitm.ac.in/~shankarram/Course_Files/ED5160/ED5160.htm
- https://dbatu.ac.in/wp-content/uploads/2020/07/B-Tech-Automobile_Final-Yr_22.06.2020-pdf
- https://www.youtube.com/channel/UCGLlbmSTaLNUPhDwsMe-SgQ

III Year B.Tech. ME – I Semester

Course Code	MECHANICAL BEHAVIOUR OF MATERIALS	L	T	P	C
23MET13c	(Professional Elective-I)	3	0	0	3

Course objectives: The objectives of the course are to	
1	Explain the structure of material over the effects of mechanical properties.
2	Familiarize the defects inside the structure and their effects on the mechanical properties.
3	Train the methods for characterization of the mechanical behavior of materials.
4	Impart knowledge about strengthening mechanisms of materials.
5	Teach mechanisms of failures of materials (fracture, fatigue and creep) and their relationship with the different types of stress.

COURSE OUTCOMES On successful completion of this course the student will be able		
CO1	Dictate the elastic behaviour of engineering materials, recall Hooke‘s law and apply the dislocation theory, forces on and between dislocations.	**L1, L2,L3**
CO2	Apply dispersion strengthening and fibre strengthening mechanisms, differentiate strain aging and dynamic strain aging and create grain size strengthening and solid solution strengthening	**L3, L4,L6**
CO3	List various modes of fracture and clarify the basic mechanism of ductile and brittle fracture, Identify importance of Griffith‘s theory. Calculate factors effecting on DBTT.	**L1,L2,L3, L6**
CO4	Explain fatigue behaviour and testing. Discuss the factors affecting fatigue. Apply fracture mechanics in design.	**L2, L3,L6**
CO5	Identify and describe various structural changes during creep. Evaluate and predict the metallurgical factors affecting creep and creep different testing.	**L2, L4,L5, L6**

UNIT – I

Elastic and plastic behavior: Elastic behavior of materials – Hooke‘s law, plastic behavior: dislocation theory – Burger‘s vectors and dislocation loops, dislocations in FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, slip and twinning.

UNIT – II

Strengthening mechanisms: Cold Working, Grain Size Strengthening, Solid Solution Strengthening, Martensitic Strengthening, Precipitation Strengthening, Dispersion Strengthening, Fibre Strengthening, Examples. Yield Point Phenomenon, Strain aging and Dynamic strain aging.

UNIT – III

Fracture and fracture mechanics: Types of Fracture, Basic Mechanism of Ductile and Brittle Fracture, Griffith's Theory of Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Factors Affecting DBTT, Determination of DBTT. Fracture Mechanics-Introduction, Modes of Fracture, Stress Intensity Factor, Strain Energy Release Rate, Fracture Toughness and Determination of K_{IC}.

UNIT - IV

Fatigue behaviour and testing: Stress Cycles, S-N Curves, Effect of Mean Stress, Factors Affecting Fatigue, Structural Changes Accompanying Fatigue, Cumulative Damage, HCF / LCF, Thermo-mechanical Fatigue, Application of Fracture Mechanics to Fatigue Crack Propagation-Paris law- Fatigue Testing Machines.

UNIT - V

Creep behavior and testing: Creep Curve, Stages in Creep Curve and Explanation, Structural Changes during Creep, Creep Mechanisms, Metallurgical Factors Affecting Creep, High Temperature Alloys, Stress Rupture Testing, Creep Testing Machines.

Text books:

1. Dieter, G.E., —Mechanical Metallurgy‖, McGraw-Hill, SI Edition, 1995.
2. Davis. H. E., Troxell G.E., Hauck.G. E. W., —The Testing Of Engineering Materials‖, McGraw-Hill, 1982.

References:

1. Wulff, The Structure and Properties of Materials, Vol. III —Mechanical Behavior of Materials‖, John Wiley and Sons, 1983.
2. Honey Combe R. W. K., —Plastic Deformation of Materials‖, Edward Arnold Publishers, 1984.
3. Suryanarayana, A. V. K., —Testing of Metallic Materials‖, Prentice Hall India, 1979.

Online Learning Resources:

https://nptel.ac.in/courses/113104105

https://nptel.ac.in/courses/113104104

https://youtube.com/playlist?list=PLyqSpQzTE6M9QPU_tubmtQ97e7zRpaMlD&si=H5qNNyv3nYL8jztY

https://youtube.com/playlist?list=PLxQw8LdroTlPNimLKW-MWldJQHVLBESGs&si=ULCr6KGQwMPXhNC2

https://youtube.com/playlist?list=PL-g1KbXtGBBvF3G4lQuY0zSGBFHh4-5kF&si=47R1eQ_zAWcO-9A_

III Year B.Tech. ME – I Semester

Course Code	WORK STUDY AND ERGONOMICS (Professional Elective-I)	L	T	P	C
23MET13d		3	0	0	3

Course objectives: The objectives of the course are	
1	To develop concepts related to principles of productivity & work study as a tool for increasing the efficiency and effectiveness in organizational systems.
2	To study the existing method, compare and propose a new method.
3	To provide the usage of the various tools and techniques used in work measurement.
4	To develop basic ideas of ergonomics and its design.
5	To develop concepts related Man-Machine Interfaces and Design of Displays and controls.

COURSE OUTCOMES: Upon completion of this course, students should be able to:		
1	Recollect the basic concepts of productivity, work content and work study and define the objective and scope of Work Study.	L1, L2
2	Define the various charts and to construct the charts on the basis of present method and develop a new / proposed method and identify the unnecessary movements.	L1, L3 L4
3	Explain the basic work measurement techniques and to gain knowledge o measurement of work, rating and imbibe the concept of allowance in estimating Standard Time	L1, L2
4	Determine the basic concepts of Ergonomics and demonstrate a sound knowledge of Ergonomics in engineering applications.	L2, L3
5	Demonstrate a sound knowledge of Man-Machine Interfaces and design of displays and controls in engineering systems	L3, L4

UNIT – I

Productivity and Work Study: Definition of productivity, task of management, productivity of materials, land, building, machine and power, factors affecting the productivity, work content, basic work content, excess work content, how manufacturing job is made up, work content due to excess product and process, ineffective time due to short comings on part of the management. Definition, Objective and scope of Work Study: Work study and management, work study and work.

UNIT – II

Method Study: Definition, objective and scope of method study, activity recording and tools, Recording tools: Out Line Process Chart, Flow Process Chart, Flow diagram, String Diagram, Travel Chart, Multiple Activity Chart, Two- Handed process chart. Principles of Motion Economy: Introduction, Classification of movements. Two- hand process chart, Micromotion study, Therbligs, SIMO Chart. Special Charts: Cyclegraph and Chronocycle graph - development, definition and installation of the improved method. Work Measurement: Definition, objectives, work measurement techniques.

Work sampling – Need, confidence levels, and sample size determination, conducting study with problems

UNIT – III

Time study - Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating: Systems of rating, standard rating, standard performance, scales of rating. Allowances: Standard time determination, predetermined motion time study (PMTS), factors affecting rate of working, problems on allowances.

UNIT – IV

Introduction to Ergonomics: Human factors and ergonomics, psychology, engineering, bio mechanics, industrial design, graphics design, statistics, operation research and anthropometry Morphology of design and its relationship with cognitive abilities of human being. Physical Ergonomics : human anatomy, and some of the anthropometric, physiological and bio mechanical characteristics as they relate to physical activity. Cognitive: mental processes, such as perception, memory, reasoning, and motor response, mental workload, and decision-making. Organizational ergonomics: optimization of socio-technical systems, including their organizational structures, policies, processes. Communication, work design, design of working times, teamwork, cooperative work, and new work programs. Environmental ergonomics: human interaction with the environment- characterized by climate, temperature, pressure, vibration, light.

UNIT – V

Man-Machine Interaction; Man-Machine interaction cycle, Man-machine interfaces, Displays factors that control choice of display, visual displays- qualitative displays; moving pointer displays, moving scale displays, digital displays Indicators, auditory displays, tactile displays. Factors affecting effectiveness of displays. Quantitative displays, check- reading displays, representational displays. Types of controls and their integration with displays. Design guidelines for displays and controls: viewing distance, Illumination, angle of view, reach etc., general design checklist for displays and controls. Standards for ergonomics in engineering and design, displays and controls.

TEXT BOOKS

1. Introduction to Work Study – ILO, 4th edition 1992

2. Mark. S. Sanders and Ernest. J McCornick. ―Human Factor in Engineering and Design‖, McGraw-Hill Book Co., Inc., New York, 1993

REFERENCE BOOKS

1. S. Dalela and Sourabh, ―Work Study and Ergonomics‖. Standard publishers 2013

2. Wesley Woodson, Peggy Tillman and Barry Tillman, ―Human Factors Design Handbook‖, McGraw-Hill; 2ndedition, 1992

3. Ralph M. Barnes, ―Motion and Time Study‖, Wiley International, 7th Edition.

4. Mark S. Sanders and Ernest J. McCormick , ―Human Factors in Engineering Design‖ 4th edition, 2013.

5. B. Niebel and Freivalds, Niebel‘s Methods Standards and Work Design, McGraw-Hill, 12th Edition, 2009,

Online Learning Resources:

https://youtu.be/b05FPBjFH6A?si=dWB1YOLOmSMRBSX7

https://youtube.com/playlist?list=PLLy_2iUCG87BbIF6sF5sy_ZZLFoUcnncb&si=n1NAnFTtiocc9vtK

https://youtube.com/playlist?list=PLuF8VVHesRxXBZzQpQSzvJI7eM_SduxwR&si=j2vyTNYybgvXrDiy

III Year B.Tech. ME – I Semester

Course Code	NANO TECHNOLOGY (Professional Elective-I)	L	T	P	C
23MET13e		3	0	0	3

COURSE OBJECTIVES

Course objectives: The objectives of the course are to	
1	Understand the fundamentals of nano science and nanotechnology, including the history, classification and analyze the structural aspects of nanomaterials.
2	Knowledge of the synthesis and fabrication techniques used in nano science, and methods for realizing semiconductor nanostructures.
3	Advanced characterization techniques used for analysing the structural, morphological, and electronic properties of nanomaterials.
4	Explore carbon nanomaterials properties and wide-ranging applications.
5	Familiarize with the diverse applications of nanotechnology, with emphasis on nanostructured thin films and quantum dots.

COURSE OUTCOMES On successful completion of this course the student will be able to		
CO1	Define and classify nanomaterials. Explain the historical development and scope of Nano science, and nanotechnology. Analyze the band structure and electronic behavior of nanomaterials.	L1, L2,L4
CO2	Explain the synthesis processes for bulk polycrystalline and single crystal materials. Differentiate between bottom-up and top-down fabrication approaches. Identify and select the requirements for semiconductor nanostructure fabrication and techniques	L2,L3,L5
CO3	Understand and explain the principles and applications of X-ray diffraction (XRD). Analyze optical properties of nanomaterials. Evaluate appropriate characterization technique.	L2,L3, L4,L5
CO4	Discuss and Characterize various carbon nanomaterials and its applications to analyze the types, synthesis methods, and Evaluate the impact of carbon nanomaterials in emerging technologies.	L2, L3, L4, L5
CO5	Identify and describe major applications, evaluate the impact in energy production, conversion, and environmental sustainability and analyze their applications and eexplore interdisciplinary applications of nano materials.	L1, L2,L3, L4

UNIT-I

INTRODUCTION: History of nano science, definition of nano meter, nano materials, nano technology. Classification of nano materials. Crystal symmetries, crystal directions, crystal planes. Band structure.

PROPERTIES OF MATERIALS:

Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto electronic properties. Effect of size reduction on properties, electronic structure of nano materials.

UNIT-II

SYNTHESIS AND FABRICATION: Synthesis of bulk polycrystalline samples, growth of single crystals. Synthesis techniques for preparation of nano particle – Bottom Up Approach – sol gel synthesis, hydro thermal growth, thin film growth, PVD and CVD; Top Down Approach – Ball milling, micro fabrication, lithography. Requirements for realizing semiconductor nano structures, growth techniques for nano structures.

UNIT-III

CHARECTERIZATION TECHNIQUES: X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, atomic force microscopy, piezoresponse microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy.

UNIT-IV

CARBON NANO TECHNOLOGY:

Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology. Applications of nano crystalling diamond films, grapheme, applications of carbon nano tubes.

UNIT-V

APPLICATIONS OF NANO TECHNOLOGY:

Applications in material science, biology and medicine, surface science, energy and environment. Applications of nano structured thin fins, applications of quantum dots.

TEXT BOOK:

Nano science and nano technology / M.S Ramachandra Rao, Shubra Singh/Wiley publishers.

Introduction to Nanotechnology by Risal Singh, Shipra Mital Gupta, Oxford Higher Education, First Publication 2016.

REFERENCE BOOKS:

Introduction to Nano Technology /Charles P. Poole, Jr., Frank J.Owens/Wiley publishers.

Nanotechnology /Jermy J Ramsden/Elsevier publishers (2015)

Nano Materials/A.K.Bandyopadhyay/ New Age

Nano The Essentials, T.Pradeep, McGrawHill, 2014

Nanotechnology the Science of Small / M.A Shah, K.A Shah/Wiley Publishers.

Online Learning Resources:

https://youtube.com/playlist?list=PLyqSpQzTE6M8682dGkNTN8936vSY4CbqZ&si=8S682KjXK7_xITpT

https://youtu.be/OLa8DQkKlyU?si=I6R1Of59MArQyPUb

https://youtu.be/u1ojNgPCHGs?si=mlIgQm4OdwZnHUo3

III Year B.Tech. ME – I Semester

Course Code	SUSTAINBLE ENERGY TECHNOLOGIES (Open Elective-I)	L	T	P	C
23MET14		3	0	0	3

Course objectives: The objectives of the course are to	
1	To demonstrate the importance the impact of solar radiation, solar PVmodules
2	To understand the principles of storage in PV systems
3	To discuss solar energy storage systems and their applications.
4	To get knowledge in wind energy and bio-mass
5	To gain insights in geothermal energy, ocean energy and fuel cells.

COURSE OUTCOMES On successful completion of this course the student will be able to		
CO1	Illustrate the importance of solar radiation and solar PV modules.	L1, L2
CO2	Discuss the storage methods in PV systems	L2,L3
CO3	Explain the solar energy storage for different applications	L2,L3
CO4	Understand the principles of wind energy, and bio-mass energy.	L2, L3
CO5	Attain knowledge in geothermal energy, ocean energy and fuel cells.	L1, L2,L3, L4

UNIT – 1

SOLAR RADIATION: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems.

SOLAR PV MODULES AND PV SYSTEMS:

PV Module Circuit Design, Module Structure, Packing Density, Interconnections, Mismatch and Temperature Effects, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module, Solar PV Systems-Design of Off Grid Solar Power Plant. Installation and Maintenance.

UNIT – 2

STORAGE IN PV SYSTEMS:

Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.

UNIT – 3

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT – 4

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

UNIT – 5

GEOTHERMAL ENERGY: Origin, Applications, Types of Geothermal Resources, Relative Merits.

OCEAN ENERGY: Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges.

FUEL CELLS: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH

2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006

References:

1. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth& John F Kreider / Taylor & Francis

2. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd

3. Renewable Energy Technologies -Ramesh & Kumar /Narosa

4. Non-conventional Energy Source- G.D Roy/Standard Publishers

Online Learning Resources:

https://nptel.ac.in/courses/112106318

https://youtube.com/playlist?list=PLyqSpQzTE6M-ZgdjYukayF6QevPv7WE-r&si=-mwIa2X-SuSiNy13

https://youtube.com/playlist?list=PLyqSpQzTE6M-ZgdjYukayF6QevPv7WE-r&si=Apfjx6oDfz1Rb_N3

https://youtu.be/zx04Kl8y4dE?si=VmOvp_OggisILTAF

III Year B.Tech. ME – I Semester

Course Code	THERMAL ENGINEERING LAB	L	T	P	C
23MEP07		0	0	3	1.5

	Course objectives: The objectives of the course are to
1	To impart knowledge on working principles of various thermal equipments like compressors, IC Engines, Boilers etc.,
2	To study the working principle of IC engines, performance and characteristics in terms of heat balancing, economical speed variations, air fuel ratio etc.,

List of Experiments:

1. Valve / Port Timing Diagrams of an I.C. Engines
2. Performance Test on a 4 -Stroke Diesel Engines
3. Performance Test on 2-Stroke Petrol engine
4. Evaluation of Engine friction by conducting Morse test on 4-Stroke Multi cylinder Engine
5. Retardation and motoring test on 4- stroke engine
6. Heat Balance of an I.C. Engine.
7. Air/Fuel Ratio and Volumetric Efficiency of an I.C. Engines.
8. Performance Test on Variable Compression Ratio Engines, economical speed test.
9. Performance Test on Reciprocating Air – Compressor Unit
10. Study of Boilers
11. Dismantling / Assembly of Engines to identify the parts and their position in an engine.
12. Exhaust Emission test on IC Engines.

	Course Outcomes: On successful completion of the course, the student will be able to,
CO1	Performance Test on 4-Stroke Diesel and 2-Stroke Petrol engine.
CO2	Able to evaluate the Engine friction of 4-Stroke Multi cylinder Engine and Air/Fuel ratio and Volumetric efficiency of I.C.Engines.
CO3	To calculate the heat balance of the IC Engines.
CO4	To calculate the efficiencies and performance characteristics of the engines.
CO5	Study the boilers and identify parts of the engine parts.

Online Learning Resources:

- https://www.youtube.com/watch?v=i4SF47hjnjQ&list=PL0AQx5JlTK3WUCXXkA9Hev3FFLz4sESSg
- https://www.youtube.com/watch?v=B-rFIdOi-No&list=PLkUEX3IbW7lfdC2ieft_9FH5zAAvUfZAn

III Year B.Tech. ME – I Semester

Course Code	Machine Tools & Metrology lab Skill Enhancement course	L	T	P	C
23MEP09		0	1	2	2

Course objectives: The objectives of the course are to	
1	To understand the parts of various machine tools and about different shapes of products that can be produced on them.
2	To measure bores, angles and tapers
3	To perform alignment tests on various machines

Course Outcomes: At the end of the course, student will be able to	
CO1	Gain knowledge about the parts of various machine tools and about different shapes of products that can be produced on them.
CO2	Learn measure bores, angles and tapers
CO3	Perform alignment tests on various machines

Note: The students have to conduct at least 6 experiments from each lab

MACHINE TOOLS LAB

1. .Introduction of general purpose machines -Lathe, Drilling machine, Milling machine, Shaper, Planing machine, Slotting machine, Cylindrical grinder, Surface grinder and Tool and cutter grinder.
2. Operations on Lathe machines- Step turning, Knurling, Taper turning,Thread cutting and Drilling
3. Operations on Drilling machine - Drilling, reaming, tapping, Rectangular drilling, circumferential drilling
4. Operations on Shaping machine - (i) Round to square (ii) Round to Hexagonal
5. Operations on Slotter - (i) Keyway (T –slot) (ii) Keyway cutting
6. Operations on milling machines - (i) Indexing (ii) Gear manufacturing

METROLOGY LAB

1. Calibration of vernier calipers, micrometers, vernier height gauge and dial gauges.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier caliper for tooth thickness inspection and flange micrometer for checking the chordal thickness of spur gear.
4. Machine tool alignment test on the lathe.
5. Machine tool alignment test on drilling machine.

6. Machine tool alignment test on milling machine.
7. Angle and taper measurements with bevel protractor, Sine bar, rollers and balls.
8. Use of spirit level in finding the straightness of a bed and flatness of a surface.
9. Thread inspection with two wire/ three wire method & tool makers microscope.
10. Surface roughness measurement with roughness measuring instrument.

Online Learning Resources:

1. https://www.youtube.com/watch?v=sG6GCfX7L3c&pp=ygUeTWFjaGluZSBUb29scyAgbGFiIGV4cGVyaW1lbnRz
2. https://www.youtube.com/watch?v=mafthRhz1iM&pp=ygUeTWFjaGluZSBUb29scyAgbGFiIGV4cGVyaW1lbnRz
3. https://www.youtube.com/watch?v=5--saq-oYBE&list=PLrcSDk_gQ7jiQCfWEzw93ZMaxHkg2v-CC
4. https://www.youtube.com/watch?v=m60m2TcbTgc&pp=ygUZbWV0cm9sb2d5IGxhYiBleHBlcmltZW50cw%3D%3D

III Year B.Tech. ME – I Semester

Course Code	DYNAMICS LAB	L	T	P	C
23MEP08		0	0	3	1.5

	Course objectives: The objectives of the course are to
1.	To supplement the principles learnt in kinematics and Dynamics of Machinery.
2.	To understand how certain measuring devices are used for dynamic testing.

Course Outcomes: On successful completion of the course, the student will be able to,	
1.	Ability to demonstrate the principles of kinematics and dynamics of machinery
2.	Determine the Mass moment of inertia, Range sensitivity.
3.	Drawing of Cam profile, determination of torsional, undamped and damped natural frequencies.
4.	Determining of influence of coefficient and balancing of rotating , reciprocating masses.
5.	Verify the laws of springs and forced vibration of cantilever beam.

LIST OF EXPERIMENTS

1. Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
2. Determination of Mass moment of inertia of Fly wheel and Axle system.
3. Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
4. Cams – Cam profile drawing, Motion curves and study of jump phenomenon.
5. Determination of torsional natural frequency of single Rotor systems. Un damped and Damped Natural frequencies.
6. Determination of torsional natural frequency of Double Rotor systems. Un damped and Damped Natural frequencies.
7. Multi degree freedom suspension system – Determination of influence coefficient.
8. Determination of torsional natural frequency of single and Double Rotor systems.- Un damped and Damped Natural frequencies.
9. Balancing of rotating masses.
10. Balancing of reciprocating masses.
11. Determination of natural Frequency and verification of Laws of springs
12. Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.

B. TECH-ME-III-I Sem

23ECP09	TINKERING LAB	L	T	P	C
		2	0	0	1

The aim of tinkering lab for engineering students is to provide a hands-on learning environment where students can explore, experiment, and innovate by building and testing prototypes. These labs are designed to demonstrate practical skills that complement theoretical knowledge.

	Course objectives: The objectives of the course are to
1	**Encourage Innovation and Creativity**
2	**Provide Hands-on Learning and Impart Skill Development**
3	**Foster Collaboration and Teamwork**
4	**Enable Interdisciplinary Learning, Prepare for Industry and Entrepreneurship**
5	**Impart Problem-Solving mind-set**

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

List of experiments:

1) Make your own parallel and series circuits using breadboard for any application of your choice.
2) Design and 3D print a Walking Robot
3) Design and 3D Print a Rocket.
4) Temperature & Humidity Monitoring System (DHT11 + LCD)
5) Water Level Detection and Alert System
6) Automatic Plant Watering System
7) Bluetooth-Based Door Lock System
8) Smart Dustbin Using Ultrasonic Sensor
9) Fire Detection and Alarm System
10) RFID-Based Attendance System
11) Voice-Controlled Devices via Google Assistant
12) Heart Rate Monitoring Using Pulse Sensor
13) Soil Moisture-Based Irrigation
14) Smart Helmet for Accident Detection
15) Milk Adulteration Detection System

16) Water Purification via Activated Carbon
17) Solar Dehydrator for Food Drying
18) Temperature-Controlled Chemical Reactor
19) Ethanol Mini-Plant Using Biomass
20) Smart Fluid Flow Control (Solenoid + pH Sensor)
21) Portable Water Quality Tester
22) AI Crop Disease Detection
23) AI-based Smart Irrigation
24) ECG Signal Acquisition and Plotting
25) AI-Powered Traffic Flow Prediction
26) Smart Grid Simulation with Load Monitoring
27) Smart Campus Indoor Navigator
28) Weather Station Prototype
29) Firefighting Robot with Sensor Guidance
30) Facial Recognition Dustbin
31) Barcode-Based Lab Inventory System
32) Growth Chamber for Plants
33) Biomedical Waste Alert System
34) Soil Classification with AI
35) Smart Railway Gate
36) Smart Bin Locator via GPS and Load Sensors
37) Algae-Based Water Purifier
38) Contactless Attendance via Face Recognition

 Note: The students can also design and implement their own ideas, apart from the list of experiments mentioned above.

 Note: A minimum of 8 to 10 experiments must be completed by the students

B. TECH-ME-III-I Sem

	COMMUNITY SERVICE PROJECT Experiential learning through community engagement	L	T	P	C
		0	0	0	2

Introduction

- Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development
- Community Service Project involves students in community development and service activities and applies the experience to personal and academic development.
- Community Service Project is meant to link the community with the college for mutual benefit. The community will be benefited with the focused contribution of the college students for the village/ local development. The college finds an opportunity to develop social sensibility and responsibility among students and also emerge as a socially responsible institution.

Objective

Community Service Project should be an integral part of the curriculum, as an alternative to the 2 months of Summer Internships / Apprenticeships / On the Job Training, whenever there is an exigency when students cannot pursue their summer internships. The specific objectives are;

- To sensitize the students to the living conditions of the people who are around them,
- To help students to realize the stark realities of the society.
- To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
- To make students aware of their inner strength and help them to find new /out of box solutions to the social problems.
- To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
- To help students to initiate developmental activities in the community in coordination with public and government authorities.
- To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

Implementation of Community Service Project

- Every student should put in a 6 weeks for the Community Service Project during the summer vacation.
- Each class/section should be assigned with a mentor.
- Specific Departments could concentrate on their major areas of concern. For example, Dept. of Computer Science can take up activities related to Computer Literacy to different sections of people like - youth, women, house-wives, etc
- A log book has to be maintained by each of the student, where the activities undertaken/involved to be recorded.
- The logbook has to be countersigned by the concerned mentor/faculty incharge.
- Evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.
- The final evaluation to be reflected in the grade memo of the student.

- The Community Service Project should be different from the regular programmes of NSS/NCC/Green Corps/Red Ribbon Club, etc.
- Minor project report should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.
- Award of marks shall be made as per the guidelines of Internship/apprentice/ on the job training

Procedure

- A group of students or even a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, so as to enable them to commute from their residence and return back by evening or so.
- The Community Service Project is a twofold one –
- First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area. Or it can even be a general survey, incorporating all the different areas. A common survey format could be designed. This should not be viewed as a duplication of work by the Village or Ward volunteers, rather, it could be another primary source of data.
- Secondly, the student/s could take up a social activity, concerning their domain or subject area. The different areas, could be like.
  - Agriculture
  - Health
  - Marketing and Cooperation
  - Animal Husbandry
  - Horticulture
  - Fisheries
  - Sericulture
  - Revenue and Survey
  - Natural Disaster Management
  - Irrigation
  - Law & Order
  - Excise and Prohibition
  - Mines and Geology
  - Energy
  - Internet
  - Free Electricity
  - Drinking Water

EXPECTED OUTCOMES

BENEFITS OF COMMUNITY SERVICE PROJECT TO STUDENTS

Learning Outcomes

- Positive impact on students' academic learning
- Improves students' ability to apply what they have learned in "the real world"
- Positive impact on academic outcomes such as demonstrated complexity of understanding, problem analysis, problem-solving, critical thinking, and cognitive development
- Improved ability to understand complexity and ambiguity

Personal Outcomes

- Greater sense of personal efficacy, personal identity, spiritual growth, and moral development
- Greater interpersonal development, particularly the ability to work well with others, and build leadership and communication skills

Social Outcomes

- Reduced stereotypes and greater inter-cultural understanding
- Improved social responsibility and citizenship skills
- Greater involvement in community service after graduation

Career Development

- Connections with professionals and community members for learning and career opportunities
- Greater academic learning, leadership skills, and personal efficacy can lead to greater opportunity

Relationship with the Institution

- Stronger relationships with faculty
- Greater satisfaction with college
- Improved graduation rates

BENEFITS OF COMMUNITY SERVICE PROJECT TO FACULTY MEMBERS

- Satisfaction with the quality of student learning
- New avenues for research and publication via new relationships between faculty and community
- Providing networking opportunities with engaged faculty in other disciplines or institutions
- A stronger commitment to one's research

BENEFITS OF COMMUNITY SERVICE PROJECT TO COLLEGES AND UNIVERSITIES

- Improved institutional commitment
- Improved student retention
- Enhanced community relations

BENEFITS OF COMMUNITY SERVICE PROJECT TO COMMUNITY

- Satisfaction with student participation

- Valuable human resources needed to achieve community goals
- New energy, enthusiasm and perspectives applied to community work
- Enhanced community-university relations.

SUGGESTIVE LIST OF PROGRAMMES UNDER COMMUNITY SERVICE PROJECT

The following the recommended list of projects for Engineering students. The lists are not exhaustive and open for additions, deletions and modifications. Colleges are expected to focus on specific local issues for this kind of projects. The students are expected to carry out these projects with involvement, commitment, responsibility and accountability. The mentors of a group of students should take the responsibility of motivating, facilitating, and guiding the students. They have to interact with local leadership and people and appraise the objectives and benefits of this kind of projects. The project reports shall be placed in the college website for reference. Systematic, Factual, methodical and honest reporting shall be ensured.

For Engineering Students

1. Water facilities and drinking water availability
2. Health and hygiene
3. Stress levels and coping mechanisms
4. Health intervention programmes
5. Horticulture
6. Herbal plants
7. Botanical survey
8. Zoological survey
9. Marine products
10. Aqua culture
11. Inland fisheries
12. Animals and species
13. Nutrition
14. Traditional health care methods
15. Food habits
16. Air pollution
17. Water pollution
18. Plantation
19. Soil protection
20. Renewable energy
21. Plant diseases
22. Yoga awareness and practice
23. Health care awareness programmes and their impact
24. Use of chemicals on fruits and vegetables
25. Organic farming
26. Crop rotation
27. Floury culture
28. Access to safe drinking water
29. Geographical survey
30. Geological survey
31. Sericulture
32. Study of species
33. Food adulteration
34. Incidence of Diabetes and other chronic diseases

35. Human genetics
36. Blood groups and blood levels
37. Internet Usage in Villages
38. Android Phone usage by different people
39. Utilisation of free electricity to farmers and related issues
40. Gender ration in schooling lvel- observation.

Complimenting the community service project the students may be involved to take up some awareness campaigns on social issues/special groups. The suggested list of programmes are;

Programmes for School Children

1. Reading Skill Programme (Reading Competition)
2. Preparation of Study Materials for the next class.
3. Personality / Leadership Development
4. Career Guidance for X class students
5. Screening Documentary and other educational films
6. Awareness Programme on Good Touch and Bad Touch (Sexual abuse)
7. Awareness Programme on Socially relevant themes.

Programmes for Women Empowerment

1. Government Guidelines and Policy Guidelines
2. Womens' Rights
3. Domestic Violence
4. Prevention and Control of Cancer
5. Promotion of Social Entrepreneurship

General Camps

1. General Medical camps
2. Eye Camps
3. Dental Camps
4. Importance of protected drinking water
5. ODF awareness camp
6. Swatch Bharath
7. AIDS awareness camp
8. Anti Plastic Awareness
9. Programmes on Environment
10. Health and Hygiene
11. Hand wash programmes
12. Commemoration and Celebration of important days

Programmes for Youth Empowerment

1. Leadership
2. Anti-alcoholism and Drug addiction
3. Anti-tobacco
4. Awareness on Competitive Examinations
5. Personality Development

Common Programmes

1. Awareness on RTI
2. Health intervention programmes

3. Yoga
4. Tree plantation
5. Programmes in consonance with the Govt. Departments like –
    i. Agriculture
    ii. Health
    iii. Marketing and Cooperation
    iv. Animal Husbandry
    v. Horticulture
    vi. Fisheries
    vii. Sericulture
    viii. Revenue and Survey
    ix. Natural Disaster Management
    x. Irrigation
    xi. Law & Order
    xii. Excise and Prohibition
    xiii. Mines and Geology
    xiv. Energy

Role of Students:

- Students may not have the expertise to conduct all the programmes on their own. The students then can play a facilitator role.
- For conducting special camps like Health related, they will be coordinating with the Governmental agencies.
- As and when required the College faculty themselves act as Resource Persons.
- Students can work in close association with Non-Governmental Organizations like Lions Club, Rotary Club, etc or with any NGO actively working in that habitation.
- And also with the Governmental Departments. If the programme is rolled out, the District Administration could be roped in for the successful deployment of the programme.
- An in-house training and induction programme could be arranged for the faculty and participating students, to expose them to the methodology of Service Learning.

Timeline for the Community Service Project Activity

Duration: 8 weeks

1. **Preliminary Survey (One Week)**
   - A preliminary survey including the socio-economic conditions of the allotted habitation to be conducted.
   - A survey form based on the type of habitation to be prepared before visiting the habitation with the help of social sciences faculty. (However, a template could be designed for different habitations, rural/urban.
   - The Governmental agencies, like revenue administration, corporation and municipal authorities and village secreteriats could be aligned for the survey.

2. **Community Awareness Campaigns (One Week)**
   - Based on the survey and the specific requirements of the habitation, different awareness campaigns and programmes to be conducted, spread over two weeks of time. The list of activities suggested could be taken into consideration.

3. **Community Immersion Programme (Three Weeks)**

   Along with the Community Awareness Programmes, the student batch can also work with any one of the below listed governmental agencies and work in tandem with them. This community involvement programme will involve the students in exposing themselves to the experiential learning about the community and its dynamics. Programmes could be in consonance with the Govt. Departments.

4. **Community Exit Report (One Week)**
   - During the last week of the Community Service Project, a detailed report of the outcome of the 8 weeks work to be drafted and a copy shall be submitted to the local administration. This report will be a basis for the next batch of students visiting that particular habitation. The same report submitted to the teacher-mentor will be evaluated by the mentor and suitable marks are awarded for onward submission to the University.

     Throughout the Community Service Project, a daily log-book need to be maintained by the students batch, which should be countersigned by the governmental agency representative and the teacher-mentor, who is required to periodically visit the students and guide them.

III Year B.Tech. ME – II Semester

Course Code	HEAT TRANSFER	L	T	P	C
23MET15		3	0	0	3

Course objectives: The objectives of the course are to	
1	Understand the concept of heat transfer mechanisms, focusing on steady and unsteady state heat conduction, include practical applications.
2	Define fundamental principles and types of convective heat transfer, enabling to understand and apply empirical correlations for analyzing heat transfer in both internal and external flows.
3	Knowledge on the mechanisms and regimes of boiling and condensation, emphasizing the heat transfer characteristics and practical implications of each.
4	Design and analysis of various types of heat exchangers, including performance evaluation using LMTD and NTU methods.
5	Demonstrate the principles of thermal radiation and mass transfer, including fundamental laws, radiation exchange, and diffusion mechanisms in gases and liquids.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Analyze and solve heat conduction problems in various systems, including steady and transient conditions, using appropriate mathematical models and charts.	*L3,L5,L6*
2	Evaluate convective heat transfer in various systems by applying boundary layer theory and empirical correlations for practical engineering problems.	*L2,L3,L5*
3	Analyze and distinguish between different boiling regimes and condensation modes, and solve related heat transfer problems in engineering applications.	*L2,L4,L5*
4	Design and evaluation different heat exchanger configurations, by analysing appropriate methods.	*L4,L5,L6*
5	Apply radiation laws and mass transfer principles to analyze and solve problems involving radiative heat exchange and diffusive transport in engineering systems.	*L3,L4,L5*

UNIT I: Introduction

Basic modes of heat transfer- rate equations- generalized heat conduction equation-various forms - steady state heat conduction solution for plane and composite slabs - cylinders - critical thickness of insulation- heat conduction through fins of uniform cross section- fin effectiveness and efficiency.

Unsteady State Heat Transfer Conduction- Transient heat conduction- lumped system analysis and use of Heisler charts.

UNIT II : Convection

Convection: Basic concepts of convection–heat transfer coefficients - types of convection – forced convection and free convection.

Free Convection: development of hydrodynamic and thermal boundary layer along a vertical plate – use of empirical relations for convective heat transfer on plates and cylinders in horizontal and vertical orientation

Forced convection: In external flow–concepts of hydrodynamic and thermal boundary layer- use of empirical correlations for flow over plates and cylinders. Fluid friction – heat transfer analogy, approximate solution to laminar boundary layer equation for external flow. Internal flow – Use of empirical relations for convective heat transfer in horizontal pipe flow- problems.

UNIT III

Boiling and Condensation

Different regimes of boiling- nucleate, transition and film boiling – condensation – film wise and drop wise condensation-problems.

UNIT IV

Heat Exchangers

Types of heat exchangers- parallel flow- counter flow- cross flow heat exchangers- overall heat transfer coefficient- LMTD and NTU methods- fouling in heat exchangers-problems.

UNIT V

Radiation: Radiation heat transfer – thermal radiation – laws of radiation - Black and Gray bodies – shape factor-radiation exchange between surfaces - Radiation shields - Greenhouse effect- simple problems.

Mass Transfer: Conservation laws and constitutive equations - Fick's law of diffusion, isothermal equi-mass - Equimolal diffusion- - diffusion of gases and liquids- mass transfer coefficient.

Textbooks:

1. P.K. Nag, Heat Transfer, 3/e, Tata McGraw-Hill, 2011.
2. J.P.Holman, Heat Transfer, 9/e, Tata McGraw-Hill, 2008.
3. R.C.Sachdeva, Fundamentals of Engineering Heat & Mass transfer, New Age International Publishers, 2017.

Reference Books:

1. F. P. Incropera and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, 6/e, John Wiley, 2007.
2. Cengel. A.Yunus, Heat Transfer- A Practical Approach, 4/e, Tata McGraw-Hill, 2007.

3. S.P. Sukhatme, A Text book of Heat Transfer, Universities Press, 2005.
4. S. C. Arora& S. Domkundwar , A Course in Heat and Mass Transfer, Dhan pat Rai & CO.(P) LTD-Delhi , 2007.
5. C.P. Kothandaraman and S. Subramanyan, Heat and Mass Transfer data book, New Age Publications, 2014.
6. Er.R.K.Rajput, A Text book of Heat & Mass Transfer, S.Chand publishers,1/e,2018.

Online Learning Resources:

- https://ocw.mit.edu/courses/mechanical-engineering/2-051-introduction-to-heat-transfer-fall- 2015/
- https://www.udemy.com/topic/heat-transfer/
- https://www.youtube.com/watch?v=TWTQx3W-2k8
- https://onlinecourses.nptel.ac.in/noc20_ch21/preview
- https://ekeeda.com/degree-courses/mechanical-engineering/heat-transfer
- https://www.coursera.org/lecture/thermodynamics-intro/02-04-heat-transfer-gyDfJ
- https://www.youtube.com/watch?v=cjJ2LV5lkB8

III Year B.Tech. ME – II Semester

Course Code	CAD/CAM	L	T	P	C
23MET16		3	0	0	3

Course objectives: The objectives of the course are to	
1	Understand the basic of CAD/CAM. Explore graphics standards and analyze 2D and 3D geometric transformations.
2	Knowledge and skills to apply various geometric modeling techniques, as well as solid modeling approaches.
3	Explain the principles of Computer Aided Manufacturing (CAM), numerical control (NC), and the functionalities of CNC and DNC systems.
4	Design and develop a part programming using G/M codes and APT for various machining operations.
5	Explain the basics of automation systems, robotics, group technology, CIM, and emerging trends like VR, AR, and AI.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Apply and Evaluate the CAD/CAM principles to design and manufacturing processes. Create and manipulate CAD models using appropriate software tools.	*L3,L4,L5*
2	Analyze and differentiate between Hermite, Bezier, and B-spline curves and construct and manipulate surface models. Evaluate the effectiveness of Boolean operations and create complex geometric models.	*L2,L3,L5,L6*
3	Identify and analyze key components of NC and CNC systems in manufacturing processes. Evaluate the performance of DNC systems in a manufacturing environment.	*L1,L2,L3,L4, L5*
4	Explain the structure and functioning of NC/CNC/DNC machine tools and adaptive control systems. Develop part programs using standard codes and APT for basic machining operations.	*L2,L6*
5	Understand and evaluate the role of robotics, group technology, and CIM in modern manufacturing systems, and explain emerging technologies like VR, AR, and AI.	*L2,L5*

UNIT –I Overview of CAD/CAM: Product cycle, CAD, CAM and CIM. CAD Tools, CAM Tools, Utilization in an Industrial Environment, Evaluation criteria. CAD data structure, Data base management systems.

Computer Graphics: Co-ordinate systems, Graphics package functions, 2D and 3D transformations, clipping, hidden line / surface removal color, shading.

UNIT –II Geometric Modeling: Representation techniques, Parametric and non-parametric representation, various construction methods, wire frame modeling, synthetic curves and their representations, surface modeling, synthetics surfaces and their representations. Solid modeling, solid representation, fundamentals, introduction to boundary representations, constructive solid geometry representations

UNIT- III

Numerical Control: NC, NC Modes, NC Elements, NC Machine tools and their structure, Machining center, types and features. Controls in NC, CNC systems, DNC systems. Adaptive control machining systems, types of adaptive control.

CNC Part Programming: Fundamentals, NC word, NC Nodes, canned cycles, cutter radius compensation, length compensation, computed assisted part programming using APT: Geometry statements, motion statements, post process statements, auxiliary statements, macro statement program for simple components.

UNIT -IV

Group Technology & FMS: Part Family, Classification and Coding, advantages & limitations, Group technology machine cells, benefits. FMS: Introduction, components of FMS, material handling systems, Computer control systems, advantages.

Computer Aided Quality Control: Terminology in Quality control, Inspection and testing, Contact inspection methods - optical and non-optical, integration of CAQC with CAD and CIM.

UNIT- V

Computer Aided Processes Planning: Retrieval type and Generative type, benefits Machinability data systems, Computer generated time standards.

Computer integrated production planning: Capacity planning, shop floor control, MRP-I, MRP- II, CIMS benefits. Trends in manufacturing systems: Concepts of Reconfigurable manufacturing, Sustainable manufacturing and lean manufacturing.

Textbooks:

1. Mikell P. Groover, Emory W. Zimmers , CAD/CAM, 5/e, Pearson Prentice Hall of India, Delhi, 2008.
2. Ibrahim Zeid, R.Siva Subramanian, CAD/CAM: Theory and Practice, 2/e, Tata McGraw-Hill, Delhi, 2009.

Reference Books:

1. P. N. Rao, CAD/CAM: Principles and applications, 3/e, Tata McGraw-Hill, Delhi, 2017.
2. P. Radhakrishnan, S. Subramanyan& V. Raju, CAD/CAM/CIM, 3/e, New Age International Publishers, 2008.
3. Computer Aided Manufacturing, 3/e, Tien Chien Chang, Pearson, 2008.

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc20_me44/preview
- https://www.youtube.com/watch?v=EgKc9L7cbKc
- https://www.youtube.com/watch?v=KXFpTb9cBpY
- https://web.iitd.ac.in/~hegde/cad/lecture/L01_Introduction.pdf
- https://www.vssut.ac.in/lecture_notes/lecture1530947994.pdf
- https://www.iare.ac.in/sites/default/files/lecture_notes/CAD_CAM_LECTURE_NOTES.pdf

III Year B.Tech. ME – II Semester

Course Code	DESIGN OF MACHINE MEMBERS	L	T	P	C
23MET17		3	0	0	3

Course objectives: The objectives of the course are to	
1	Understanding of the mechanical engineering design process for static and dynamic loads under various loading conditions.
2	Explore the design principles and analysis of bolted and welded joints and butt welds under various loading conditions.
3	Study the design principles of power transmission shafts and couplings, focusing on the analysis of shafts subjected loads, as well as the design of various types of couplings.
4	Explain the design principles of friction clutches, brakes, and springs, design of different brakes, clutches, helical and leaf springs under various loading conditions.
5	Demonstrate the design principles of sliding and rolling contact bearings, gears, spur gears, beam strength, and load considerations.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Apply design principles for components subjected to static and dynamic loads, analyze and design for fatigue failure using relevant criteria	*L3,L4,L6*
2	Design and analyze bolted and welded joints, considering factors such as different types of loads, including eccentric loading scenarios.	L2,L4,L6
3	Design power transmission shafts and couplings for fluctuating loads, and selecting appropriate couplings such as flange, bushed pin, and universal couplings.	L4,L5,L6
4	Design friction clutches, brakes, and springs, applying the various theories and analyze the working for mechanical applications.	L2,L4,L6
5	Design and analyze the sliding and rolling contact bearings, spur gears, considering beam strength, dynamic, and wear load factors.	L3,L4,L6

UNIT I

Introduction, Design for Static and Dynamic loads

Mechanical Engineering Design: Design process, design considerations, codes and standards of designation of materials, selection of materials.

Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads. Theories of failure for static loads.

Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

UNIT II

Design of Bolted and Welded Joints

Design of Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, gasketed joints and eccentrically loaded bolted joints.

Welded Joints: Strength of lap and butt welds, Joints subjected to bending and torsion. Eccentrically loaded welded joints.

UNIT III

Power transmission shafts and Couplings

Power Transmission Shafts: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.

Couplings: Design of flange and bushed pin couplings, universal coupling.

UNIT IV

Design of Clutches, Brakes and Springs

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory and uniform pressure theory.

Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band and block brakes, disc brakes.

Springs: Design of helical compression, tension, torsion and leaf springs.

UNITV

Design of Bearings and Gears

Design of Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.

Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue.

Design of Gears: Spur gears, beam strength, Lewis equation, design for dynamic and wear loads.

Textbooks:

1. R.L. Norton, Machine Design an Integrated approach, 2/e, Pearson Education, 2004.
2. V.B.Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.

Reference Books:

1. R.K. Jain, Machine Design, Khanna Publications, 1978.
2. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986.
3. M.F.Spotts and T.E.Shoup, Design of Machine Elements, 3/e, Prentice Hall (Pearson Education), 2013.

4. K. Mahadevan &K.Balaveera Reddy, Design data handbook, CBS Publications, 4/e, 2018.
5. Dr. N. C. Pandya &Dr. C. S. Shah, Machine design, 17/e, Charotar Publishing House Pvt. Ltd, 2009.

Online Learning Resources:

- https://www.yumpu.com/en/document/view/18818306/lesson-3-course-name-design-of- machine-elements-1-nptel
- https://www.digimat.in/nptel/courses/video/112105124/L01.html
- https://dokumen.tips/documents/nptel-design-of-machine-elements-1.html
- http://www.nitttrc.edu.in/nptel/courses/video/112105124/L25.html

III Year B.Tech. ME – II Semester

Course Code	ENGINEERING FRACTURE MECHANICS (Professional Elective-II)	L	T	P	C
23MET18a		3	0	0	3

Course objectives: The objectives of the course are to	
1	Understanding of Engineering Fracture Mechanics (EFM principles and fatigue crack growth models, with a focus on analyzing and preventing spectacular structural failures.
2	Explore the principles of crack growth and fracture mechanisms, and their applications in material failure analysis.
3	Review the theory of elasticity and explore Westergaard‘s solution for stress and displacements in Mode I fracture, along with the relationship between the stress intensity factor (K) and the energy release rate (G).
4	Familiarize multi-parameter stress fields for Mode I, Mode II, and mixed-mode fractures, explore the calculation of stress intensity factors (SIF) for various geometries
5	To study fracture toughness testing, crack growth models, analysis, failure assessment diagrams, and mixed-mode fracture, along with methods for crack arrest and repair.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Apply LEFM, EPFM, and fatigue crack growth models to assess and prevent catastrophic structural failures at different loads.	*L2,L3,L5*
2	Apply Griffith's theory, calculate energy release rates, and analyze crack propagation mechanisms in materials to predict and prevent fractures in engineering applications.	L3,L4,L5
3	Analyze and apply the theory of elasticity and displacement in Mode I fracture, and understand the connection between the stress intensity factor (K) and the energy release rate (G).	L2,L3,L4
4	Analyze and calculate multi-parameter stress fields for different fracture modes and apply Irwin‘s and Dugdale‘s models to understand deformation around crack tips.	L2,L4,L5
5	Perform fracture toughness testing, apply crack growth models, and understand crack closure and failure assessment diagrams.	L2,L3,L5

UNIT 1

EFM Course outline and Spectacular Failures, Introduction to LEFM and EPFM, Fatigue Crack Growth Model

UNIT 2

Crack Growth and Fracture Mechanisms, Griffith TMs Theory of Fracture, Energy Release Rate

UNIT 3

Review of Theory of Elasticity , Westergaard Solution for Stress and Displacements for Mode I, Relationship between K and G

UNIT 4

Introduction to multi parameter stress field for Mode I, Mode II and Mixed Modes, SIF for Various Geometries, Modeling Plastic Deformation, Irwin TMs model, Dugdale Model

UNIT 5

Fracture Toughness Testing, Paris Law and Sigmoidal curve, Crack Closure, Crack Growth Models, J-Integral, Failure Assessment Diagram, Mixed Mode Fracture, Crack Arrest and Repair Methodologies

Text Books

1. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009.
2. K. R.Y. Simha, Fracture Mechanics for Modern Engineering Design, Universities Press (India) Limited,2001.

Reference Books

1. D. Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Dordrecht, 1986.
2. T.L. Anderson, Fracture Mechanics "Fundamentals and Applications, 3rd Edition, Taylor and Francis Group, 2005.
3. K. Ramesh, e-Book on Engineering Fracture Mechanics, IIT Madras, 2007.

Online Learning Resources:

1. https://nptel.ac.in/courses/112106065
2. https://youtube.com/playlist?list=PLA218B83235A4AD5C&si=XI175OWGIvdMCQH9
3. https://youtube.com/playlist?list=PLA218B83235A4AD5C&si=ruHP1MIsJGNAyMYV
4. https://youtube.com/playlist?list=PLfIFNJ1DPG4ks5AjeCgpbm8nLGM1Pgxer&si=F-fj413KzPAkjPSs

III Year B.Tech. ME – II Semester

Course Code	INTRODUCTION TO TURBO MACHINERY	L	T	P	C
23MET18b	(Professional Elective-II)	3	0	0	3

Course objectives: The objectives of the course are to	
1	Understanding of the principles, classifications, and governing equations of turbo machinery.
2	Familiarize of gas turbine cycles including Brayton, regenerative, reheat, and inter-cooling processes, as well as the operation and performance of turboprop, turbojet, and turbofan engines with thrust augmentation techniques.
3	Principles of similarity analysis and cascade theory in turbo machinery, for performance evaluation of compressor and turbine blades.
4	Design and analysis of axial and centrifugal compressors and pumps, considering different parameters.
5	Develop a thorough understanding of axial flow turbine design and performance parameters, and to introduce computational fluid dynamics (CFD) as a tool for analyzing turbo machinery.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Analyze and apply the fundamental concepts of fluid motion in rotating systems to design and evaluate the performance of various turbo machines.	*L3,L4,L5,*
2	Compare, Analyze, and evaluate various gas turbine cycles and engine configurations for optimum propulsion and power generation applications.	L2,L4,L5
3	Apply similarity principles and cascade analysis techniques to evaluate blade performance, estimate aerodynamic losses, and optimize turbo machine blade designs.	L3,L4,L5
4	Design, analyze, and evaluate the performance of axial and centrifugal compressors and pumps, and thermodynamic principles for improved efficiency and functionality.	L4,L5,L6
5	Create and evaluate axial flow turbines and apply CFD techniques to simulate and analyze fluid flow and thermal behavior in turbo machinery systems.	L4,L5,L6

UNIT 1

Introduction and Classification: Axial flow, radial flow and mixed flow machines, the equations of motion in rotating frame of reference, effects of Coriolis and Centrifugal forces, momentum and energy equation, Euler work and illustrative examples.

UNIT 2

Gas Turbine Cycle: Brayton Cycle, regenerative cycle, reheat, inter-cooling, turboprop, turbojet and turbofan engine, thrust augmentation and illustrative examples.

UNIT 3

Similarity Analysis: Similarity rules, specific speed, Cordier diagram and illustrative examples. Cascade Analysis: Two-dimensional cascade theory, lift and drag, blade efficiency, estimation of loss, compressor and turbine cascade, blade geometry and illustrative examples.

UNIT 4

Axial Flow Compressor: Two-dimensional pitch line design and analysis, h-s diagram, degree of reaction, the effect of Mach number, performance and efficiency, three-dimensional flow, tip clearance, losses, compressor performance and illustrative examples.

Centrifugal Pump and Compressor: Theoretical analysis and design, the effect of circulation and Coriolis forces, reversal eddies, slip factor, head and efficiency, diffuser, introduction to the combustion system and illustrative examples.

UNIT 5

Axial Flow Turbine: Two-dimensional pitch line design, stage loading capacity, degree of reaction, stage efficiency, turbine performance, blade cooling, and illustrative examples.. CFD Applied to Turbomachinery Flows: Governing equations, numerical methods, and test cases illustrating flow and heat transfer related to turbo machines.

Text Books:

1. Fluid Mechanics and Thermodynamics of Turbomachinery, S. L. Dixon and C. A. Hall, Butterworth-Heinemann, Seventh Edition, 2014.
2. Gas Turbine Theory, H. Cohen, GFC Rogers and HIH Saravanamuttoo, Addison Wesley Longman Limited, 4th Edition, 1996.

Reference Books:

1. Fundamentals of Turbomachinery, Venkanna B. K Prentice Hall India Learning Private Limited, 2009.
2. Principles of Turbomachinery, Seppo A. Korpela, 2nd Edition, (2019) John Wiley and Son‘s, USA.

Online Learning Resources:

1. https://youtube.com/playlist?list=PLbMVogVj5nJQQp3QLuzbcHrt0XncZZTiE&si=ts0mwl6etWcmKO1i
2. https://youtube.com/playlist?list=PLWCscP8J8VQ4i0BoPCAgP5mXQh9VWmyuS&si=cLzUxZke5BJV-lUg
3. https://youtube.com/playlist?list=PLbMVogVj5nJQQp3QLuzbcHrt0XncZZTiE&si=Rzs-PEl9nqP45rKe

B. TECH-ME-III-II Sem

23EET19	CONTROL SYSTEMS (Professional Elective-II)	L	T	P	C
		3	0	0	3

Course objectives: The objectives of the course are to	
1	Fundamentals of control systems, mathematical modeling, and transfer function derivation for electro-mechanical components.
2	Knowledge on system representation, and to introduce classical control design techniques.
3	To equip students with the ability to represent and simplify control, and to design effective controllers for achieving desired system performance.
4	Knowledge and skills to analyze control system stability and performance in the frequency domain, using Bode, polar, and transfer functions.
5	State-space analysis of different models from block diagrams, and concepts of controllability, observability, and state transition matrices.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	del dynamic systems, distinguish between loop controls, analyze feedback effects, and derive transfer functions for DC/AC servo motors and synchro devices.	*,L2,L4*
2	alyze and simplify control systems, and create effective controllers such as lag, lead, lead-lag, and PID to meet system performance specifications.	L2,L4,L6
3	alyze and simplify control systems using block diagrams and signal flow graphs, and design appropriate controllers to achieve desired system performance.	L3,L4,L6
4	alyze the frequency response of control systems using Bode, polar, and evaluate system stability and performance such as gain margin and phase margin.	L1,L4,L5
5	velop state-space models from block diagrams, analyze system controllability and observability, and solve time-invariant state equations using the state transition matrix.	,L4,L6

UNIT - I

BASICS IN CONTROL SYSTEM AND TRANSFER FUNCTION: Introduction of Control Systems, Various types of systems (Open Loop and closed loop) and their differences- Classification and Feed-Back Characteristics of control system- Effects of feedback. Mathematical models – Differential equations, Translational and Rotational mechanical systems. Transfer Function of DC Servo motor - AC Servo motor- Synchro transmitter and Receiver.

UNIT - II

REPRESENTATION OF TRANSFER FUNCTION AND CONTROL DESIGN TECHNIQUES: Block diagram representation of systems considering electrical systems as examples. Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula. Compensation techniques – Lag, Lead, Lead-Lag Controllers design, PID Controllers.

UNIT - III

TIME RESPONSE ANALYSIS: Standard test signals - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications – Steady state response - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems. STABILITY ANALYSIS: The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability. The root locus concept - construction of root locieffects of adding poles and zeros to G(s) H(s) on the root loci.

UNIT - IV

FREQUENCY RESPONSE ANALYSIS: Introduction, Frequency domain Specifications-Bode diagrams Determination of Frequency domain specifications and transfer function from the Bode Diagram-Phase margin and Gain margin Stability Analysis from Bode Plots. **STABILITY ANALYSIS IN FREQUENCY DOMAIN**: Polar Plots-Nyquist Plots-Stability Analysis.

UNIT - V

STATE SPACE ANALYSIS: Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

TEXT BOOKS:

1. I. J. Nagrath, M .Gopal (2011), Control Systems Engineering, 5th edition, New Age International (P) Limited, New Delhi, India.
2. Benjamin. C. Kuo (2003), Automatic Control Systems, 8th edition, John Wiley and Son's, USA.

REFERENCE BOOKS:

1. K. Ogata (2008), Modern Control Engineering, 4th edition, Prentice Hall of India Pvt. Ltd, New Delhi. 2. N. K. Sinha (2008), Control System.
2. Prof. Vishwajit K. Barbudhe Control system Engineering National Press (2020)
3. Richard Dorf and Robert Bishop Modern Control Systems Pear son, 13th edition (2016)

Online Learning Resources:

1. https://nptel.ac.in/courses/107106081
2. https://nptel.ac.in/courses/108107115
3. https://nptel.ac.in/courses/108103007
4. https://nptel.ac.in/courses/115108104

III Year B.Tech. ME – II Semester

Course Code	OPERATIONS RESEARCH (Professional Elective-II)	L	T	P	C
23MET18c		3	0	0	3

Course objectives: The objectives of the course are to	
1	Understanding of OR, focusing on model classification, formulation, and solution techniques for LP problems.
2	Knowledge and techniques for formulating and solving transportation and assignment problems, and the Traveling Salesman Problem.
3	Fundamentals of game theory and job sequencing, including optimal strategies, and scheduling techniques.
4	Demonstrate of queuing theory, queuing models based on Poisson arrivals and exponential service times, and the analysis of single and multichannel systems with various queue lengths.
5	Familiarize replacement and maintenance strategies, fundamentals of dynamic programming and its applications in optimization problems.

Course Outcomes (Learning Outcomes): On successful completion of this course, the student will be able to		
1	Build and compare different mathematical models of the real time situations by using different Research models. Solve the LP problems and find Multiple Optimal Solutions.	L3, L2,L5
2	Implement Transportation and Assignment problems to solve the real time industry needs.	L1,L3,L5
3	Choose the best strategy of Game theory and capable of identifying the suitable techniques .Solve the Job Sequencing Problem.	L2,L3, L5
4	Apply different Queuing models to optimize the queuing length. Define the queuing and inventory terminology to solve the different inventory and queuing problems.	L1, L3,L6
5	Apply concepts of replacement and maintenance analysis and solve optimization problems using dynamic programming techniques.	L3,L4,L5

UNIT I

Introduction to OR

Introduction to Operations Research (OR): OR definition - Classification of Models, modeling – Methods of solving OR Models, limitations and applications of OR models

Linear Programming(LP): Problem Formulation, Graphical Method, Simplex Method, Big-M Method, Two–Phase Simplex Method, Special Cases of LP- Degeneracy, Infeasibility and Multiple Optimal Solutions; Concept of dual theorem

UNIT – II

Transportation and Assignment Problems

Transportation Problem – Formulation; Different Methods of Obtaining Initial Basic Feasible Solution –North West Corner Rule, Least Cost Method, Vogel's Approximation Method; Optimality Method – Modified Distribution (MODI) Method; Special Cases – Unbalanced Transportation Problem, Degenerate Problem. Assignment Problem – Formulation, Hungarian Method for Solving Assignment Problems, Traveling Salesman problem.

UNIT – III

Game theory & Job Sequencing

Game theory: Optimal solution of two person zero sum games, the max min and min max principle. Games without saddle points, mixed strategies. Reduction by principles of dominance, arithmetic, algebraic method and graphical method.

Job Sequencing: Introduction to Job shop Scheduling and flow shop scheduling, Solution of Job Sequencing Problem, Processing of n Jobs through two machines, Processing of n Jobs through m machines, graphical method.

UNIT – IV

Queuing Theory & Inventory Control

Queuing Theory: Introduction – Terminology, Arrival Pattern, Service Channel, Population, Departure Pattern, Queue Discipline, Birth & Death Process, Single Channel Models with Poisson Arrivals, Exponential Service Times with infinite and finite queue length; Multichannel Models with Poisson Arrivals, Exponential Service Times with infinite queue length.

Inventory Control: Introduction, Deterministic models – EOQ model with and without shortages, Production model, Buffer stock and discount inventory models with single price breaks. Selective inventory control.

UNIT – V

Replacement and Maintenance Analysis & DP

Replacement and Maintenance Analysis: Introduction – Types of Maintenance, Make or buy decision. Types of Replacement Problems, Determination of Economic Life of an Asset, and Simple Probabilistic Model for Items which completely fail-Individual Replacement Model, Group Replacement Model. **Dynamic Programming (DP):** Introduction –Bellman‘s Principle of Optimality – Applications of Dynamic Programming – Shortest Path Problem – Capital Budgeting Problem – Solution of Linear Programming Problem by DP.

Textbooks:

1. Sharma S.D., Operations Research: Theory, Methods and Applications, 15/e, Kedar Nath Ram Nath, 2010
2. Taha H.A., Operations Research, 9/e, Prentice Hall of India, New Delhi, 2010.

Reference Books:

1. Hiller F.S., and Liberman G.J., Introduction to Operations Research, 7/e, Tata McGraw Hill, 2010.
2. Sharma J.K., Operations Research: Theory and Applications, 4/e, Laxmi Publications, 2009.
3. Prem kumar Gupta and Hira, Operations Research, 3/e, S Chand Company Ltd., New Delhi, 2003.
4. Pannerselvam R., Operations Research, 2/e, Pentice Hall of India, New Delhi, 2006.
5. Sundaresan.V, and Ganapathy Subramanian.K.S, Resource Management Techniques: Operations Research, A.R Publications, 2015.

Online Learning Resources:

- http://www2.informs.org/Resources/
- http://www.mit.edu/~orc/
- http://www.ieor.columbia.edu/
- http://www.universalteacherpublications.com/univ/ebooks/or/Ch1/origin.htm
- http://www.wolfram.com/solutions/OperationsResearch/

III Year B.Tech. ME – II Semester

Course Code	SMART MATERIALS	L	T	P	C
23MET18d	(Professional Elective-II)	3	0	0	3

Course objectives: The objectives of the course are to	
1	Fundamental characteristics of different metals and provide an understanding of smart materials, their classification and real-world applications.
2	Knowledge of various types of smart materials and electro rheological fluids, and shape memory materials.
3	Processing techniques of various smart materials, and smart fluids, with a focus on synthesis and fabrication methods such as metallization and UV curing.
4	Understanding of various types of sensors, and advanced sensors such as carbon nanotube and polymer-based sensors.
5	Principles, types, and applications of actuators used in smart systems, and electro thermal actuators.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Understand and distinguish between traditional engineering materials and smart materials, and identify appropriate smart materials for various engineering applications.	*L1,L2,L3*
2	Explain the working principles, properties, and applications of different smart materials and evaluate their suitability for specific engineering and technological applications.	L2,L3,L5
3	Understand and apply suitable processing and fabrication techniques for different smart materials in engineering applications.	L1,L2,L3
4	Identify, describe, and equate different sensor technologies and select appropriate sensors for engineering applications.	L1,L2,L5
5	Demonstrate the working mechanisms of various actuators compare and select suitable actuation methods for different smart materials for create system applications.	L2,L3,L6

UNIT-1

Introduction

Characteristics of metals, polymers and ceramics. Introduction to smart materials. Classification of smart materials, Components of a smart System, Applications of smart material.

UNIT-2

Smart Materials Piezoelectric materials, Electro strictive Materials, Magnetostrictive materials, Magnetoelectric materials, Magnetorheological Electrorheological fluids, Shape Memory materials.

UNIT-3

Processing of Smart Materials Semiconductors and their processing, Metals and metallization techniques, Ceramics and their processing, Polymers and their synthesis, UV radiation curing of polymers, fluids.

UNIT-4

Sensors Introduction, Conductometric sensors, Capacitive sensors, Piezoelectric sensors, Magnetostrictive sensors, Piezoresistive sensors, Optical sensors, Resonant sensors, semiconductor-based sensors, Acoustic sensors, polymerize sensors, Carbon nanotube sensors.

UNIT-5

Actuators Introduction, Electrostatic transducers, Electromagnetic transducers, Electrodynamic transducers, Piezoelectric transducers, Electro-strictive transducers, Magneto-strictive transducers, Electro thermal actuators, Comparison of actuation, Applications

Text Books:

1. Smart Material Systems and MEMS: Design and Development Methodologies, V. K. Varadan, K. J. Vinoy, S. Gopalakrishnan, John Wiley and Sons, England, 2006.
2. Smart Structures and Materials, Brain Culshaw, Artech House, London, 1996.
3. Smart Materials and Structures, Mukesh V. Gandhi, Brian S. Thompson, , Springer, May-1992.

Reference Books:

1. Smart Structures: Analysis and Design, A. V. Srinivasan, Cambridge University Press, Cambridge, New York, 2001.
2. Smart Structures, P. Gauenzi, Wiley, 2009.
3. Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, G. Gautschi, Springer, Berlin, New York, 2002.
4. Analysis and Performance of Fiber Composites, B. D. Agarwal and L. J. Broutman, John Wiley & Sons.
5. Engineering aspects of Shape memory Alloys, T. W. Duerig, K. N. Melton, D. Stockel,C.
6. Mayman, Butterworth – Heinemann, 1990.

Web Resources:

1. https://nptel.ac.in/courses/112104173/

2. www.iop.org/EJ/article/0964-1726/5/3/002/sm6301.ps.gz

MOOCs:

1. https://nptel.ac.in/courses/112104173/

2. https://nptel.ac.in/courses/112104251/

III Year B.Tech. ME – II Semester

Course Code	APPLICATIONS OF COMPUTATIONAL FLUID DYNAMICS (Professional Elective-III)	L	T	P	C
23MET19a		3	0	0	3

Course objectives: The objectives of the course are to	
1	Foundation in numerical techniques, and finite element methods for solving partial differential equations under various boundary conditions.
2	Solid understanding of numerical methods for solving time-dependent partial differential equations, with emphasis on stability and accuracy analysis.
3	To introduce students to numerical formulations for incompressible and compressible viscous flows using finite difference and advanced computational techniques, enabling them to model and analyze fluid flow problems governed by the Euler and Navier-Stokes equations.
4	Knowledge and skills to apply the finite volume method using finite difference formulations for solving two- and three-dimensional fluid flow and heat transfer problems.
5	Understand the concepts of linear fluid flow problems, steady state problems and transient problems.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Formulate and solve partial differential equations using finite element methods, apply and analyze the stability, accuracy of explicit and implicit methods.	*L2,L3,L4*
2	Apply and analyze explicit and implicit numerical schemes, solve nonlinear and second-order PDEs, using appropriate numerical techniques.	L3,L4,L5
3	Create and solve incompressible and compressible viscous flow problems, apply appropriate boundary conditions.	L2,L5,L6
4	Develop and implement finite volume formulations based on finite difference methods, ensuring accurate and conservative solutions in CFD applications.	L1,L3,L6
5	Analyze and solve linear fluid flow problems, using appropriate numerical methods and interpret the physical significance of the computed results.	L1,L4,L5

UNIT I

Introduction and Solution methods

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

UNIT II

Hyperbolic equations:

Hyperbolic equations:explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT III

Formulations Of Incompressible Viscous Flows

Formulations Of Incompressible Viscous Flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

Treatment of compressible flows: potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

UNIT IV

Finite Volume Method:

Finite Volume Method Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT V

Standard Variational Methods:

Standard Variational Methods Linear fluid flow problems, steady state problems, Transient problems.

Textbooks:

1. T. J. C'hung, Computational fluid dynamics, Cambridge University press,2002.
2. John D. Anderson, Computational Fluid Dynamics: Basics with applications, Mc Graw Hill. 2017

Reference Books:

1. Frank Choriton, Text book of fluid dynamics, CBS Publishers & distributors, 1985.
2. Suhas V. Patankar, Numerical heat transfer and fluid flow, Hema shava Publishers corporation & Mc Graw Hill, 1990.
3. Muralidaran, Computational Fluid Flow and Heat Transfer, Narosa Publications, 2003.
4. Tapan K. Sengupta, Fundamentals of Computational Fluid Dynamics, Universities Press, 2004.
5. C. Pozrikidis, Introduction to Theoretical and Computational Fluid Dynamics, Oxford University press, 2/e, 2012.

Online Learning Resources:

- https://nptel.ac.in/courses/112107079
- https://www.youtube.com/watch?v=3QFT7pGx03I
- https://www.youtube.com/watch?v=t7jS7V_6TGQ
- https://nptel.ac.in/courses/112107080

III Year B.Tech. ME – II Semester

Course Code	INDUSTRIAL SAFETY (Professional Elective-III)	L	T	P	C
23MET19b		3	0	0	3

Course objectives: The objectives of the course are to	
1	Understand the concepts of industrial safety and management.
2	Demonstrate the accident preventions and protective equipment.
3	Understand and apply the knowledge of safety acts
4	knowledge about fire prevention and protection systems
5	Understand and apply fire safety principles in buildings

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Students learn the concepts of industrial safety and management.	*L2*
2	Learn about the smart machines and smart sensors	L1,L2
3	Apply IoT to Industry 4.0 and they are able to make a system tailor-made as per requirement of the industry	L4,L5
4	Students learn about fire prevention and protection systems.	L2,L3
5	Students learn and apply the fire safety principles in buildings	L2,L4

UNIT-I

INTRODUCTION TO THE DEVELOPMENT OF INDUSTRIAL SAFETY AND MANAGEMENT: History and development of Industrial safety: Implementation of factories act, Safety and productivity, Safety organizations. Safety committees and structure, Role of management and role of Govt.in industrial safety.

UNIT-II

ACCIDENT PREVENTIONS AND PROTECTIVE EQUIPMENT: Personal protective equipment, Survey the plant for locations, Part of body to be protected, Education and training in safety, Prevention causes and cost of accident, Housekeeping, First aid, Accident reporting, Investigations. Industrial psychology in accident prevention, Safety trials, Safety related to operations.

UNIT-III

SAFETY ACTS: Features of Factory Act, Introduction of Explosive Act, Boiler Act, ESI Act, Workman's compensation Act, Industrial hygiene, Occupational safety, Diseases prevention, Ergonomics, Occupational diseases, stress, fatigue, health, safety and the physical environment, Engineering methods of controlling chemical hazards, safety and the physical environment, Control of industrial noise and protection against it, Code and regulations for worker safety and health, codes for safety of systems.

UNIT-IV

FIRE PREVENTION AND PROTECTION: Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-Fire extinguishing agents- Water, Foam, Dry chemical powder, Carbon-dioxide Halon alternatives Halocarbon compounds-Inert gases, dry powders – types of fire extinguishers – fire stoppers –hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills –first aid for burns.

UNIT-V

BUILDING FIRE SAFETY: Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design -exit– width calculations – fire certificates – fire safety requirements for high rise buildings.

TEXT BOOKS:

1. Occupational Safety Management and Engineering Willie Hammer–PrenticeHall (2000)
2. Purandare D.D & Abhay D.Purandare, ―Handbook on Industrial Fire Safety‖ P&A publications, NewDelhi, 2006.

REFERENCE BOOKS:

1. Installation, Servicing and Maintenance Bhattacharya, S.N.-S.Chandand Co.
2. Jain VK ―Fire Safety in Building‖ New Age International 1996.
3. Reliability, Maintenance and Safety Engineering by Dr.A. K.Guptha
4. A Text book of Reliability and Maintenance Engineering by Alakesh Manna
5. McElroy,FrankE.,―Accident Prevention Manual for Industrial Operations‖, NSC, Chicago, 1988.
6. Green, A.E.,―High Risk Safety Technology‖, John Wiley and Sons, 1984.

Online Learning Resources:

https://nptel.ac.in/courses/110105094

https://youtube.com/playlist?list=PLbRMhDVUMngdXebaRB59KdKwstzuAovua&si=FcbDQzZK6i_3TASD

https://youtube.com/playlist?list=PLbRMhDVUMngdXebaRB59KdKwstzuAovua&si=6RaMiYhEkp5-EfAH

https://youtube.com/playlist?list=PLln3BHg93SQ8RYKhe9czOHq1hVjpEWMts&si=5y0WMqX3wrvvispq

III Year B.Tech. ME – II Semester

Course Code	Design of Automobile Transmission Systems (Professional Elective-III)	L	T	P	C
23MET19c		3	0	0	3

Course objectives: The objectives of the course are to	
1	Explain the various elements involved in a transmission system.
2	Focus on the various forces acting on the elements of a transmission system.
3	Design the system based on the input and the output parameters.
4	Produce working drawings of the system involving pulleys, gears, clutches and brakes.
5	Demonstrate the energy considerations in the design of motion control elements.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Design and select suitable flexible power transmission elements and analyze the load conditions, and performance requirements.	*L2,L4,L6*
2	Analyze spur gear geometry and kinematics, and design spur gears for desired power transmission capacity based on bending and contact stress criteria.	L1,L4,L6
3	Analyze and design different types of gears by evaluating their efficiency, ensuring reliable performance in mechanical power transmission systems.	L4,L5,L6
4	Create speed reducers and multi-speed gearboxes by developing structural and ray diagrams, selecting appropriate gear combinations for various mechanical applications.	L2,L3,L6
5	Select, and design various types of clutches and brakes, analyze and choose appropriate friction materials for effective motion control.	L2,L4,L6

UNIT I

Flexible power transmission systems: Design of Belts – Flat Belts and Pulleys – V Belts and Pulleys – Design of chain drives – Wire ropes .

Design of bearing: Lubrication- hydrodynamic lubrication theory, Design of sliding contact bearing using Sommer field number – Design using Mckee‘s equation – Selection of rolling contact bearings.

UNIT II

Spur gear: Gear geometry – Kinematics – Forces on gear tooth – Stresses in Gear tooth – Selection of gear material based on bending stress and contact stress – Design of Spur gear – Power transmitting capacity.

UNIT III

Helical, bevel and worm gears: Parallel Helical Gears – Kinematics – Tooth proportions – Force analysis – Stresses in Helical gear – Design of helical gear – Crossed Helical gears – Straight Bevel gears – Kinematics – Force analysis – Stresses in straight bevel gear tooth – Design of bevel gear – Worm gearing – Kinematics – Forces - Friction and Efficiencies – Stresses in worm gear tooth.

UNIT IV

Design of gear boxes: Design of Speed reducers – Design of multi speed gear boxes for machine tools – Structural and ray diagrams.

UNIT V

Elements of motion control: Internal – Expanding Rim clutches and Brakes – External – Contracting Rim clutches and Brakes – Band type Clutches – Cone clutches and Brakes – Energy considerations – Temperature rise – Friction materials.

TEXT BOOKS:

1. Joseph Edward Shigley and Charles, R. Mischke, ―Mechanical Engineering Design‖, McGraw –Hill International Editions, 2000.

2. Robert L. Norton, ―Machine Design‖- an integrated approach, (5th Edition) Pearson publisher, 2000

REFERENCES:

1. ―Design Data‖, PSG College of Technology, DPV Printers, Coimbatore, 2005.

2. Malisa, ―Hand Book of Gear Design‖, Tata Mc Graw Hill, International Edition, 2000.

3. V.B. Bhandari ,―Design of Machine Elements‖, Tata Mc Graw Hill, 2001

Online Learning Resources:

https://youtube.com/playlist?list=PLyqSpQzTE6M-7nTyaGekZRTLLUzGfRPMo&si=Jvicxjkhv8LS6Lt_
https://youtube.com/playlist?list=PLyqSpQzTE6M-7nTyaGekZRTLLUzGfRPMo&si=aFp27b3qPylydjCV
https://youtu.be/ftJKqKuppF4?si=wzfkYJUOeDxWHWRW

III Year B.Tech. ME – II Semester

Course Code	MECHANICS AND MANUFACTURING OF COMPOSITE MATERIALS	L	T	P	C
23MET19d	(Professional Elective-III)	3	0	0	3

Course objectives: The objectives of the course are to	
1	Fundamentals of composite materials, including their classification, and to familiarize them with various fiber-reinforced plastic processing techniques used in manufacturing.
2	Understanding of the micro- and macro-mechanical behavior of composite laminas.
3	Equip theoretical and analytical tools for evaluating the strength and mechanical behavior of composite laminates
4	Introduce metal matrix composites (MMCs), focusing on reinforcement materials, base metal selection, fabrication techniques.
5	Deep understanding of micromechanics-based failure analysis in unidirectional composite laminas, and the selection of appropriate failure criteria.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Classify and describe the characteristics of different types of composite materials, and explain and apply various fiber-reinforced plastic processing methods.	*L1,L2,L3*
2	Evaluate the elastic moduli of composite laminas, apply Hooke's law to different material types and solve numerical problems.	L3,L4,L5
3	Analyze the failure of composite laminates, and perform macro-mechanical analysis using Classical Laminate Theory (CLT), for various laminate configurations through numerical problem-solving.	L2,L4,L5
4	Identify and select appropriate reinforcements and base metals for MMCs, understand and apply various fabrication processes.	L1,L2,L3
5	Analyze and evaluate the failure mechanisms of unidirectional lamina using micromechanical models and apply suitable failure theories through practical examples.	L3,L4,L5

UNIT I

Introduction to Composite Materials

Introduction to Composite Materials: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites. **Applications:** Automobile, Aircrafts. missiles. Space hardware, Electrical and electronics, Marine, recreational and sports equipment, future potential of composites.

Fiber Reinforced Plastic Processing: Lay-up and curing, fabricating process, open and closed mould process, hand lay-up techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding.

UNIT II

Micro Mechanical Analysis of a Lamina:

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli by Rule of mixture, Numerical problems.

Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

UNIT III

Biaxial Strength Theories

Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai, Wu tensor theory, Numerical problems.

Macro Mechanical Analysis of Laminate

Introduction, code, Kirchoff hypothesis, CL T, A, B, and D matrices (Detailed derivation) , Special cases of laminates, Numerical problems.

UNIT IV

Metal Matrix Composites:

Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC‘s and its application.

Fabrication Process For MMC's: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

Study Properties Of MMC's: Physical Mechanical, Wear, machinability and Other Properties. Effect of size, shape and distribution of particulate on properties.

UNIT V

Failure Theories

Micromechanics of Failure of Unidirectional Lamina, Anisotropic Strength and Failure Theories, Importance of Shear Strength, Choice of Failure Criteria, Examples.

Textbooks:

1. K.K. Chawla, Composite Materials, Springer-Verlag, New York, 1998.
2. B.T. Astrom, Manufacturing of Polymer Composites, Chapman & Hall, 1997.
3. Stuart M Lee, J. Ian Gray, Miltz, Reference Book for Composites Technology, CRC press, 1989.

Reference Books:

1. Frank L Matthews and R D Rawlings, Composite Materials: Engineering and Science, Taylor and Francis, 2006.
2. D. Hull and T.W. Clyne, Introduction to Composite Materials, Cambridge University Press, 1996.
3. M.R. Piggott, Load Bearing Fibre Composites, Pergamon press, Oxford, 1998.
4. F. Ashby and D.R.H. Jones, Engineering Materials, Pergamon press, 1999.
5. R.W. Davidge and A. Kelly, Mechanical behavior of ceramics, Cambridge university press, 1999.
6. Andrew C. Marshall, Composite Basics, Marshall Consulting. Mode of Evaluation Quiz/Assignment/ Seminar/Written Examination, 1998.

Online Learning Resources:

- https://nptel.ac.in/courses/112104221
- https://nptel.ac.in/courses/112104229
- https://nptel.ac.in/courses/112104161
- https://onlinecourses.nptel.ac.in/noc22_me40/preview

III Year B.Tech. ME – II Semester

Course Code	INTRODUCTION TO HYBRID AND ELECTRIC VEHICLES	L	T	P	C
23MET19e	(Professional Elective-III)	3	0	0	3

Course objectives: The objectives of the course are to	
1	Foundational and applied knowledge of electric vehicle systems, battery technologies, and battery management systems.
2	Understanding of electric vehicle power plants, and drive control techniques essential for efficient electric vehicle propulsion.
3	Knowledge of hybrid and electric vehicle technologies, including their historical evolution and energy efficiency optimization.
4	Provide comprehensive knowledge of electric and hybrid electric vehicle systems, and real-world applications ranging from passenger cars to heavy-duty and fuel cell vehicles.
5	Demonstration of hybrid and electric vehicle design, energy management strategies for efficient and sustainable vehicle operation.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	Analyze and design electric vehicle propulsion and energy storage systems, evaluate battery performance and management strategies	*L3,L4,L5*
2	Implement electric machine operation, design and analyze control power electronic converters, and apply drive control strategies in electric vehicle applications.	L3,L4,L6
3	Analyze hybrid and electric drivetrain configurations, evaluate and create various electric motor drives and hybrid vehicle propulsion systems.	L4,L5,L6
4	Compare hybrid and electric vehicle architectures, understand control strategies for various drive systems, and evaluate the role of emerging technologies in improving vehicle efficiency and sustainability.	L1,L2,L5
5	Design and evaluate hybrid and electric vehicle systems, and applying control and communication principles across various electric and hybrid vehicle architectures.	L3,L5,L6

UNIT I:

Electric Vehicle Propulsion and Energy Sources

Introduction to electric vehicles, vehicle mechanics - kinetics and dynamics, roadway fundamentals propulsion system design - force velocity characteristics, calculation of tractive power and energy required, electric vehicle power source - battery capacity, state of charge and discharge, specific energy, specific power, Ragone plot. battery modeling - run time battery model, first principle model, battery management system- soc measurement, battery cell balancing. Traction batteries - nickel metal hydride battery, Li-Ion, Lipolymer battery.

UNIT II:

Electric Vehicle Power Plant And Drives

Introduction electric vehicle power plants. Induction machines, permanent magnet machines, switch reluctance machines. Power electronic converters-DC/DC converters - buck boost converter, isolated DC/DC converter. Two quadrant chopper and switching modes. AC drives- PWM, current control method. Switch reluctance machine drives - voltage control, current control.

UNIT III:

Hybrid And Electric Drive Trains

Introduction hybrid electric vehicles, history and social importance, impact of modern drive trains in energy supplies. Hybrid traction and electric traction. Hybrid and electric drive train topologies. Power flow control and energy efficiency analysis, configuration and control of DC motor drives and induction motor drives, permanent magnet motor drives, switch reluctance motor drives, drive system efficiency.

UNIT IV:

Electric and Hybrid Vehicles - Case Studies

Parallel hybrid, series hybrid -charge sustaining, charge depleting. Hybrid vehicle case study – Toyota Prius, Honda Insight, Chevrolet Volt. 42 V system for traction applications. Lightly hybridized vehicles and low voltage systems. Electric vehicle case study - GM EV1, Nissan Leaf, Mitsubishi Miev. Hybrid electric heavy duty vehicles, fuel cell heavy duty vehicles.

UNIT V:

Electric And Hybrid Vehicle Design :

Introduction to hybrid vehicle design. Matching the electric machine and the internal combustion engine. Sizing of propulsion motor, power electronics, drive system. Selection of energy storage technology, communications, supporting subsystem. Energy management strategies in hybrid and electric vehicles - energy management strategies- classification, comparison, implementation.

Text Books :

1. Iqbal Hussein, ―Electric and Hybrid Vehicles: Design Fundamentals‖, 2nd edition, CRC Press, 2003.
2. Amir Khajepour, M. Saber Fallah, Avesta Goodarzi, ―Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach‖, illustrated edition, John Wiley & Sons, 2014.

References:

1. James Larminie, John Lowry, ―Electric Vehicle Technology‖, Explained, Wiley, 2003.
2. John G. Hayes, G. Abas Goodarzi, ―Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles‖, 1st edition, Wiley- Blackwell, 2018.
3. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, ―Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design‖, CRC Press, 2004.

Online Learning Resources:

https://nptel.ac.in/courses/108103009

- https://youtube.com/playlist?list=PL9-f9hWLZS62VF18qPQ1gC7NqIAjaClsl&si=JKUPBH9r1LPqsm9-
- https://youtu.be/h5ysddrlXLw?si=UzfPunK1x-MQOAz1
- https://youtu.be/i7Rq0bN8eig?si=iHGLGNTGOzSTaGpW

III Year B.Tech. ME – II Semester

Course Code	Modern Manufacturing Methods (Professional Elective-III)	L	T	P	C
23MET19c		3	0	0	3

Course objectives: The objectives of the course are to	
1	Define various Modern Machining Processes.
2	Acquire knowledge in the elementary mechanism and machinability of materials with different Modern Machining Processes.
3	Determine basic principles of operation for each process and their applications.
4	State various parameters influencing MRR in Non – Traditional Machining Process.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	llustrate advanced machining processes, cutting tools and cutting fluids for a specific material and part features.	*L1,L2,L3*
2	Classify the mechanism of Mechanical Energy based machining processes, its applications and limitations.	L2,L3,L5
3	Differentiate Electrical Energy Based machining processes, mechanism of metal removal, machine tool selection.	L1,L2,L3
4	Interpret Electro Chemical machining process, economic aspects of ECM and problems on estimation of metal removal rate.	L1,L2,L5
5		L2,L3,L6

UNIT I

Non – Traditional Machining Processes: Introduction, Need, Classification and Brief Overview, Considerations in Process selection, Materials, Applications**.**

Mechanical Energy Based Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultra Sonic Machining – Working Principle, Description of Equipment, Process Parameters, Metal Removal Rate, Applications, Advantages and Limitations.

UNIT II

Electrical Energy Based Processes: Electric Discharge Machining – Working Principles, Description of Equipment, Process Parameters, Surface Finish and MRR, Electrode / Tool, Power and Control Circuits, Tool Wear, Dielectric Fluid, Flushing, Advantages, Limitations and Applications. Wire cut EDM – Working Principle and Applications**.**

UNIT III

Chemical and Electro Chemical Energy Based Processes: Chemical Machining and Electro Chemical Machining – Working Principle, Description of Equipment, Etchants, Maskants, Techniques of Applying Maskants, Process Parameters, Surface Finish and MRR, Electro Chemical Grinding, Electro Chemical Honing, Applications, Advantages and Limitations.

UNIT IV

Thermal Energy Based Processes: Laser Beam Machining and Drilling, – Plasma Arc Machining, Electron Beam Machining – Working Principle, Description of Equipment, Process Parameters, Applications, Advantages

and Limitations.

UNIT V

OTHER ADVANCED MACHINING PROCESS

Magnetic Abrasive Finishing: Principle and working, material removal and surface finish and applications.
Abrasive Flow Finishing: Principle and working – Process performance.
Electro Stream Drilling: Principle and working – Process performance,Shaped Tube.
Electrolytic Machining: Principle and working, applications.

Textbooks:

1. Jain V.K., Advanced Machining Processes, 1st Edition, Allied Publishers Pvt. Ltd., New Delhi, 2007.
2. Pandey P.C and Shan H.S., Modern Machining Processes, 1/e, McGraw Hill, New Delhi, 2007.
3. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1/e, Springer, 2010.

Reference Books:

1. Chua C.K., Leong K.F. and Lim C.S., Rapid Prototyping: Principles and Applications, 2/e, World Scientific Publishers, 2003.
2. Benedict G.F., Nontraditional Manufacturing Processes, 1/e, CRC Press, 1987.
3. Mishra P.K., Nonconventional Manufacturing, 1/e, Narosa Publishing House, New Delhi, 2014.
4. McGeough J.A., Advanced Methods of Machining, 1/e, Springer, 1988.

Web Resources:

- https://nptel.ac.in/courses/112/107/112107078/
- https://youtu.be/t3y_Ys3LgGM
- https://www.youtube.com/watch?v=E4VZ_rFqpG4&t=1s
- https://youtu.be/-tcaR7oSx_w
- https://youtu.be/Uybg6VDLoRQ
- https://youtu.be/Uybg6VDLoRQ
- https://youtu.be/aWQsEX1TrSI

III B. Tech -II Sem

23MET20	**AUTOMATION AND ROBOTICS** (Open Elective – II)	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course objectives: The objectives of the course are to		
1	Fundamentals of industrial automation, production types, automation strategies, and hardware elements used in modern manufacturing processes.	
2	Understanding of automated manufacturing systems, and strategies for improving productivity and flexibility in industrial automation.	
3	Knowledge of industrial automation and robotics, sensors, and end-effector design for modern manufacturing environments.	
4	Explain industrial automation and robotics, and trajectory planning for intelligent and efficient manufacturing applications.	
5	Familiarity of industrial automation and robotics, and practical applications in manufacturing processes.	
COURSE OUTCOMES On successful completion of this course the student will be able to		
1	derstand and analyze the structure and functions of automated manufacturing systems, and evaluate hardware components for efficient production.	*L2,L4,L5*
2	alyze and design automated flow lines with or without buffer storage, perform quantitative evaluations, apply assembly line balancing techniques.	L4,L5,L6
3	ssify robot configurations, select suitable actuators and sensors, analyze and apply automation and robotics principles to optimize production efficiency and flexibility.	L2,L3,L4
4	ply kinematic and dynamic modeling using D-H notation and select appropriate hardware and control strategies for real-world industrial scenario to analyze and design automated and robotic systems.	L3,L4,L5
5	sign, program, and implement robotic systems, understand and apply robotics technology to manufacturing tasks.	L1,L3,L6

UNIT-I

Introduction to Automation:

Introduction to Automation, Need, Types, Basic elements of an automated system, Manufacturing Industries, Types of production, Functions in manufacturing, Organization and information processing in manufacturing, Automation strategies and levels of automation, Hardware components for automation and process control, mechanical feeders, hoppers, orienters, high speed automatic insertion devices.

UNIT –II

Automated flow lines:

Automated flow lines, Part transfer methods and mechanisms, types of Flow lines, flow line with/without buffer storage, Quantitative analysis of flow lines. Assembly line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

UNIT- III

Introduction to Industrial Robotics:

Introduction to Industrial Robotics, Classification of Robot Configurations, functional line diagram, degrees of freedom. Components common types of arms, joints grippers, factors to be considered in the design of grippers.

Robot actuators and Feedback components: Actuators, Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors.

UNIT- IV

Manipulator Kinematics:

Manipulator Kinematics, Homogenous transformations as applicable to rotation and transition - D-H notation, Forward inverse kinematics.

Manipulator Dynamics: Differential transformations, Jacobians, Lagrange - Euler and Newton – Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion, joint integrated motion - straight line motion.

UNIT- V

Robot Programming:

Robot Programming, Methods of programming - requirements and features of programming languages, software packages. Problems with programming languages.

Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading - Process - spot and continuous arc welding & spray painting - Assembly and Inspection.

Text Books:

1. Automation , Production systems and CIM,M.P. Groover /Pearson Edu.
2. Industrial Robotics - M.P. Groover, TMH.

References:

1 Robotics , Fu K S, McGraw Hill, 4th edition, 2010.

2 An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.

3 Robotic Engineering , Richard D. Klafter, Prentice Hall

4 Robotics, Fundamental Concepts and analysis – Ashitave Ghosal ,Oxford Press, 1/e, 2006

5 Robotics and Control , Mittal R K &Nagrath I J , TMH.

Online Learning Resources:

https://www.youtube.com/watch?v=yxZm9WQJUA0&list=PLRLB5WCqU54UJG45UnazSYmnmhl-gt76o

https://www.youtube.com/watch?v=6f3bvIhSWyM&list=PLRLB5WCqU54X5Vy4DwjfSODT3ZJgwEjyE

III Year B.Tech. ME – II Semester

Course Code	HEAT TRANSFER LAB	L	T	P	C
23MEP10		0	0	3	1.5

Course Objectives: Students undergoing this course would	
1	Understand different modes of heat transfer
2	Gain knowledge about natural and force convection phenomenon
3	Estimate experimental uncertainty in measurements

Course Outcomes: Upon the successful completion of course, students will be able to	
1	Explain different modes of heat transfer
2	Identify parameters for measurement for calculating heat transfer
3	Determine effectiveness of heat exchanger
4	Design new equipment related to heat transfer
5	Apply principles of heat transfer in wide application in industries.

List of Experiments:

1. Determine the overall heat transfer coefficient across the width of composite wall
2. Determine the thermal conductivity of a metal rod
3. Determine the thermal conductivity of insulating powder material through concentric sphere apparatus
4. Determine the thermal conductivity of insulating material through lagged pipe apparatus
5. Determine the efficiency of a pin fin in natural and forced convection.
6. Determine the heat transfer coefficient for a vertical cylinder in natural convection
7. Determine the heat transfer coefficient in forced convection of air in a horizontal tube.
8. Determine the heat transfer coefficients on film and drop wise condensation apparatus.
9. Determine the effectiveness of a parallel and counter flow heat exchanger.
10. Study the pool boiling phenomenon and different regimes of pool boiling.
11. Experiment on pool boiling
12. Determine the emissivity of the test plate surface.
13. Experiment on Stefan-Boltzmann apparatus
14. Determine the heat transfer rate coefficient in fluidized bed apparatus.

Virtual Lab:-

1. Determination of thermal conductivity of a metal rod

   https://sites.google.com/view/vlab-bnmitmech/home/heat-transfer-lab/determination-of-thermal-conductivity-of-a-metal-rod
2. Natural Convection heat transfer

   https://sites.google.com/view/vlab-bnmitmech/home/heat-transfer-lab/natural-convection
3. Heat Transfer by Radiation

   https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=802&cnt=1
4. HeattransferbyConduction

   https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=801&cnt=1
5. The Study of phase change

   https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=709&cnt=1
6. BlackBodyRadiation:DeterminationofStefan'sConstant

   https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=548&cnt=1
7. Newton's Law of Cooling

   https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=354&cnt=1
8. Lee's Disc Apparatus

   https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=353&cnt=1
9. ThermoCouple-SeebeckEffect
10. https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=351&cnt=1

B.Tech (ME)– III-II Sem

23MEP11	**CAD/CAM Lab (Professional Core)**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

Course objectives: The objectives of the course are to	
1	Develop students' skills in drafting and understanding orthographic, isometric views, and CAD file formats like DXE and IGES.
2	Enable the creation of 3D part models using basic and advanced features in CAD tools.
3	Hands-on experience in assembly modeling using both feature-based and Boolean-based methods.
4	Familiarize with CAM software for generating NC code for various machining processes.
5	Expertise industrial manufacturing via the use of post-processors and NC machines for real-time machining.

Course Outcomes: On successful completion of the course, the student will be able to,		
1	Create accurate 2D technical drawings using orthographic and isometric projections, and interpret file formats like DXE and IGES.	*L1,L2,L3*
2	Develop 3D part models using features such as protrude, revolve, shell, and sweep, and demonstrate and evaluate parent-child relationships.	*L2,L3,L5*
3	Construct and analyze assemblies using feature-based and Boolean operations for simple mechanical systems and create complex mechanical assemblies.	*L3,L4,L6*
4	Generate NC code for complex surfaces using CAM tools and study the function of various post-processors.	*L1,L3,L6*
5	Transfer NC code to CNC machines. Perform and evaluate basic machining tasks such as turning and milling and generate new technics by using modern tools.	*L4,L5,L6*

List of Experiments:

1. **Drafting:** Development of part drawings for various components in the form of orthographic and isometric. Representation of Dimensioning and tolerances scanning and plotting. Study of script, DXE AND IGES FILES.

2. **Part Modelling:** Generation of various 3D Models through Protrusion, revolve, shell sweep. Creation of various features. Study of parent child relation.

3. **Assembly modelling:** Feature based and Boolean based modelling surfaces, Assembly Modelling of simple components and Design of simple components.

4. CAM**:**

a) Study of various post processors used in NC Machines.

b) Development of NC code for free form and sculptured surfaces using CAM packages.

c) Machining of simple components on NC lathe and Mill by transferring NC Code / from a CAM packages. Through Any Four Software Packages from the following: Use of Auto CAD, Micro Station, CATIA, Pro-E, I-DEAS, , CAEFEM, Gibbs CAM, Master CAM etc,.

5. Evaluation of Stress/Strain for a plate with a hole.

III Year B.Tech. ME – II Semester

Course Code	3 D PRINTING LAB (Skill Enhancement Course)	L	T	P	C
23MEP12		0	1	2	2

Course Objectives: Students undergoing this course would	
1	Understand different methods of 3D Printing.
2	Gain knowledge about simulation of FDM process
3	Estimate time and material required for manufacturing a 3D component

Course Outcomes: Upon the successful completion of course, students will be able to	
1	Explain different types of 3d Printing techniques
2	Identify parameters for powder binding and jetting process
3	Determine effective use of ABS material for 3D Printing
4	Apply principles of mathematics to evaluate the volume of material require.

Module 1:

Introduction to Prototyping, Working of 3D Printer, Types of 3D printing Machines:

Exp 1: Modelling of Engineering component and conversion of STL format.

Exp 2: Slicing of STL file and study of effect of process parameter like layer thickness, orientation, and infill on build time using software.

Exercise 1 : Component-1

Exercise 2 : Component-2

Module 2:

Exp 1 : 3D Printing of modelled component by varying layer thickness.

Exp 2 : 3D Printing of modelled component by varying orientation.

Exp 3: 3D Printing of modelled component by varying infill.

Module 3:

Study on effect of different materials like ABS, PLA, Resin etc, and dimensional accuracy.

Module 4:

Identifying the defects in 3D Printed components.

Module 5

Exp1: Modelling of component using 3D Scanner of real life object of unknown dimension in reverse engineering.

Exp 2: 3D Printing of above modelled component.

References:

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1/e, Springer, 2010.
2. Chua C.K., Leong K.F. and Lim C.S., Rapid Prototyping: Principles and Applications, 2/e, World Scientific Publishers, 2003.

Online Learning Resources/Virtual Labs:

- https://www.hubs.com/knowledge-base/introduction-fdm-3d-printing/
- https://slideplayer.com/slide/6927137/
- https://www.mdpi.com/2073-4360/12/6/1334
- https://www.centropiaggio.unipi.it/sites/default/files/course/material/2013-11-29%20-%20FDM.pdf
- https://lecturenotes.in/subject/197
- https://www.cet.edu.in/noticefiles/258_Lecture%20Notes%20on%20RP-ilovepdf-compressed.pdf
- https://www.vssut.ac.in/lecture_notes/lecture1517967201.pdf
  https://www.youtube.com/watch?v=NkC8TNts4B4

B. TECH-ME-III-II Sem

23BST28	TECHNICAL REPORT WRITING & IPR	L	T	P	C
		2	0	0	0

Course Objectives:·

1. To enable the students to practice the basic skills of research paper writing
2. To make the students understand the importance of IP and to educate them on the basic concepts of Intellectual Property Rights.
3. To practice the basic skills of performing quality literature review
4. To help them in knowing the significance of real life practice and procedure of Patents.
5. To enable them learn the procedure of obtaining Patents, Copyrights, & Trade Marks

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

COURSE OUTCOMES: At the end of the course, students will be able to		**Blooms Level**
CO1	Identify key secondary literature related to their proposed technical paper writing	L1, L2
CO2	Explain various principles and styles in technical writing	L1, L2
CO3	Use the acquired knowledge in writing a research/technical paper	L3
CO4	Analyse rights and responsibilities of holder of Patent, Copyright, Trademark, International Trademark etc.	L4
CO5	Evaluate different forms of IPR available at national & international level	L5
CO6	Develop skill of making search of various forms of IPR by using modern tools and techniques.	L3, L6

UNIT – I:

Principles of Technical Writing: styles in technical writing; clarity, precision, coherence andlogical sequence in writing-avoiding ambiguity- repetition, and vague language -highlighting your findings-discussing your limitations -hedging and criticizing -plagiarism and paraphrasing .

UNIT – II:

Technical Research Paper Writing: Abstract- Objectives-Limitations-Review of Literature- Problems and Framing Research Questions- Synopsis

UNIT – III:

Process of research: publication mechanism: types of journals- indexing-seminars- conferences- proof reading – plagiarism style; seminar & conference paper writing;
Methodology-discussion-results- citation rules

UNIT – IV:

Introduction to Intellectual property: Introduction, types of intellectual property, International organizations, agencies and treaties, importance of intellectual property rights
Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

UNIT – V:

Law of copy rights: Fundamentals of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.Patent law, intellectual property audits.

Textbooks:

1. Deborah. E. Bouchoux, *Intellectual Property Rights*, Cengage Learning India, 2013
2. Meenakshi Raman, Sangeeta Sharma. *Technical Communication:Principles and practices.*Oxford.

Reference Books:

1. R.Myneni, *Law of Intellectual Property*, 9th Ed, Asia law House, 2019.
2. Prabuddha Ganguli,*Intellectual Property Rights* Tata Mcgraw Hill, 2001
3. P.Naryan,*Intellectual Property Law*, 3rd Ed ,Eastern Law House, 2007.
4. Adrian Wallwork. *English for Writing Research Papers*Second Edition. Springer Cham Heidelberg New York ,2016
5. Dan Jones, Sam Dragga, *Technical Writing Style*

Online Resources

1. **https://theconceptwriters.com.pk/principles-of-technical-writing/**
2. **https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/TechPaperWriting.html**
3. **https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/TechPaperWriting.html**
4. **https://www.manuscriptedit.com/scholar-hangout/process-publishing-research-paper-journal/**
5. **https://www.icsi.edu/media/website/IntellectualPropertyRightLaws&Practice.pdf**
6. **https://lawbhoomi.com/intellectual-property-rights-notes/**
7. **https://www.extension.purdue.edu/extmedia/ec/ec-723.pdf**

B.Tech (ME)– Honor's in Mechanical Engineering (R23)

23MEH01	AUTOMOTIVE THERMAL SYSTEM	L	T	P	C
		3	0	0	3

Unit I

Fundamentals and Systematic Approach to Heat Transfer Concepts

Energy, Heat & Work, First Law of Thermodynamics, Heat Engines, Refrigerators, and Heat Pumps, Second Law of Thermodynamics, Carnot Cycle, Conduction, Convection-Parallel flow on a Isothermal Plate, A cylinder in cross flow, Flow in Ducts, Free Convection, Radiation. Formulation of Thermal System Design-Requirement and Specifications, Design Variables, Constraints. Designing a workable system, Optimization methods -overview and significance

Unit II

Automotive Engine Thermal Management

Fundamentals of First & Second Law of Thermodynamics to the engine performance (Volumetric efficiency and Thermal Efficiency), heat balance equation, Fundamentals of Exergy, Energy analysis, Thermal Models and Operating Strategy- smart valve, variable speed pump, variable speed fan. Applications of Thermoelectric generators and Thermoelectric coolers, Applications of heat pipes and heat sink.

Unit III

Fundamentals of Automotive Climate Control

Psychrometric properties, Use of psychrometric chart, coefficient of performance, Refrigerants – Types of refrigerants, Properties and Selection of refrigerants, Factors affecting the air flow, Types of fans, Axial and Centrifugal fans, Load calculations, Winter air-conditioning, Two-phase flow effects in the Evaporator and Condenser, air side heat transfer on the Evaporator and Condenser, System mass effects, Simplified cabin thermal model. Convective thermal interaction-cabin air and atmosphere.

Unit IV

Fundamentals- Heat Exchangers

Functions of radiator, compressor, Functions of condenser, evaporator, expansion valve, Classification of heat exchangers – According to transfer process, Number of fluids, surface compactness, Construction features, flow arrangements, heat transfer mechanisms, Selection and design of heat exchangers based on – Types, heat transfer rate, cost, pumping power, size and materials. Coolant- function, types, and required properties. Advanced cooling system with smart valve, variable speed pump, variable speed fan, engine block, radiator, and sensors (temperature, mass flow rate and power).

Unit V

Thermal management in EV systems

Temperature sensitivity and heat generation of batteries- electro-thermal, Internal heat generation, Rate of Discharge, Battery ageing, Thermal runaway, battery heat transfer medium. Role of thermal management in power electronics and controllers, heat sink design and configuration, Application of microfluidics and nano fluids.

TEXT BOOKS:

1. Yunus A Cengel, Afshin J Ghajar, "Heat and Mass Transfer"., Tat McGraw Hill Education Private Limited, New Delhi,2018

2. W. F. Stoecker Design of Thermal Systems Third Edition, McGraw – Hill, New york, 1989
3. HoSung Lee "Thermal Design: Heat Sinks, Thermoelectrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells" 2011 John Wiley & Sons, Inc

REFERENCES:

1. Jaluria, Yogesh.Design and optimization of thermal systems 2nd Edition CRC Press, Taylor & Francis Group 2018.
2. Quansheng Zhang "Automotive Air Conditioning Optimization, Control and Diagnosis" Springer International Publishing AG 2016
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2012.
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003 8. "Bosch' Automotive Handbook", 8thEdition

Online Learning Resources:

https://nptel.ac.in/courses/112108317
https://nptel.ac.in/courses/112108149
https://nptel.ac.in/courses/112103275
https://nptel.ac.in/courses/112103276

B.Tech (ME)– Honor's in Mechanical Engineering (R23)

23MEH02	SIMULATION AND MODELLING OF MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

UNIT – I

System – ways to analyze the system – Model – types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages & Disadvantages. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1& 2 errors – Framing – strong law of large numbers.

UNIT – II

Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modeling – Techniques for verification – statistical procedures for developing credible model. Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling.

UNIT – III

Generation of random variates – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – weibull – normal Bernoullie – Binomial – uniform – poisson. Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs Simulators – software features – statistical capabilities – G P S S – SIMAN- SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages.

UNIT – IV

Output data analysis – Types of Simulation w.r.t output data analysis – warmup period- Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons

UNIT –V

Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – Newboy paper problem.

TEXT BOOKS:

1. Law, A.M. & Kelton, "Simulation Modelling and Analysis", McGraw Hill, 2nd Edition, New York, 1991.
2. Narahari and M. Vishwanathan Prentice hall England wood Cliffs, "Performance modelling of automated manufacturing systems". NJ USA 1992.

REFERENCES:

1. Carrie A. / Wiley, NY, "Simulation of Manufacturing Systems", 1990.
2. Ross, S.M., McMillan, NY, "A Course in Simulation", 1990. Simulation Modelling and SIMNET / Taha H.A / PH, Englewood Cliffs, NJ, 1987.
3. Banks J. & Carson J.S., PH, "Discrete Event System Simulation", Englewood Cliffs, NJ, 1984

Online Learning Resources:

https://nptel.ac.in/courses/112102318
https://nptel.ac.in/courses/112104188
https://nptel.ac.in/courses/112104189
https://nptel.ac.in/courses/112101005

B.Tech (ME)– Honor's in Mechanical Engineering (R23)

23MEH03	SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

UNIT-1

Introduction to Supply Chain Management

Supply chain - objectives - importance - decision phases - process view -competitive and supply chain strategies - achieving strategic fit – supply chain drivers - obstacles – framework - facilities -inventory-transportation-information-sourcing-pricing.

UNIT-2

Designing the distribution network

Role of distribution - factors influencing distribution - design options - e-business and its impact – distribution networks in practice –network design in the supply chain - role of network -factors affecting the network design decisions modeling for supply chain. Role of transportation - modes and their performance – transportation infrastructure and policies - design options and their trade-offs tailored transportation.

UNIT-3

Supply Chain Analysis.

Sourcing - In-house or Outsource - 3rd and 4th PLs - supplier scoring and assessment, selection - design collaboration - Procurement process - Sourcing planning and analysis. Pricing and revenue management for multiple customers, perishable products, seasonal demand, bulk and spot contracts.

UNIT-4

Dimensions of Logistics

A macro and micro dimension - logistics interfaces with other areas - approach to analyzing logistics systems - logistics and systems analysis - techniques of logistics system analysis - factors affecting the cost and importance of logistics. Demand Management and Customer Service Outbound to customer logistics systems - Demand Management –Traditional Forecasting - CPFRP - customer service - expected cost of stock outs - channels of distribution.

UNIT-5

Recent Trends in Supply Chain Management-Introduction, New Developments in Supply Chain Management, Outsourcing Supply Chain Operations, Co-Maker ship, The Role of E-Commerce in Supply Chain Management, Green Supply Chain Management, Distribution Resource Planning, World Class Supply Chain Management

TEXT BOOKS:

1. Sunil Chopra and Peter Meindl, Supply Chain Management – "Strategy, Planning and Operation", 3rd Edition, Pearson/PHI, 2007.
2. Supply Chain Management by Janat Shah Pearson Publication 2008.

REFERENCE BOOKS:

1. A Logistic approach to Supply Chain Management – Coyle, Bardi, Longley, Cengage Learning, 1/e
2. Donald J Bowersox, Dand J Closs, M Bixby Coluper, "Supply Chain Logistics Management", 2nd edition, TMH, 2008.
3. Wisner, Keong Leong and Keah-Choon Tan, "Principles of Supply Chain Management A Balanced Approach", Cengage Learning, 1/e
4. David Simchi-Levi et al, "Designing and Managing the Supply Chain" – Concepts.

Online Learning Resources:

https://nptel.ac.in/courses/112103774
https://nptel.ac.in/courses/112107219
https://nptel.ac.in/courses/112101005

B.Tech (ME)– Honor's in Mechanical Engineering (R23)

23MEH04	ADVANCED MECHANISM DESIGN	L	T	P	C
		3	0	0	3

UNIT– I

Introduction – review of fundamentals of kinematics - analysis and synthesis – terminology, definitions and assumptions – planar, spherical and spatial mechanisms‟ mobility – classification of mechanisms – kinematic Inversion – Grashoff`s law Position and displacement – complex algebra solutions of planar vector equations – coupler curve generation velocity – analytical methods - vector method – complex algebra methods – Freudenstein‟s theorem

UNIT– II

Planar complex mechanisms - kinematic analysis - low degree complexity and high degree complexity, Hall and Ault`s auxiliary point method – Goodman‟s indirect method for low degree of complexity mechanisms Acceleration – analytical methods – Chase solution - Instant centre of acceleration. Euler-Savory equation - Bobillier construction

UNIT – III

Synthesis of mechanisms: Type, number and dimensional synthesis – function generation – two position synthesis of slider crank and crankrocker mechanisms with optimum transmission angle – three position synthesis – structural error – Chebychev spacing - Cognate linkages – Robert-Chebychev theorem – Block‟s method of synthesis, Freudenstein‟s equation

UNIT – IV

Static force analysis of planar mechanism – static force analysis of planar mechanism with friction – method of virtual work Dynamic force analysis of planar mechanisms - Combined static and inertia force analysis

UNIT – V

Kinematic analysis of spatial revolute-Spherical-Spherical-Revolute mechanism – Denavit-Hartenberg parameters – forward and inverse kinematics of robotic manipulators

TEXT BOOK:

1. Amitabh Ghosh and Ashok Kumar Mallik, "Theory of Mechanisms and Machines,",3e,EWP, 1999
2. Arthur G. Erdman and G.N. Sandor, "Advanced Mechanism Design: Analysis and Synthesis", Vol. II, PHI, 1984.

REFERENCES:

1. Shighley Joseph Edwards and Uicker John Joseph, "Theory of Machines and Mechanism", 2e, McGraw Hill,1985.
2. Arthur G. Erdman and G.N. Sandor, "Advanced Mechanism Design: Analysis and Synthesis", Vol. I, PHI, 1984.

Online Learning Resources:

https://nptel.ac.in/courses/112101005
https://nptel.ac.in/courses/112104230
https://nptel.ac.in/courses/112107258

B.Tech (ME)– Honor's in Mechanical Engineering (R23)

23MEH05	BIO MECHANICS	L	T	P	C
		3	0	0	3

Unit I

Introductory Mechanics – Statics and Dynamics – Basic Principles. The human body as a biomechanical system – basic terminologies.

Unit II

Kinematics of muscles and joints - free-body diagrams and equilibrium, forces and stresses in joints

Biomechanical analysis of joints of upper limb - Shoulder, Elbow, wrist, hand and fingers.

Unit III

Upper limb as a mechanical system – analysis of reaching as movement of a multi-link serial chain – forward kinematics, analysis of fingertip forces as a parallel manipulator

Unit IV

Biomechanical analysis of joints – Spine, Hip, Knee, Ankle. Introduction to Postural stability and Gait analysis. Gait analysis in health and disease - basics. Mechanics of Hard Tissues - Definition of Stress and Strain, Deformation Mechanics, structure and mechanical properties of bone - cortical and cancellous bones, Wolff's law of bone remodeling.

Unit V

Soft Tissues - Structure, functions, material properties – tendon function, elasticity in a tendon, models of non-linear elasticity in a tendon – physiological and non-physiological regimes, Davis' law of soft tissue remodeling. Visco-elastic properties of soft tissues, Models of visco-elasticity: Maxwell & Voight models. Basic Biofluid mechanics - Flow properties of blood in the intact human cardiovascular system.

TEXT BOOKS

1. David A. Winter, Biomechanics and Motor Control of Human Movement .
2. Margareta Nordin and Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System.

REFERENCE BOOKS

1. Francisco Valero-Cuevas, Fundamentals of Neuromechanics.
2. Susan Hall, Basic Biomechanics.
3. Irving Hermann, Physics of Human Body.

Online Learning Resources:

https://nptel.ac.in/courses/112105305
https://nptel.ac.in/courses/112104029

B.Tech (ME)– Honors(R23)

		L	T	P	C
23MEH06	**APPLIED PROJECT WORK**	**0**	**0**	**6**	**3**

23MEM01	MATERIAL SCIENCE & ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I

Structure of Metals & Constitution of Alloys

Structure of Metals: Crystal Structures: Unit cells, Metallic crystal structures, Imperfection in solids: Point, Line, interstitial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

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

UNIT II

Steels & Cast irons

Steels: Plain carbon steels, use and limitations of plain carbon steels. AISI& BIS classification of steels. Classification of alloys steels. Microstructure, properties and applications of alloy steels-stainless steels and tool steels.

Cast irons: Microstructure, properties and applications of white cast iron, malleable cast iron, grey cast iron, nodular cast iron and alloy cast irons.

UNIT III

Heat Treatment of Steels:

Annealing, tempering, normalizing and hardening, isothermal transformation diagrams for Fe-Fe_3C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening - carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, and vacuum and plasma hardening

UNIT IV

Non-ferrous Metals and Alloys Microstructure, properties and applications of copper, aluminium, titanium, nickel and their alloys. Study of Al-Cu phase diagram

UNIT V

Ceramics, Polymers and Composites

Structure, properties and applications of ceramics, polymers and composites. Introduction to super alloys and nanomaterials.

Text Book(s)

1. V.Raghavan, Material Science and Engineering, 5/e, Prentice Hall of India, 2004.
2. R.Balasubramaniam, Callister's Material Science and Engineering, 2/e, Wiley India, 2014.

References

1. Y. Lakhtin, Engineering Physical Metallurgy, University Press of the Pacific, 2000.
2. S.H.Avner, Introduction to Physical Metallurgy, 2/e, Tata McGraw- Hill, 1997.
3. L.H.Van Vlack, Elements of Material Science and Engineering, 6/e, Pearson Education, 2008.
4. George E.Dieter, Mechanical Metallurgy, 3/e, McGraw-Hill, 2013.

Online Learning resources
https://nptel.ac.in/courses/113107078
https://nptel.ac.in/courses/112107767
https://nptel.ac.in/courses/113104073

23MEM02	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives:

- Familiarize of additive manufacturing / rapid prototyping and its applications in various fields.
- Impart reverse engineering technologies.
- Explain different processes available in additive manufacturing.

UNIT – I

Introduction to Additive Manufacturing (AM) Systems: History and Development of AM, Need of AM, Difference between AM and CNC, Classification of AM Processes: Based on Layering Techniques, Raw Materials and Energy Sources, AM Process Chain, Benefits and Applications of AM, Representation of 3D model in STL format, RP data formats: SLC, CLI, RPI, LEAF, IGES, CT, STEP, HP/GL.

UNIT – II

CAD & Reverse Engineering: Basic Concept, Digitization techniques, Model Reconstruction, Data Processing for Additive Manufacturing Technology: CAD model preparation, Part Orientation and support generation, Model Slicing, Tool path Generation, Software's for Additive Manufacturing Technology: MIMICS, MAGICS. Reverse Engineering (RE) –Meaning, Use, RE – The Generic Process, Phase of RE Scanning, Contact Scanners, Noncontact Scanners, Point Processing, Application Geometric Model, Development.

UNIT – III **Solid and Liquid Based AM Systems:** Stereolithography (SLA): Principle, Process, Materials,Advantages, Limitations and Applications.Solid Ground Curing (SGC): Principle, Process,Materials, Advantages, Limitations, Applications.Fusion Deposition Modeling (FDM): Principle, Process,Materials, Advantages, Limitations, Applications.Laminated Object Manufacturing (LOM): Principle,Process, Materials, Advantages, Limitations,Applications.

UNIT – IV

Powder Based AM Systems: Principle and Process of Selective Laser Sintering (SLS), Advantages, Limitations and Applications of SLS, Principle and Process of Laser Engineered Net Shaping (LENS), Advantages, Limitations and Applications of LENS, Principle and Process of Electron Beam Melting (EBM), Advantages, Limitations and Applications of EBM.

UNIT – V

Other Additive Manufacturing Systems: Three Dimensional Printing (3DP): Principle, Process, Advantages, Limitations and Applications. Ballistic Particle Manufacturing (BPM): Principle, Process, Advantages, Limitations, Applications. Shape Deposition Manufacturing (SDM): Principle, Process, Advantages, Limitations, Applications.

Text Books:

1. Ian Gibson, David W. Rosen, Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", 1st edition, Springer, 2010.
2. Chua C.K., Leong K.F. and Lim C.S., "Rapid Prototyping: Principles and Applications", 2nd edition, World Scientific Publishers, 2003.

3. Liou W. Liou, Frank W., Liou, "Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development", CRC Press, 2007.

Reference Books:

1. Pham D.T. and Dimov S.S., "Rapid Manufacturing; The Technologies and Application of RPT and Rapid Tooling", Springer, London 2001.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC Press, 2005.
4. RafiqNoorani, "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons, 2006.

Online Learning resources

https://nptel.ac.in/courses/112103306
https://nptel.ac.in/courses/112104312
https://nptel.ac.in/courses/112101623
https://nptel.ac.in/courses/113108632

23MEM03	MATERIALS CHARACTERIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

UNIT — I:

STRUCTURE ANALYSIS BY POWDER X-RAY DIFFRACTION

Introduction, Bragg's law of diffraction, Intensity of Diffracted beams —factors affecting Diffraction Intensities - structure of polycrystalline Aggregates, Determination of crystal structure, Crystallite size by Scherrer and WH Methods, Small angle X-ray scattering (SAXS) (in brief).

UNIT — II:

MICROSCOPY TECHNIQUE -1—SCANNING ELECTRON MICROSCOPY (SEM)

Introduction, Principle, Construction and working principle of Scanning Electron Microscope, Specimen preparation, Different types of modes used (Secondary Electron and Backscatter Electron), Advantages, limitations and applications of SEM.

UNIT — III:

MICROSCOPY TECHNIQUE -2 - TRANSMISSION ELECTRON MICROSCOPY (TEM)

Construction and Working principle, Resolving power and Magnification, Bright and dark fields, Diffraction and image formation, Specimen preparation, Selected Area Diffraction, Applications of Transmission Electron Microscopy, Difference between SEM and TEM, Advantages and Limitations of Transmission Electron Microscopy.

UNIT — IV:

SPECTROSCOPY TECHNIQUES

Principle, Experimental arrangement, Analysis and Advantages of the spectroscopic techniques — (i) UV-Visible spectroscopy (ii) Raman Spectroscopy, (iii) Fourier Transform infrared (FTIR) spectroscopy, (iv) X-ray photoelectron spectroscopy (XPS).

UNIT — V:

ELECTRICAL & MAGNETIC CHARACTERIZATION TECHNIQUES

Electrical Properties analysis techniques (DC conductivity, AC conductivity) Activation Energy, Effect of Magnetic field on the electrical properties (Hall Effect). Magnetization measurement by induction method, Vibrating sample Magnetometer (VSM) and SQUID (Superconducting Quantum Interference Device)

Text Books:

1. Material Characterization: Introduction to Microscopic and Spectroscopic Methods — **Yang** Leng — John Wiley & Sons (Asia) Pvt. Ltd. 2008
2. Micro structural Characterization of Materials - David Brandon, Wayne D Kalpan, **John** Wiley & Sons Ltd., 2008.

Reference Books:

1. Fundamentals of Molecular Spectroscopy — IV Ed. — Colin Neville Banwell and Elaine M. McCash, Tata McGraw-Hill, 2008.
2. Elements of X-ray diffraction — Bernard Dennis Cullity & Stuart R Stocks, Prentice Hall ,2001 — Science.

Online Learning resources

https://nptel.ac.in/courses/113105100
https://nptel.ac.in/courses/112107767

23MEM04	3D PRINTING MATERIALS & APPLICATIONS	L	T	P	C
		3	0	0	3

UNIT I

Introduction to 3D Printing

Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP.

UNIT II

Solid and Liquid Based RP Systems

Working Principle, Materials, Advantages, Limitations and Applications of Fusion Deposition Modelling (FDM), Laminated Object Manufacturing (LOM), Stereo lithography (SLA), Direct Light Projection System (DLP) and Solid Ground Curing (SGC).

UNIT III

Powder Based & Other RP Systems

Powder Based RP Systems: Working Principle, Materials, Advantages, Limitations and Applications of Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Laser Engineered Net Shaping (LENS) and Electron Beam Melting (EBM).

Other RP Systems: Working Principle, Materials, Advantages, Limitations and Applications of Three Dimensional Printing (3DP), Ballastic Particle Manufacturing (BPM) and Shape Deposition Manufacturing (SDM).

UNIT IV

Rapid Tooling & Reverse Engineering

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

Reverse Engineering (RE): Meaning, Use, RE – The Generic Process, Phases of RE Scanning, Contact Scanners and Noncontact Scanners, Point Processing, Application Geometric Model, Development

UNIT V

Errors in 3D Printing and Applications:

Pre-processing, processing and post-processing errors, Part building errors in SLA, SLS, etc. Software: Need for software, MIMICS, Magics, SurgiGuide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, Solid View, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP. Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.

Textbooks:

1. Chee Kai Chua and Kah Fai Leong, “3D Printing and Additive Manufacturing Principles and Applications” 5/e, World Scientific Publications, 2017.
2. Ian Gibson, David W Rosen, Brent Stucker, “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, Springer, 2/e, 2010.

Reference Books:

1. Frank W.Liou, "Rapid Prototyping & Engineering Applications", CRC Press, Taylor & Francis Group, 2011.
2. Rafiq Noorani, "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley&Sons, 2006.

Online Learning Resources:

- NPTEL Course on Rapid Manufacturing.
- https://nptel.ac.in/courses/112/104/112104265/
- https://www.hubs.com/knowledge-base/introduction-fdm-3d-printing/
- https://slideplayer.com/slide/6927137/
- https://www.mdpi.com/2073-4360/12/6/1334
- https://www.centropiaggio.unipi.it/sites/default/files/course/material/2013-11-29%20-
- %20FDM.pdf
- https://lecturenotes.in/subject/197
- https://www.cet.edu.in/noticefiles/258_Lecture%20Notes%20on%20RP-ilovepdfcompressed.pdf
- https://www.vssut.ac.in/lecture_notes/lecture1517967201.pdf
- https://www.youtube.com/watch?v=NkC8TNts4B4.

23MEM05	CAD/CAM	L	T	P	C
		3	0	0	3

UNIT–I

Overview of CAD/CAM: Product cycle, CAD, CAM and CIM. CAD Tools, CAM Tools, Utilization in an Industrial Environment, Evaluation criteria. CAD data structure, Data base management systems.

Computer Graphics: Co-ordinate systems, Graphics package functions, 2D and 3D transformations, clipping, hidden line / surface removal color, shading.

UNIT–II

Geometric Modeling: Representation techniques, Parametric and non-parametric representation, various construction methods, wire frame modeling, synthetic curves and their representations, surface modeling, synthetics surfaces and their representations. Solid modeling, solid representation, fundamentals, introduction to boundary representations, constructive solid geometry representations

UNIT- III

Numerical Control: NC, NC Modes, NC Elements, NC Machine tools and their structure, Machining center, types and features. Controls in NC, CNC systems, DNC systems. Adaptive control machining systems, types of adaptive control.

CNC Part Programming: Fundamentals, NC word, NC Nodes, canned cycles, cutter radius compensation, length compensation, computed assisted part programming using APT: Geometry statements, motion statements, post process statements, auxiliary statements, macro statement program for simple components.

UNIT -IV

Group Technology & FMS: Part Family, Classification and Coding, advantages & limitations, Group technology machine cells, benefits. FMS: Introduction, components of FMS, material handling systems, Computer control systems, advantages. Computer Aided Quality Control: Terminology in Quality control, Inspection and testing, Contact inspection methods - optical and non-optical, integration of CAQC with CAD and CIM.

UNIT- V

Computer Aided Processes Planning: Retrieval type and Generative type, benefits Machinability data systems, Computer generated time standards.

Computer integrated production planning: Capacity planning, shop floor control, MRP-I, MRP- II, CIMS benefits. Trends in manufacturing systems: Concepts of Reconfigurable manufacturing, Sustainable manufacturing and lean manufacturing.

Textbooks:

1. Mikell P. Groover, Emory W. Zimmers , CAD/CAM, 5/e, Pearson Prentice Hall of India, Delhi, 2008.
2. Ibrahim Zeid, R.Siva Subramanian, CAD/CAM: Theory and Practice, 2/e, Tata McGraw-Hill, Delhi, 2009.

Reference Books:

1. P. N. Rao, CAD/CAM: Principles and applications, 3/e, Tata McGraw-Hill, Delhi, 2017.
2. P. Radhakrishnan, S. Subramanyan& V. Raju, CAD/CAM/CIM, 3/e, New Age International Publishers, 2008.
3. Computer Aided Manufacturing, 3/e, Tien Chien Chang, Pearson, 2008.

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc20_me44/preview
- https://www.youtube.com/watch?v=EgKc9L7cbKc
- https://www.youtube.com/watch?v=KXFpTb9cBpY
- https://web.iitd.ac.in/~hegde/cad/lecture/L01_Introduction.pdf
- https://www.vssut.ac.in/lecture_notes/lecture1530947994.pdf
- https://www.iare.ac.in/sites/default/files/lecture_notes/CAD_CAM_LECTURE_NOTES.pdf

23MEM06	COMPUTER AIDED MACHINE DRAWING	L	T	P	C
		0	0	3	1.5

I. The following contents are to be done by any 2D software package

Conventional representation of materials and components:

Detachable joints: Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut, stud joint, screw joint and foundation bolts.

Riveted joints: Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints.

Welded joints: Lap joint and T joint with fillet, butt joint with conventions.

Keys: Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.

Couplings: rigid – Muff, flange; flexible – bushed pin-type flange coupling, universal coupling, Oldhams' coupling.

II. The following contents to be done by any 3D software package

Sectional views

Creating solid models of complex machine parts and create sectional views.

Assembly drawings: (Any four of the following using solid model software)

Lathe tool post, tool head of shaping machine, tail stock, machine vice, gate valve, carburettor, piston, connecting rod, eccentric, screw jack, plumber block, axle bearing, pipe vice, clamping device, Geneva cam, universal coupling,

Manufacturing drawing:

Representation of limits, fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

Text books:

1. K.L.Narayana, P.Kannaiah and K.Venkat Reddy, Production Drawing, New Age International Publishers, 3/e, 2014
2. Software tools/packages- Auto CAD, Solid works or equivalent.

Reference Books:

1. Cecil Jensen, Jay Helsel and Donald D.Voisinet, Computer Aided Engineering Drawing, Tata Mcgraw-Hill, NY, 2000.
2. James Barclay, Brain Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2003.
3. N.D.Bhatt, Machine Drawing, Charotar, 50/e, 2014.

Online Learning Resources:
https://eeedocs.files.wordpress.com/2014/02/machinedrawing.pdf

23MEM07	3D PRINTING PRACTICE (Lab)	L	T	P	C
		0	0	3	1.5

Course Objectives:

Students undergoing this course would

- Understand different methods of 3D Printing.
- Gain knowledge about simulation of FDM process
- Estimate time and material required for manufacturing a 3D component

Module 1:

Introduction to Prototyping, Working of 3D Printer, Types of 3D printing Machines:
Exp 1: Modelling of Engineering component and conversion of STL format.
Exp 2: Slicing of STL file and study of effect of process parameter like layer thickness, orientation, and infill on build time using software.
Exercise 1 : Component-1
Exercise 2 : Component-2

Module 2:

Exp 1 : 3D Printing of modelled component by varying layer thickness.
Exp 2 : 3D Printing of modelled component by varying orientation.
Exp 3: 3D Printing of modelled component by varying infill.

Module 3:

Study on effect of different materials like ABS, PLA, Resin etc, and dimensional accuracy.

Module 4:

Identifying the defects in 3D Printed components.

Module 5

Exp1: Modelling of component using 3D Scanner of real life object of unknown dimension in reverse engineering.
Exp 2: 3D Printing of above modelled component.

References:

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1/e, Springer, 2010.
2. Chua C.K., Leong K.F. and Lim C.S., Rapid Prototyping: Principles and Applications, 2/e, World Scientific Publishers, 2003.
3.

Online Learning Resources/Virtual Labs:

- https://www.hubs.com/knowledge-base/introduction-fdm-3d-printing/
- https://slideplayer.com/slide/6927137/
- https://www.mdpi.com/2073-4360/12/6/1334
- https://www.centropiaggio.unipi.it/sites/default/files/course/material/2013-11-29%20-%20FDM.pdf
- https://lecturenotes.in/subject/197
- https://www.cet.edu.in/noticefiles/258_Lecture%20Notes%20on%20RP-ilovepdf-compressed.pdf
- https://www.vssut.ac.in/lecture_notes/lecture1517967201.pdf
- https://www.youtube.com/watch?v=NkC8TNts4B4

(23MEM08) PRODUCTION PLANNING & CONTROL

Course objectives: The objectives of the course are to	
1	Understand the various components and functions of production planning and control
2	Explain the importance of Work study.
3	Familiarize with the terminology of product planning, process planning
4	Impart knowledge 0n Production Scheduling Policies and its Types.
5	Teach the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP). .

	Course Outcomes: On successful completion of the course, the student will be able to,			
	CO1	Students can able to prepare production planning and control activities.	L2	
	CO2	Understand the concepts of Work study.	L1, L2	
	CO3	Analyse the Pre requisite information needed for process planning	L2, L3	
	CO4	Understand the Scheduling techniques.	L1, L2	
	CO5	Students can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).	L3, L4	

UNIT - I

Introduction

Objectives and benefits of planning and Control-Functions of production Control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational Aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even ana a new design.

UNIT - II

Work Study

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT - III

Product Planning And Process Planning

Product planning-Extending the original product information-Value Analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi-product system.

UNIT - IV

Production Scheduling

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT – V

Inventory Control And Recent Trends In PPC

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder Procedure-Introduction to computer integrated production planning systems- elements of Just in Time Systems-Fundamentals of MRP II and ERP.

Textbooks:

1. James. B. Dilworth," Operations management – Design, Planning and Control for manufacturing and services" McGraw Hill International edition 1992.
2. Mart and Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

Reference Books:

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990.
4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, "Operations management – A value driven approach" Irwin McGraw hill.

Online Learning Resources:

https://www.youtube.com/watch?v=yYIVumq6sVM
https://nptel.ac.in/courses/110107141
https://nptel.ac.in/courses/112107143
https://www.youtube.com/watch?v=Q7KpUY8spmM

(23MEM09) MARKETING MANAGEMENT

Course objectives: The objectives of the course are to	
1	Developing and understanding of ideas and nuances of modern marketing.
2	Describe the process to formulate and manage the B2B marketing strategy including all key components.
3	Explain the techniques to conduct market analysis practices including market segmentation and targeting.
4	Compare and contrast different perspectives that characterize the study of consumer behavior.
5	Explain the role of IMC in the overall marketing program.

Course Outcomes: On successful completion of the course, the student will be able to,		
CO1	Knowledge of analytical skills in solving marketing related problem.	L2, L4
CO2	Awareness of marketing management process	L2, L3
CO3	Identify the scope and significance of Marketing in Domain Industry	L1, L2
CO4	Examine marketing concepts and phenomenon to current business events In the Industry.	L6, L4
CO5	illustrate market research skills for designing innovative marketing strategies for business firms	L3, L4

UNIT – I

Introduction

Marketing – Definitions - Conceptual frame work – Marketing environment: Internal and External – Marketing interface with other functional areas – Production, Finance, Human Relations Management, Information System. Mark global environment – Prospects and Challenges.

UNIT – II

Marketing Strategy

Marketing strategy formulations – Key Drivers of Marketing Strategies - Strategies for Industrial Marketing – Consumer Marketing — Services marketing – Competitor analysis - Analysis of consumer and industrial markets – Strategic Marketing Mix components.

UNIT - III

Marketing Mix Decisions

Product planning and development – Product life cycle – New product Development and Management – Market Segmentation – Targeting and Positioning – Channel Management – Advertising and sales promotions – Pricing Objectives, Policies and methods.

UNIT - IV

Buyer Behaviour

Understanding industrial and individual buyer behaviour - Influencing factors – Buyer Behaviour Models – Online buyer behaviour - Building and measuring customer satisfaction – Customer relationships management – Customer acquisition, Retaining, Defection.

UNIT – V

Marketing Research & Trends In Marketing

Marketing Information System – Research Process – Concepts and applications: Product – Advertising – Promotion – Consumer Behaviour – Retail research – Customer driven organizations - Cause related marketing - Ethics in marketing –Online marketing trends.

Textbooks:

1. Philip Kotler and Kevin Lane Keller, Marketing Management, PHI 14/e, 2012
2. Paul Baines, Chris Fill and Kelly Page, Marketing, Oxford University Press, 2/e,2011.
3. Kotler, Philip(2002) Marketing Management, Millennium Edition. Intl ed. US: Prentice Hall, 2002

Reference Books:

1. Philip Kotler and Kevin Lane Keller, Marketing Management, PHI 14th Edition, 2012
2. KS Chandrasekar, "Marketing management-Text and Cases", Tata McGraw Hill, First edition,2010
3. Lamb, hair, Sharma, Mc Daniel– Marketing – An Innovative approach to learning and teaching-A south Asian perspective, Cengage Learning — 2012
4. Paul Baines, Chris Fill and Kelly Page, Marketing, Oxford University Press, 2/e,2011.
5. MichealR.Czinkota& Masaaki Kotabe, Marketing Management, Cengage, 2000.

Online Learning Resources:

https://nptel.ac.in/courses/110104068
https://www.youtube.com/watch?v=uTIfDBH80HU&list=PLPjSqITyvDeUgSjU9XcEdZmd5Epz1L-Yn
https://www.youtube.com/watch?v=XD7Ie16qMT4&list=PLNsppmbLKJ8JSbzCxO8TYG8HDxxO5sSmV

(23MEM10) SUPPLY CHAIN MANAGEMENT

Course objectives: The objectives of the course are to	
1	Provide Knowledge on logistics and supply chain management
2	Enable students in designing the distribution network
3	Train the students in knowing the supply chain Analysis
4	Impart knowledge on Dimensions of logistic
5	know the recent trends in supply chain management

Course Outcomes: On successful completion of the course, the student will be able to,		
CO1	erstand the strategic role of logistic and supply chain management in the cost reduction and offering best service to the customer	L2
CO2	erstand Advantages of SCM in business	L2
CO3	ly the knowledge of supply chain Analysis	L4, L2
CO4	lyze reengineered business processes for successful SCM implementation	L6, L4
CO5	Evaluate Recent trend in supply chain management	L3, L4

UNIT-1

Introduction to Supply Chain Management

Supply chain - objectives - importance - decision phases - process view -competitive and supply chain strategies - achieving strategic fit – supply chain drivers - obstacles – framework - facilities -inventory-transportation-information-sourcing-pricing.

UNIT-2

Designing the distribution network

Role of distribution - factors influencing distribution - design options - e-business and its impact – distribution networks in practice –network design in the supply chain - role of network -factors affecting the network design decisions modelling for supply chain. Role of transportation - modes and their performance – transportation infrastructure and policies - design options and their trade-offs tailored transportation.

UNIT-3

Supply Chain Analysis.

Sourcing - In-house or Outsource - 3rd and 4th PLs - supplier scoring and assessment, selection - design collaboration - Procurement process - Sourcing planning and analysis. Pricing and revenue management for multiple customers, perishable products, seasonal demand, bulk and spot contracts.

UNIT-4

Dimensions of Logistics

A macro and micro dimension - logistics interfaces with other areas - approach to analyzing logistics systems - logistics and systems analysis - techniques of logistics system analysis - factors affecting the cost and importance of logistics. Demand Management and Customer Service Outbound to customer logistics systems - Demand Management –Traditional Forecasting - CPFRP - customer service - expected cost of stock outs - channels of distribution.

UNIT-5

Recent Trends in Supply Chain Management-Introduction, New Developments in Supply Chain Management, Outsourcing Supply Chain Operations, Co-Maker ship, The Role of E-Commerce in Supply Chain Management, Green Supply Chain Management, Distribution Resource Planning, World Class Supply Chain Management

TEXT BOOKS:

1. Sunil Chopra and Peter Meindl, Supply Chain Management – "Strategy, Planning and Operation", 3rd Edition, Pearson/PHI, 2007.
2. Supply Chain Management by Janat Shah Pearson Publication 2008.

REFERENCE BOOKS:

1. A Logistic approach to Supply Chain Management – Coyle, Bardi, Longley, Cengage Learning, 1/e
2. Donald J Bowersox, Dand J Closs, M Bixby Coluper, "Supply Chain Logistics Management", 2nd edition, TMH, 2008.
3. Wisner, Keong Leong and Keah-Choon Tan, "Principles of Supply Chain Management A Balanced Approach", Cengage Learning, 1/e
4. David Simchi-Levi et al, "Designing and Managing the Supply Chain" – Concepts

Online Learning Resources:

https://nptel.ac.in/courses/109105494
https://nptel.ac.in/courses/110108056
https://nptel.ac.in/courses/110106045
https://nptel.ac.in/courses/110105141

(23MEM11) STRATEGIC MANAGEMENT FOR COMPETITIVE ADVANTAGE

Course objectives: The objectives of the course are to	
1	Explain Strategic Management concepts and their use in business
2	Provide information pertaining to Business, Corporate and Global Reforms
3	Learn various steps in strategic implementation.
4	Acquaint the learners with recent developments and trends in the business corporate world
5	Provide importance of corporate Governance and Ethical Issues.

Course Outcomes: On successful completion of the course, the student will be able to,		
CO1	Understand new forms of Strategic Management concepts and their use in business	L1,L2
CO2	Summarize strategic formulation process.	L2, L3
CO3	Develop analytical skills to solve cases and to provide strategic solutions	L3, L4
CO4	Understand Strategic Evaluation, Monitoring and Control	L1, L2
CO5	Create awareness on corporate Governance and Ethical Issues.	L3, L4

Unit I

Basic concepts

Basic Concepts of Strategic Management, Strategic Management Process, Vision, Mission and Goals, Benefits and Risks of Strategic Management, Levels of Strategies Concepts of corporate strategy, Corporate, Business and Operational Level Strategy, Functional Strategies: Human Resource Strategy, Marketing Strategy, Financial Strategy, Operational Strategy Business Environment: Components of Environment Micro and Macro and Environmental Scanning. Competitive Analysis - Competition and Competitor Analysis, Porter Five Forces Model Internal Corporate analysis, Sustainability, Value Chain Analysis.

Unit II

Strategic Formulation:

Strategic Choices and Importance, Formulation of Alternative Strategies: Generic Strategies, Grand Strategy, Diversification Mergers, Acquisitions, Takeovers, Joint Ventures, Diversification, Turnaround, Divestment and Liquidation. Strategic Analysis and Choice: Issues and Structures, Corporate Portfolio Analysis-SWOT Analysis, BCG Matrix, GE Nine Cell Matrix, Hofer's Matrix, ETOP-Environmental Threat and Opportunity Profile, Strategic Choice-Factors and Importance.

Unit III

Strategic Implementation:

Strategy Implementation - Strategy and Structure Steps, Importance and Problems, Resource Allocation-Importance & Challenges Strategic 7S Framework; Management of Change Strategy Implementation - Organizational culture and Leadership; Functional Strategies.

Unit IV

Strategic Evaluation, Monitoring and Control - Strategic Controls; Balanced Scorecard; Strategy map Evaluation and Control: Importance, Limitations and Techniques Budgetary Control: Advantages, Limitations. Corporate Restructuring Strategies: Concept, Need and Forms, Corporate Renewal Strategies: Concept, Internal and External factors and Causes.

Unit V

Corporate Governance and Ethical Issues, Corporate Social Responsibility and sustainability, Strategic Enablers: Innovation and Entrepreneurship, Knowledge Management, Technology Management. Public Private Participation: Importance, Problems and Governing Strategies of PPP Model. Information technology Driven Strategies: Importance, Limitations and contribution of IT sector in Indian Business. Start-up Business Strategies and Make in India Model: Process of business startups and its Challenges, Growth Prospects and government initiatives in Make in India Model with reference to National manufacturing, Contribution of Make in India Policy in overcoming industrial sickness

TEXT BOOKS:

1. Strategic Management, A Dynamic Perspective-Concepts and Cases– Mason A. Carpenter, Wm. Gerard Sanders, Prashant Salwan, Published by Dorling Kindersley (India) Pvt Ltd, Licensees of Pearson Education in south Asia.
2. Strategic Management and Competitive Advantage-ConceptsJay B. Barney, William S. Hesterly, Published by PHI Learning Private Limited, New Delhi.
3. Strategic Management Formulation, Implementation and Control, Pearce & Robinson, McGraw-Hill Publications.

REFERENCE BOOKS:

1. Crafting and Executing Strategy – The Quest for Competitive Advantage, Thomson & Strickland, McGraw-Hill Publications, 21st edition.
2. Exploring Strategy – Text and Cases, Gerry Johnson, Richard Whittington, Kevan Scholes, Duncan Angwin, and Patrick Regner, Pearson, 10th edition.
3. Strategic Management - Planning for Domestic and Global Competition, John A. Pearce II, Richard B.Robinson, Amita Mital, McGraw Hill Education, 14th edition.
4. Contemporary Strategy Analysis – Text and Cases, Robert M. Grant, 8th ed, John Wiley & Sons Inc.
5. Strategic Management – An Integrated Approach, Charles Hill & Gareth Jones, Cengage Learning, 9th edition.

Online Learning Resources:

https://nptel.ac.in/courses/110105161
https://nptel.ac.in/courses/110108161

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(23A03M12) **SIX SIGMA & LEAN MANUFACTURING**

Course objectives: The objectives of the course are to	
1	Teach the students, the basic concepts of six sigma and lean manufacturing.
2	Expose with various quality issues in Inspection.
3	Gain Knowledge on quality control and its applications to real time.
4	Know the extent of cellular manufacturing and 5S.
5	Understand the importance of Quality standards in manufacturing.

Course Outcomes: On successful completion of the course, the student will be able to,		
CO1	Summarize various techniques that are related to the six-sigma and lean manufacturing	L2
CO2	Outline the concepts of cellular manufacturing, JIT and TPM	L2, L3
CO3	Illustrate the principles and implementation of 5S techniques	L1, L2
CO4	Discuss procedure and principles of value stream mapping	L6, L4
CO5	Determine the reliability function using six-sigma.	L3, L4

UNIT — 1

Introduction to Six-Sigma

Probabilistic models-Six Sigma measures-Yield-DPMO-Quality level-Reliability function using Six Sigma- MTTF using Six Sigma-Maintenance free operating period- Availability using Six- Sigma Point availability-Achieved availability-Operational Availability-Examples.

UNIT — II

The Elements of Six Sigma and their Determination

The Quality Measurement Techniques: SQC, Six Sigma, Cp and Cpk- The Statistical quality control (SQC) methods-The relationship of control charts and six sigma-The process capability index (Cp)Six sigma approach-Six sigma and the 1.5 a shift-The Cpk Approach Versus Six Sigma-Cpk and process average shift- Negative Cpk-Choosing six sigma or Cpk-Setting the process capability index-Examples.

UNIT — III

Introduction to Lean Manufacturing

Conventional Manufacturing versus Lean Manufacturing — Principles of Lean Manufacturing —Basic elements of lean manufacturing — Introduction to LM Tools.

UNIT — IV

Cellular Manufacturing, JIT, TPM

Cellular Manufacturing — Types of Layout, Principles of Cell layout, Implementation. JIT —Principles of JIT and Implementation of Kanban. TPM — Pillars of TPM, Principles and implementation of TPM.

UNIT — V:

Set Up Time Reduction, TQM, 5S, VSM 10

Set up time reduction — Definition, philosophies and reduction approaches. TQM Principles and implementation. 5S Principles and implementation - Value stream mapping procedure and principles.

Text Books:

1. U Dinesh Kumar, Crocker, Chitra and Harithe Saranga, Reliability and Six Sigma, Springer Publishers.
2. Sung H. Park, Six Sigma for Quality and Productivity Promotion, Asian Productivity Organization

Reference Books:

1. Sammy G. Shina, Six Sigma for Electronics Design and Manufacturing, McGraw-Hill.
2. Design and Analysis of Lean Production Systems, Ronald G. Askin & Jeffrey B. Goldberg, John Wiley & Sons, 2003.
3. **Mikell** P. Groover (2002) Automation, Production Systems and **CIM.**
4. **Rother M.** and Shook J, 1999 Learning to See: Value Stream Mapping to Add Value and Eliminate Muda` , Lean Enterprise Institute, Brookline, MA.

Online Learning Resources:

https://nptel.ac.in/courses/110105123
https://nptel.ac.in/courses/110105039

B.Tech (ME)– MINORS(R23)

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23MEM13	**APPLIED PROJECT WORK**	**0**	**0**	**6**	**3**