Seventh Semester

B. Tech. (7th Semester) Mechanical Engineering							
MEO-401	**SMART MATERIALS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to develop the understanding of various aspects of smart materials, smart structures and their applications.						
Course Outcomes							
CO1	Students will be able to recognize the key concepts behind classification and fabrication of smart materials and various functions of intelligent materials.						
CO2	Students will be able to categorize the various types of smart structure systems, actuators and sensors.						
CO3	Students will be able to describe the various types of SMA based hybrid composites and smart battery materials.						
CO4	Students will be able to perceive the structure and properties of various types of nanotubes.						

UNIT-I

Smart materials: key concepts: Introduction to smart materials, definition of smart materials, define smart materials, basic principles behind smart properties, classification of smart materials according to their production technologies and applications in various industries, approaches to fabrication of smart materials, properties of smart materials, nanoscale and microscale structure property relationship, Intelligent materials, primitive functions of intelligent materials, intelligence inherent in materials, intelligent materials in harmony with humanity, intelligent biological materials, biomimetics.

UNIT-II

Smart materials and structural systems: Introduction, actuator materials, sensing technologies, sensing technologies, microsensors, intelligent systems, hybrid smart materials, passive sensory smart structures, reactive actuator based smart structures, active sensing and reactive smart structures, smart skins.

UNIT–III

Shape memory alloys: Phase transition, shape-memory effect, shape memory alloy fiber/metal matrix composites, shape memory alloy fiber/polymer matrix composites, SMA particulate / aluminum matrix composites.

Smart battery materials: Introduction, electrochemical concepts involved in a battery, types of batteries, lithium ion batteries, layered oxide cathodes, spinel oxide cathodes, olivine oxide cathodes, carbon anodes.

UNIT–IV

Nanoscale intelligent materials and structures: Introduction, nanotube geometric structures, structures of carbon nanotubes, structures of non-carbon nanotubes, designations of nanotubes and nanostructured materials, mechanical and physical properties of nanotubes; elastic properties, electrical conductivity, magnetoresistance, piezo-resistance, electrokinetics of nanotube, piezoelectric properties, electrochemical effects, nanotube power generation, nanotube contact phenomena.

Text books:

1. Smart Materials and Structures - M.V. Gandhi and B.S. Thompson, Chapman and Hall pub.
2. Encyclopedia of Smart Materials - Mel Shwartz Vol.1 and 2, John Wiley & Sons, Inc.
3. Nano engineering of Structural, Functional, and Smart Materials - Mark J. Schulz, Ajit D. Kelkar, and Mannur J. Sundaresan , Taylor and Francis Pub.

Reference books:

1. Micro and smart systems - Ananthasuresh, Wiley India Ltd.
2. Coursera course Smart Materials: Microscale and Macroscale Approaches - Peter the great St. Petersburg Polytechnic University.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEO-405	**NON-DESTRUCTIVE TESTING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to make the students understand about different inspection and testing methods of components safely and without damage.						
Course Outcomes							
CO1	Students will be able to learn the fundamental concepts of NDT.						
CO2	Students will be able to describe the different methods of NDE.						
CO3	Students will be able to describe the concept of thermography and eddy current testing.						
CO4	Students will be able to explain the ultrasonic testing and acoustic emissions.						

UNIT-I

Introduction to NDT: NDT vs destructive testing, overview of the don-destructive, Testing methods for the detection of manufacturing defects as well as material characterization, relative merits and limitations, various physical characteristics of materials and their applications in NDT, visual inspection – unaided and aided

UNIT-II

Surface NDE methods: Liquid penetrant testing – principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, testing procedure, interpretation of results, magnetic particle testing-theory of magnetism, inspection materials magnetization methods, interpretation and evaluation of test indications, principles and methods of demagnetization, residual magnetism.

UNIT–III

Thermography and eddy current testing (ET): Thermography- principles, contact and non-contact inspection methods, techniques for applying liquid crystals, advantages and limitations – infrared radiation and infrared detectors, instrumentations and methods, applications, eddy current testing-generation of eddy currents, properties of eddy currents, eddy current sensing elements, probes, instrumentation, types of arrangement, applications, advantages, limitations, interpretation/evaluation

UNIT–IV

Ultrasonic testing (UT) and acoustic emission (AE): Ultrasonic testing-principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan, phased array ultrasound, time of flight diffraction, acoustic emission technique–principle, AE parameters, applications.

Text books:

1. Non-Destructive Testing - Baldev Raj, T. Jayakumar, M. Thavasimuthu Narosa Publishing House.
2. Non-Destructive Testing Techniques - Ravi Prakash, 1st revised edition, New Age International Publishers.

Reference books:

1. ASM Metals Handbook,Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio.
2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.
3. Handbook of Nondestructive evaluation by Charles, J. Hellier, McGraw Hill, New York 2001.
4. Introduction to Non-destructive testing: a training guide by Paul E Mix, Wiley, 2nd Edition New Jersey, 2005.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEO-407	**MANUFACTURING COST ESTIMATION**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to impart the students with the knowledge of cost estimating function and controls, organizing and staffing for cost estimation and cost estimation of machining, joining and finishing processes.						
Course Outcomes							
CO1	Students will be able to describe cost reduction techniques, cost estimating functions, and establish staff and organization for cost estimation.						
CO2	Students will be able to discuss cost estimating controls and various estimating procedures.						
CO3	Students will be able to estimate the costs for different machining and casting processes.						
CO4	Students will be able to estimate the costs for different joining and surface finishing processes.						

UNIT-I

The estimating function and costing studies: Explanation of terms, importance of the life of the product, target cost, product costs, purpose of estimating, types of estimates, a systematic approach to cost reduction, cost reduction examples, team efforts.

Organizing and staffing for estimating: Coordinated product cost estimating, cost estimating department, type of organization and cost estimating, qualifications of a cost estimator, development of a cost estimator.

UNIT-II

Cost estimating controls: Administrative controls, initiating cost requests, estimating methods, controlling the cost estimate, controlling estimate deviations, estimating in a changing cost environment, do's and don'ts of cost estimating.

Estimating procedures: Cost estimating analysis, part analysis, preliminary manufacturing plan, facilities, direct material cost, tooling costs, manufacturing time, direct labour costs, factory burden, total manufacturing cost.

UNIT–III

Cost estimation for machining: Traditional machining operations defined, gathering information, economical machining, cost modelling and calculations, grinding application, milling application, non-traditional machining applications.

Estimating casting costs: Casting materials, casting processes, determining material costs, foundry tooling defined, molding costs, core costs, machining and cleaning costs, heat treatment, inspection and shipping costs, foundry burden.

UNIT–IV

Estimation of cost: Joining Costs: Welding, Braze Welding, Brazing, Soldering, Electron Beam Welding, Laser Beam Welding, Plasma Arc Welding, Adhesive Bonding, Fastening, Ultrasonic Welding.

Estimating surface finishing costs: Deburring, ultrasonic cleaning, polishing, honing, hybrid finishing processes, painting, electroplating, cost modelling and calculations.

Text books:

1. Realistic cost estimating for manufacturing. Third Edition - Lembersky, Michael Society of Manufacturing Engineers, 2016.
2. Process Planning and Cost Estimation, Second Edition - R. Kesavan, C. Elanchezhian, B. Vijaya Ramanath, New age international publishers.

Reference books:

1. Process Planning And The Cost Estimation - M. Adithan, New age international publishers.
2. Estimating and Costing for the Metal Manufacturing Industries - Robert Creese (Author), M. Adithan (Author), CRC Press

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEO-409	**ERGONOMICS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	0	0	3	75	25	100	3
Purpose	The purpose of this course is to make the students aware of the human factor engineering principles and its application to different disciplines.						
Course Outcomes							
CO1	Students will be able to explain the ergonomics fundamentals and anthropometry.						
CO 2	Students will be able to analyse the human posture, relative movements and human behavior and perception.						
CO 3	Students will be able to apply the ergonomics principles in visuals display and product designing.						
CO 4	Students will be able to describe the workstation design and occupational safety.						

UNIT-I

Discipline approach: ergonomics/ human factors: Introduction to ergonomics, Fitting task to man their contractual structure, domain, philosophy and objective, mutual task comfort: two way dialogue, communication model, ergonomics/ human factors fundamentals, physiology (work physiology) and stress.

Human physical dimension concern: Human body- structure and function, anthropometrics, Anthropometry: body growth and somatotypes, static and dynamic anthropometry, stand posture-erect, Anthropometry landmark: sitting postures, Anthropometry: squatting and cross-legged postures, anthropometric measuring techniques, statistical treatment of data and percentile calculations.

UNIT-II

Posture and movement: Human body- structure and function, posture and job relation, posture and body supportive devices, chair characteristics, vertical work surface, horizontal work surface, movement, work counter

Behaviour and perception: Communication and cognitive issues, psycho-social behaviour aspects, behaviour and stereotype, information processing and perception, cognitive aspects and mental workload, human error and risk perception

UNIT-III

Visual Issues: Visual performance, visual displays, environments factors, environmental factors influencing human performance

Ergonomic design process: Ergonomics design methodology, Ergonomics criteria/check while designing, Design process involving ergonomics check, some checklists for task easiness.

UNIT-IV

Performance support and design intervention: Occupational safety and stress at workplace in view to reduce the potential fatigue, errors, discomforts and unsafe acts workstation design, furniture support, vertical arm reach and design application possibility

Humanising design: Design and human compatibility, comfort and adaptability aspects, Design Ergonomics in India: scope for exploration.

Text Books:

1. Introduction to Ergonomics - R. Bridger-CRC Press, Taylor & Francis Group.
2. Human Factors in Engineering and Design-M. Sanders, E. McCormick, McGraw-Hill International Editions: Psychology Series.
3. An Introduction to Human Factors Engineering-C. Wicknes, S. Gordon, Y. Liu and S. Gordon-Becker, New York.
4. Indian Anthropometric Dimensions for Ergonomic Design Practice-D. Chakrabarti, National Institute of Design, Ahmedabad.

Reference Books:

1. Handbook of Human Factors and Ergonomics-G. Salvendy, John Wiley & Sons, Inc.
2. Ergonomics for Beginners, A Quick Reference Guide, J. Dul and B. Weerdmeester, CRC Press, Taylor & Francis Group.

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEO-411	**AIR AND NOISE POLLUTION**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	0	0	3	75	25	100	3
Purpose	The objective of this course is to analyze the emissions from automobiles, industries and to describe various techniques of reducing these emissions. Also to understand the concept to control noise pollution.						
Course Outcomes							
CO1	Students will be able to analyze the emissions from industries and various vehicles.						
CO2	Students will be able to understand standards, alternative control strategies and AAQ guidelines.						
CO3	Students will be able to describe various processes for desulfurization, flue control methods for various exhaust gases.						
CO4	Students will be able to explain the characterization of noise, physical sound and various noise barriers.						

UNIT-I

Introduction: Concept of unpolluted air, gaseous and vapour pollutants in atmosphere, scales of air pollution, primary and secondary pollutants, ambient air quality, monitoring of pollutants (SO_2, NO_2, O_3, PAN, particulates, hydrocarbons, PAH's) and their health effects, stack monitoring for SO_x, NO_x, CO, CO_2, Hydrocarbons, Fluorides, Ammonia, VOCs, effects of air pollution on vegetation, materials and structures, stack monitoring for thermal power plant, oil refinery industry, fertilizer industry, non-ferrous metal industry. recent techniques of online stack monitoring, emission inventory, trends of AAQ in urban, rural and Industrial areas.

UNIT-II

Air quality: National and International air emission standards and AAQ guidelines, indoor air quality, averaging time, air pollution system, alternative control strategies, GLC estimates for multiple sources using standard software (e.g., EPA's ISC model), determination of effective stack height.

UNIT–III

Emission Standards and Particulate matter: Distribution and sources of particulate matter, Hood duct design, particulate collection mechanisms, control systems and their design, flue-gas desulfurization processes, flue gas control methods for NO_x, emission standards for automobiles, origin of exhaust emissions from gasoline, diesel, CNG and LPG engines, crankcase and evaporative emissions, emission reduction by fuel changes, emission reduction by engine design changes, catalytic converters, diesel engine emissions.

UNIT–IV

Noise: Characteristics, sources, types of noise, impact of noise.

Physics of sound- Speed of sound, sound pressure, frequency, wavelength, RMS sound pressure, sound pressure level, loudness, sound power level and sound energy density, sound propagation, wind and temperature gradient.

Enclosures and Barriers: Lead as a noise barrier, plenum barriers, barrier around pipe, wires and rectangular ductwork, high transmission loss ceilings, acoustical foams, nylon in noise reduction, damping compounds.

Noise measuring equipments: Sound level meter, octave band analyzer, statistical analyzer and noise average meter.

Text books:

1. Rao M.N. and Rao H.V.N., "Air Pollution", Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Wang L.K., Pereira N.C., Hung Y.T., "Advanced Air and noise pollution control", Volume I andII, Humana Press, New Jersey.

Reference books:

1. Ghassemi A., "Pollution Control and Waste Minimization", Marcel Dekker, Inc., New York.
2. Rao C.S., "Environmental Pollution Control Engineering", New Age International (P) Ltd., New Delhi.
3. Singal S.P., "Noise Pollution and Control Strategy", Alpha Science International, New Delhi.
4. Ray T.K., "Air Pollution Control in Industries", Volume I, Tbi, New Delhi.
5. Stern A.C., Bauble R.W., Fox D.L., Turner B., "Fundamentals of Air Pollution, Hardcover", Elsevier Science and Technology Books.
6. Narayanan P., "Environmental Pollution Principles, Analysis and Control", CBS Publishers

Note: The paper setter will set the paper as per the question paper template provided.

MEC-401	AUTOMATION IN MANUFACTURING						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to impart knowledge of production automation, robotics, flexible manufacturing, CNC programming, material handling and automated storage systems.						
Course Outcomes							
CO1	Students will be able to explain the role automation in manufacturing and robotics in industry.						
CO2	Students will be able to describe the group technology and flexible manufacturing techniques in the automated production line and manufacturing system.						
CO3	Students will be able to explain computer aided process planning and shop floor manufacturing activities.						
CO4	Students will be able to develop CNC programs and understand the concept automated guided vehicle and automated storage system in material handling.						

UNIT-I

Introduction: Production system, automation in production system, manual labour in production system, automation principle and strategies, manufacturing industries and products, manufacturing operations, product facilities, product/ production relationship, basic elements of an automation system, advance automation function, level of automation.

Industrial robotics: Robot anatomy and related attributes, joint and links, common robot configuration, joint drive system, sensors in robotics, robot control system, end effectors, grippers and tools, applications of industrial robots, material handling, processing operation, assembly and inspection, robot programming.

UNIT-II

Group technology and cellular manufacturing: Part families, parts classifications and coding, production flow analysis, cellular Manufacturing- composite part concept, machine cell design, applications of group technology, grouping parts and machines by rank order clustering technique, arranging machines in a G.T. cell.

Flexible manufacturing: Introduction, FMS components, flexibility in manufacturing – machine, product, routing, operation, types of FMS, FMS layouts, FMS planning and control issues, deadlock in FMS, FMS benefits and applications.

UNIT- III

Process planning: Introduction, manual process planning, computer aided process planning – variant, generative, decision logic decision tables, decision trees, Introduction to artificial intelligence.

Shop floor control: Introduction, shop floor control features, major displays, major reports, phases of SFC, order release, order scheduling, order progress, manufacturing control, methodology, applications,

shop floor data collections, Types of data collection system, data input techniques, automatic data, collection system.

UNIT- IV

CNC basics and part programming: Introduction, historical, background, basic components of an NC, steps in NC, verifications of numerical control machine tool programs, classification of NC Machine tool, basics of motion control and feedback for NC M/C, NC part programming, part programming methods, modern machining system, automatically programmed tools, DNC, adaptive control.

Automated guided vehicle and storage system: Functions of AGV, types of AGV, safety consideration for AGV, design of AGV; Introduction to storage system, storage system performance, storage location strategies, conventional storage method and equipment, automated storage system, fixed aisle automated storage/ retrieval system, carousel storage systems, analysis of storage system, fixed aisle automated storage/ retrieval systems, carousel storage systems.

Text Books:

1. CAD/CAM/CIM-P. Radhakrishnan, S. Subramanayan and V.Raju, New Age International (P) Ltd., New Delhi.
2. Computer Integrated Manufacturing- Alavudeen and Venkateshwaran, Prentice- Hall of India Pvt. Ltd., New Delhi.

Reference Books:

1. Automation, Production System and Computer Integrated Manufacturing- Mikell P. Groover, Pearson fourth edition.
2. CAD/CAM: Computer Aided Design and Manufacturing-Groover-M.P. and Zimmers E. W.,Prentice Hall International, New Delhi, 1992.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering								
MEC-403L	**MECHANICAL ENGINEERING LAB-III**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose:	To provide practical knowledge in the concerned subject that a student opt from the program electives offered in the curriculum.							

COMPUTER AIDED DESIGN PRACTICALS

Course Outcomes

CO1 Students will be able to draw and design 2D models.

CO 2 Students will be able to draw and design 3D modelling.

CO 3 Students will be able to assemble the parts.

List of experiments:

1 To study the 2 dimensional drawing, orthographic views, front view, top view and side view.
2 Introduction to Solid Works and working with sketch mode.
3 To study the wireframe, surface and solid modelling.
4 Working with the tools like Pattern, Copy, Rotate, Move and Mirror etc.
5 Working with creating 3D features (Extrude & Revolve).
6 Working with the tools like Hole, Round, and Chamfer etc.
7 Create the part drawing of product 1 using any 3D software.
8 Draw the part drawing of product 2 using any 3D software.
9 Draw the part drawing of product 3 using any 3D software.
10 Make assembly by using any 3D software.

Note: Product 1, 2 and 3 must be based on MEP-401.

FINITE ELEMENT ANALYSIS LAB:

Course Outcomes

CO1 Students will be able to apply the basic theory of elasticity to continuum problems

CO2 Students will be able to formulate Finite Element problems like bar, truss and beam elements for linear static structural analysis

CO3 Students will be able to formulate 2D and axisymmetric finite elements

CO4 Students will be able to formulate and solve finite element equations for 1D heat transfer elements

List of Experiments:

1. To solve problems related to solid mechanics, heat transfer and free vibration by using NASTRAN/SIMULIA/ANSYS/ABAQUS.
2. Introduction of GUI of the software in the above mentioned areas realistic problems.
3. To analyze beams and frames (bending and torsion problems).

4. To analyze plane stress and plane strain problems.
5. Problems leading to analysis of axisymmetric solids.
6. Problems leading to analysis of three dimensional solids: (a) Heat Transfer problems (b) Modal analysis problem:

By writing own code for finite element analysis using MATLAB for:

7. Plane stress and Plane strain problems.
8. Modal analysis problems.

Reference Books:

1. Finite Element Method using MATLAB-Young W Kwon and Hyochoong Bang, CRC Press Washington, USA.
2. Finite Element Method: A Practical Course-G. R. LIU and S. S. Quek, Elsevier Science, Butterworth – Heinemann publication.

POWER PLANT ENGINEERING LAB:

Course Outcomes

CO1 Students will be able to explain the constructional features and working of different boilers, accessories, mountings, heat balance sheet preparation and to analyze the quality of steam.

CO2 Students will be able to describe the functions of different cooling towers and condensers and calculate their efficiencies.

CO3 Student will be able to calculate the calorific value of fuels using a bomb calorimeter.

CO4 Student will be able to explain the functioning and use of solar photovoltaic systems and calculate the efficiency of a solar cell.

List of Experiments:

1. To study high pressure boilers.
2. To study low pressure boilers.
2. To study about the mountings & accessories of high and low-pressure boilers.
3. To prepare the heat balance sheet for the given boiler.
5. To find the calorific value of a given sample of solid/liquid fuel(s) using a bomb calorimeter.
6. To find power output and efficiency of impulse and reaction steam turbine.
7. To study cooling tower and calculate its efficiency.
8. To study various types of condenser and calculate efficiency.
9. To find the dryness fraction of steam using separating and throttling calorimeters.
10. To study solar photovoltaic systems and calculation of efficiency of a solar cell.

MECHATRONIC SYSTEMS PRACTICALS

Course Outcomes

CO1 Students will be able to control the speed of DC motor and servo motor using 8051 microcontrollers.

CO2 Students will be able to control the motion of single and double acting cylinder using Pneumatic and Hydraulic training kit.

CO3 Students will be able to control traffic light signals using PLC and 8051 microcontrollers.

CO4 Students will be able to perform operations of addition, subtraction, multiplication and division using 8086 Microprocessor.

List of Experiments

1 To run a stepper motor at different speeds and directions using 8051 assembly language.

2 To control traffic light by interfacing with PLC kit.

3 To perform speed control of DC motor with 8051 microcontroller.

4 To perform experiment on hydraulic trainer kit.

5 To perform experiment on pneumatic trainer kit.

6 To study various types of sensors and transducers.

7 To control a traffic light system using 8051 Microcontroller

8 To perform the 8-bit addition and subtraction using 8086 Microprocessor.

9 To perform the 8-bit multiplication and division using 8086 Microprocessor.

INDUSTRIAL ROBOTICS PRACTICALS

Course Outcomes

CO 1 Students will be able to analyze the movement of various positions of robotics arm.
CO 2 Students will be able to design the robotics systems.
CO 3 Students will be able to analyze the pneumatic and hydraulic systems.
CO 4 Students will be able to demonstrate sensors, grippers etc.

List of Experiments

1. Recoding Robot positions (Absolute positions, Delete Positions, Save and load positions and Move the Robot to recorded positions).
2. Demonstration of Cartesian/ cylindrical/ spherical robot.
3. Study of different types of grippers.
4. Study of sensor integration.
5. Study of robotic system design.
6. Setting robot for any one industrial application after industrial visit.
7. Study the major equipment/Software/Components in Robotics Lab, e.g. Robotic Arm components, Arena etc.
8. Study of pneumatic and hydraulic system in Robotics.

SOLAR ENERGY ANALYSIS PRACTICALS

Course Outcomes

CO 1 Students will be able to analyze the solar based heating concepts and flow of working fluid in collector.
CO 2 Students will be able to analyze the solar parabolic trough and evacuated tube collector.
CO 3 Students will be able to know about the solar energy storage by different means and understand the sun-earth relationships for sun tracking.
CO 4 Students will able to describe the functioning of solar PV collector power plant.

List of Experiments:

1. To evaluate the system efficiency and heat transfer of evacuated tube collector in different parts of system at different ambient conditions.
2. Evaluation of system thermal efficiency solar collector during charging storing and discharging the PCM.
3. To determine the thermal Performance of the Parabolic Trough collector with different inlet temperature of water and oil.
4. To evaluate the thermal performance of flat plate collector in thermosiphon and forced mode of flow at different radiation level.
5. To find the drying rate and drying time of different fruits and vegetables in flat plate based solar dryer.
6. To determine the efficiency of solar photo voltaic collector with and without sun tracking.

B. Tech. (7th Semester) Mechanical Engineering								
MEC-405L	**PROJECT-III**							
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Practical**	**Total Time**	**Time (Hrs.)**
0	**0**	**10**	**5**	**0**	**100**	**100**	**200**	**3**
Purpose:	To implement the engineering principles and theories into innovative practical projects for solving real world problems.							
Course Outcomes								
CO1	Students will be able to apply the theoretical knowledge into practical/software projects.							
CO2	Students will be able to design new products using latest technologies.							

The project work could be done for the problem statement of an industry or practical project in the institute. The students may also opt for the analysis based software projects with proper validation. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Note: The maximum number of students in a group should not exceed four.

B. Tech. (7th Semester) Mechanical Engineering							
MEP-401	**COMPUTER AIDED DESIGN**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	To apply the computer's technology in designing.						
Course Outcomes							
CO1	To understand the fundamentals of CAD and analyze the CAD hardware.						
CO2	Students will be able to evaluate the CAD software and various transformation operations.						
CO3	Students will be able to analyze the geometric modeling.						
CO4	Students will be able to create surface modeling and understand the data exchange.						

UNIT-I

Fundamentals of CAD: Introduction, Traditional product cycle, CAD/CAM product cycle, rapid prototypic, design for everything, computer aided design, computer aided engineering, customer relationship management, product lifecycle management,

CAD hardware: Introduction, basic structure of computer, input, storage, processing, output, control, microcomputer, minicomputer, mainframes, supercomputer**,** input out device, LAN, MAN, WAN.

UNIT-II

CAD Software: Introduction, system software, application software, General CAD process, selection of CAD system, database management system, data structure, database types, function of database management system, advantages of DBMS, database coordinate system.

Geometric transformations: Introduction, 2D transformation, translation, rotation, scaling, homogeneous coordinate relationship, reflection transformation, shear transformation, inverse transformation for translation, rotation, scaling, reflection, shear, composite transformation, examples of composite transformation, geometric transformations in engineering design, solved examples.

UNIT-III

Geometric modeling: Need of geometric modeling, requirements of geometric modeling, wire frame modeling, surface modeling, solid modeling, difference between wireframe, surface and solid modeling, introduction to solid modeling, set theory, representation schemes for solid models, boundary representation, cellular decomposition, feature based modeling, Euler theory, mass property calculation.

Mathematical representation of 2D entity: Introduction, parametric representation, of analytic curves, lines, circle, conic selection, ellipse, parabola, hyperbola, parametric representation of synthetic curve, Hermite cubic spline curve, Bezier curves, B- spline curve, non-uniform rational, B splines, manipulation of curves.

UNIT-IV

Mathematical representation of surface entity: Introduction, surface entities, analytic surface, plane surface, tabulated surface, ruled surface, surface of revolution, sweep surface, synthetic surface, Hermite Bicubic surface, Bazier surface, bilinear surface, coons surface

Data exchange formats: Introduction, CAD/CAM data exchange, neutral file formats, data exchange format, initial graphics exchange specification, standard triangular language, standard for exchange of product data.

Text Books:

1. CAD/CAM – Principle Practice and Manufacturing Management - Chris McMahon and Jimmie Browne, Addison Wesley England, Second Edition, 2000.
2. CAD/CAM Theory and Practice, Mastering CAD/CAM - Ibrahim Zeid, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Reference Books:

1. Mathematical Elements for Computer Graphics - NC-Rogers, D.F. and Adams, McGraw Hill, NY, 1989
2. CAD/CAM/CIM - P. Radhakrishnan, S. Subramanayan and V. Raju, New Age International (P) Ltd., New Delhi.
3. CAD/CAM: Computer Aided Design and Manufacturing - Groover M.P. and Zimmers E. W., Prentice Hall International, New Delhi, 1992.
4. CAD/CAM/CAE - Chougule N. K, Scitech publications (INDIA) PVT. LTD.

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEP-403	**FINITE ELEMENT ANALYSIS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	0	0	3	75	25	100	3
Purpose	The purpose of this course is to understand the formulation of FEA problems and to describe various methods of FEM. Also to understand the FEM with CI continuity and FDM.						
Course Outcomes							
CO1	Students will be able to understand the basic steps in FEM formulation. Also to study various concepts associated and assembly along with the boundary conditions in FEM formulation.						
CO2	Students will be able to analyze how FEM problems are formulated in 1-D elements. Also to discuss shape functions, h and p approximations; and various solvers associated in FEM.						
CO3	Students will be able to study FEM formulation of 2-D elements using various methods like Galerkin approach, Weighted Residual etc. Also to understand the natural coordinates, numerical integration and various other concepts related to 2-D FEM formulation.						
CO4	Students will be able to describe the axi-symmetric problems along with plane stress and plane strain problems with regards to solid mechanics. Also to discuss various elements of FEM, FEM with CI continuity and FDM problems.						

UNIT-1

Introduction: Basic steps in FEM formulation, general applicability of the method, variational functional, Ritz Method.

Variational FEM: Derivation of elemental equations, assembly, imposition of boundary conditions, solution of the equations.

UNIT-II

1-D Elements: Basis functions and shape functions, convergence criteria, h and p approximations, natural coordinates, numerical integration, Gauss elimination based solvers, computer implementation: pre-processor, processor, post-processor.

UNIT-III

Methods of FEA: Alternate formulation: Weighted Residual Method, Galerkin Method;

Problems with C1 Continuity: beam bending, connectivity and assembly of C1 continuity elements.

2-D Elements (Triangles and Quadrilaterals) and Shape Functions: Natural Coordinates, Numerical Integration, Elemental Equations, .Connectivity and Assembly, Imposition of Boundary Conditions.

Axisymmetric (Heat Conduction) problem, plane strain and plane stress solid mechanics problems, sub-parametric, iso-parametric and super-parametric elements; elements with C1 continuity.

UNIT-IV

Free vibration problems and FDM: Formulation of eigenvalue problems, FEM formulation, time-dependent problems, combination of Galerkin FEM and FDM (Finite Difference Method), convergence and stability of FD Scheme.

Text Books:

1. Finite element analysis-C. S. Krishnamoorthy, Tata McGraw Hill
2. An introduction to Finite element method-J. N Reddy, Tata Mc. Graw Hill
3. Finite Element Method with applications in Engineering-Y. M. Desai, Pearson Education India.

Reference Books:

1. Nonlinear Finite Elements for Continua and Structures (Paperback)-Belytschko (shelved 1 time as *finite-elements*)
2. The Finite Element Method for Three-Dimensional Thermomechanical Applications (Hardcover)-Guido Dhondt (shelved 1 time as *finite-elements*)
3. Numerical Solution of Partial Differential Equations by the Finite Element Method (Paperback)- Claes Johnson (shelved 1 time as *finite-elements*)

Note: The paper setter will set the paper as per the question paper template provided.

	B. Tech. (7th semester) Mechanical Engineering						
MEP-405	**POWER PLANT ENGINEERING**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	To understand modern aspects of power generation, different power plants, their combinations, operation and components, energy demand and supply and power plant economics.						
Course Outcomes							
CO1	Students will be able to analyze the economics of power generation and describe the variety of power plants.						
CO2	Students will be able to analyze steam power cycles and understand the coal handling process in detail.						
CO3	Students will be able to understand about the operation & advancements of Solar, Diesel and Gas turbine power plants.						
CO4	Students will be able to describe the role of nuclear energy in power generation and various combinations of power plants and their operation.						

UNIT-I

Economics of power generation: Introduction to economics of power generation, different terms and definitions, hydrology, rainfall, runoff, hydrographs, flow duration curves, cost analysis, power plant locations, selection of power plant equipment, factors affecting economics of generation and distribution of power, performance and operating characteristics of power plants, economic load sharing, tariff for electrical energy.

Different types of power plants: Recent developments in power plants, geothermal power plants, tidal power plants, windmills, solar power plants, hydroelectric power plant: site selection, classification, estimation of power availability, selection of water turbines, advantages and disadvantages of hydro power plants.

UNIT-II

Analysis of steam cycle: The ideal Rankine cycle, externally irreversible Rankine cycle, superheat, reheat, regeneration, internally irreversible Rankine cycle, open feed water heaters, closed type feed water heaters with drains cascaded backward and pumped forward, typical layout of steam power plant, efficiency and heat rate.

Coal handling plant: Coal Handling: unloading, feeding, crushing, feeding system, conveyor system, stacking system, magnetic separator/ metal detector, bin/chute vibratory system, coal weighment, coal sampling, fire-fighting system, dust suppression system, dust extraction system, mechanical stokers, pulverized fuels and burners, ash handling and disposal.

UNIT-III

Solar Power Plants: Introduction; solar collectors: flat plate and concentrating; absorber coating; solar pond electric power plant; solar thermal electric conversion systems: low temperature, medium

temperature and high temperature; solar electric power generation: solar photovoltaics, solar cell working and principle; combination of solar and hydropower plants; solar chimney power plant system.

Diesel engine & gas turbine power plants: Introduction, Types, layout of diesel engine power plant, different components of diesel power plant, performance characteristics, supercharging, layout and components of gas turbine power plants, gas turbine fuels, material selection for gas turbines.

UNIT-IV

Nuclear power plants: Basic theory and terminology, nuclear fission and fusion processes, fission chain reaction, moderation, fertile materials, nuclear fuels, general components of nuclear reactor, different types of reactors: PWR, BWR, GCR, LMFBR, CANDU-PHW, disposal of nuclear waste and related issues.

Power plant combinations: Combination of hydro power plants with steam plants, GT-ST Combined Cycle plant, combined cycles with heat recovery boiler, PFBC combined cycle, STIG (steam injected gas turbine) cycle, combined cycles with multi-pressure steam, combined cycle for nuclear power plants.

Text Books:

1. Power Plant Engineering-Morse, D. Van Nostrand.
2. Power Plant Engineering-PK Nag, McGraw Hill.
3. Power Plant Technology-El-Wakil, McGraw Hill.

Reference Books:

1. Power Plant Engineering-P.C. Sharma, SK Kataria & Sons.
2. Power Plant Engineering-Domkundwar, Dhanpat Rai & Co.
3. Power Plant Technology-G.D.Rai, Khanna Publishers.
4. Power Plant Engineering-R.K. Rajput, Laxmi Publications.

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech (7th Semester) Mechanical Engineering							
MEP-407	**MECHATRONIC SYSTEMS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to provide students with an in-depth knowledge of mechatronics systems. The subject will give knowledge of electronics components to students and assist them to acquire inter disciplinary skills.						
Course Outcomes							
CO1	Students will be able to understand Mechatronics systems and their applications. The students will be able to understand different sensors and transducers as well as able to select the transducers as per applications.						
CO2	Students will be able to describe different types of number systems and Boolean algebra and able to convert number systems from one system to another. The students will be able to explain pin configuration and architecture of microprocessor.						
CO3	Students will be able to understand the architecture of microcontroller and structure of PLC. The students will also be able to draw the ladder diagram.						
CO4	Students will be able to understand various types of actuator. The students will also be able to explain the working of DC and servo motor.						

UNIT-I

Introduction: Definition of mechatronics, multi-disciplinary scenario, evaluation of mechatronics, objectives, advantages & disadvantages of mechatronics, an overview of mechatronics, microprocessor based controllers, principle of working of automatic camera, automatic washing machine & engine management system.

Review of sensors and transducers: Definition and classification of transducers, definition & classification of sensors, performance terminology, working principle and application of displacement, position & proximity, velocity and motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensors, selection of transducers.

UNIT-II

Digital principles: Introduction, digital number system, range and weight of binary number system, octal and hexadecimal number systems, conversion, BCD number systems, gray code, Boolean algebra, logic states, logic functions, more logic gates, universal gates, exclusive-OR gate, minimization of Boolean expression using Karnaugh map.

Microprocessor: 8086 CPU architecture: 8086 Block diagram, description of data registers, address registers; pointer and index registers, PSW, Queue, BIU and EU, 8086 Pin diagram descriptions, 8086 minimum mode and maximum mode CPU module.

UNIT–III

Micro controller: Introduction of 8051 microcontroller & its block diagram, comparison of microprocessor and microcontroller

PLC: Programmable logic controllers, basic structure, input/output processing, ladder diagram timers, internal relays and counters, shift registers, master and jump controls, data handling, analogue input/output, selection of a PLC.

UNIT–IV

Actuators: Definition, classification of actuators, mechanical actuation systems, types of motion, kinematics chains, cams, gear trains, ratchet and pawl, belt and chain drives, bearings, brief survey of electromechanical actuators, drive requirements for cutting movements, requirements of feed drives, calculation of drive requirements on feed motor shaft.

Motors: DC motors & Control of DC motors, DC & AC servomotors, stepper motors-types, characteristics, advantages, limitations and applications, mechanical aspects of motor selection.

Text books:

1. A Textbook of Mechatronics-R. K Rajput, S. Chand & Company, Edition 2010
2. Mechatronics, W. Bolton – Pearson Education Asia - 2nd Edition, 2011.

Reference books:

1. Mechatronics, HMT Ltd., McGraw Hill Education, 2017
2. Mechatronics Principles, Concepts and Application-Nitaigour and Premchand, Mahilik – Tata McGraw Hill – 2003
3. Mechatronics: An Introduction-Robert H. Bishop, CRC Press, 2015
4. Mechatronics: Integrated Mechanical Electronic System- Ramachandran, Vijayaraghavan, Balasundaran- Wiley Publication, 2008

Note: The paper setter will set the paper as per the question paper template provided.

B. Tech. 7th Semester Mechanical Engineering							
MEP-409	**INDUSTRIAL ROBOTICS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to make the students understand about the fundamental of robotics technology, its components and robotics cell design and control.						
Course Outcomes							
CO1	Students will be able to understand the fundamentals of robotics and find its applications.						
CO2	Students will be able to explain the use of different sensors and end effectors in robotics.						
CO3	Students will be able to describe the application of robotics in manufacturing.						
CO4	Students will be able to design and analyze the work cell and robotic motion.						

UNIT-I

Introduction: Automation and robotics, robotics in science fiction, a brief history of robotics, the robotics market and the future prospectus,

Fundamental of robotics: Robot anatomy, work volume, robot drives systems, control systems, precession of movement, end effectors, robot application.

UNIT-II

Sensors in robotics: Type of sensors in robotics, exteroceptors or external sensors, force and torque sensors, proximity sensors (position sensors), range sensors, machine vision sensors, velocity sensors. tactile sensor, proximately and range sensors, use of sensor in robotics.

Robot end effectors: Types of end effectors, characteristics of end-of-arm tooling, elements of end-of-arm tooling.

UNIT-III

Material transfer and equipments: General consideration in robot material handling, material transfer applications, machine loading and unloading,

Grippers: Tool selection of gripper, gripping mechanism, types of gripper, mechanical gripper, vacuum and magnetic grippers.

UNIT-IV

Robot cell design and control: Robot cell layouts, multiple robots and machine interface, other considerations in work cell design, work cell control, interlocks, the work cell controller, robot motion analysis and control: introduction to manipulator kinematics, manipulator path control, robot dynamics, configuration of robot control.

Text books:

1. Robot Analysis and Control- Asada, H., and J. J. Slotine, Wiley.

2. CAD/CAM: Computer Aided Design and Manufacturing- Groover M.P. and Zimmers E. W., Prentice Hall International, New Delhi.

Reference Books:

1. Robotics and Control-R. K. Mittal, I. J. Nagrath, McGraw Hill.
2. Fundamental of Robotics Analysis and Control-Robert J Schilling, Pearson
3. Industrial Automation and Robotics-J K Arora, Laxmi Publications

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Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. (7th Semester) Mechanical Engineering							
MEP-411	**SOLAR ENERGY ANALYSIS**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	The purpose of this course is to make the students aware about the importance, availability, use and applications of solar energy.						
Course Outcomes							
CO1	Students will be able to describe the sun-earth relationships and various solar activities based on sun and earth rotation.						
CO 2	Students will be able to analyze the concentrating collector in solar energy applications and solar energy storage by different means.						
CO 3	Students will be able to apply the solar based heating-cooling concepts in building structures and explain the water heating flow systems.						
CO 4	Students will be able to analyze solar power generation, refrigeration and air-conditioning systems.						

Unit-I

Introduction: Basic Heat transfer principles, availability of solar energy, nature of solar energy, solar energy and environment, sun as the source of radiation, solar radiation: measurement of solar radiation, irradiance, solar constant, insolation, radiosity, emissive power, earth's equator, meridian longitude, sun earth angles, sunrise, sun set and day length, solar time, equation of time, various methods of using solar energy, photo thermal, photovoltaic, photosynthesis, present & future scope of solar energy.

Unit-II

Solar thermal energy: Stationary collectors, FPC, CPC, ETC, sun tracking, concentrating collectors, PTC, PDR, HFC, Fresnel collectors, solar thermal power plants, solar chimney power plant, solar pond, solar water heater, solar cooker, types- solar disinfection, limitations of solar thermal energy.

Heat Storage: Sensible and latent heat storage, chemical energy system, performance calculations.

Unit-III

Flow systems: Natural and forced flow systems, water heating systems for domestic, industrial and space heating requirements, solar distillation.

Solar heating and cooling: Direct, indirect and isolated heating concepts, cooling concepts, load calculation methods, performance evaluation methods.

Unit-IV

Solar thermal power generation: Introduction, paraboloid concentrating systems, cylindrical concentrating systems, central receiver system.

Solar refrigeration and air conditioning systems: Introduction, solar refrigeration and air conditioning systems, solar desiccant cooling.

Text Books:

1. Solar Thermal Engineering Process - Duffie and Beckman.
2. Advanced Solar Energy Technology - H.P. Garg, Kluver.
3. Solar Energy- S.P. Sukhatme, TMH.

Reference Books:

1. Solar Energy- J.S. Hsieh, Pearson College DIV.
2. Solar Thermal Engineering- P.J. Lunde, John Wiley & Sons.

Note: The paper setter will set the paper as per the question paper templates provided.

B. Tech. (7th Semester) Mechanical Engineering								
MEC-407	**INDUSTRIAL TRAINING-III**							
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
2	**0**	**0**	**--**	**--**	**100**	**--**	**100**	**--**
Purpose	To provide an industrial exposure to the students and enhance their skills and creative capability for conversion of their innovative ideas into physical reality.							
Course Outcomes								
CO 1	Students will be able to self-improve through continuous professional development and life-long learning.							
CO 2	Students will be able to develop social, cultural, global and environmental responsibility as an engineer.							
CO 3	Students will be able to weigh all the latest changes in technological world.							

Note: MEC-407 is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone for minimum 4 weeks after 6th semester and students will be required to get passing marks to qualify.

The candidate has to submit a training report of his/her work/project/assignment completed in the industry during the training period. The evaluation will be made on the basis of training report submitted and viva-voce/presentation.