Faculty of Engineering & Technology
KAKATIYA UNIVERSITY, WARANGAL-506 009
Department of Mechanical Engineering

B. Tech. (Mechanical) VII SEMESTER

S.No	Course Code	Course Title	Scheme of Instruction			Lecture Hrs/ week	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
Theory									
1.	PC4101ME	CAD/CAM	3	-	-	3	30	70	3
2.	PC4102ME	Industrial Automation	3	-	-	3	30	70	3
3.	PC4103ME	Advanced Material Science and Engineering	3	-	-	3	30	70	3
4.	PE III*	Professional Elective -III	3	-	-	3	30	70	3
5.	PEC IV*	Professional Elective -IV	3	-	-	3	30	70	3
6.	OE II	Open Elective II	3			3	30	70	3
PRACTICALS									
7.	PC4113ME	Product Design by CAD Lab	-	-	2	2	25	50	1
8.	PW4114ME	PROJECT WORK-I	-	-	3	3	50	00	1.5
		Total	18	-	5	23	255	470	20.5

* (PE-III) **PROFESSIONAL ELECTIVE COURSE -III**	
PE4104 ME	Computational Fluid Dynamics
PE4105 ME	Mechatronics
PE4106 ME	Tool Design

* (PE-IV) **PROFESSIONAL ELECTIVE COURSE -IV**	
PE4107 ME	Additive Manufacturing
PE4108ME	Design for Manufacturing
PE4109ME	Fuel Cell Technology

* (OE-II) **OPEN ELECTIVE COURSE -II**	
OE4110 EE	Energy Storage Systems
OE4111 EC	Optimization Techniques
OE4112 EC	Fundamentals of IoT

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KAKATIYA UNIVERSITY, WARANGAL-506 009
Department of Mechanical Engineering

B. Tech. (ME) VII SEMISTER
PC4101ME CAD/CAM
(Professional Core Course)

Course code	PC4101ME				
Category	Professional Core Course				
Course title	CAD/CAM				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT – I

Fundamentals of CAD/ CAM, Application of computers for Design and Manufacturing, Benefits of CAD/ CAM - Computer peripherals for CAD/ CAM, Design workstation, Graphic terminal, CAD/ CAM software- definition of system software and application software, CAD/ CAM database and structure.

Geometric Modeling: Wire frame modeling, wire frame entities, Interpolation and approximation of curves, Concept of parametric and non-parametric representation of curves, Curve fitting techniques, definitions of cubic spline, Bezier, and B-spline.

UNIT – II

Surface Modeling: Algebraic and geometric form, Parametric space of surface, Blending functions, parameterization of surface patch, Subdividing, Cylindrical surface, Ruled surface, Surface of revolution Spherical surface, Composite surface, Bezier surface. B-spline surface, Regenerative surface and pathological conditions.

Solid Modeling: Definition of cell composition and spatial occupancy enumeration, Sweep representation, Constructive solid geometry, Boundary representations.

UNIT – III

NC Control Production Systems: Numerical control, Elements of NC system, NC part programming: Methods of NC part programming, manual part programming, Computer assisted part programming, Post Processor, Computerized part program, SPPL (A Simple Programming Language). CNC, DNC and Adaptive Control Systems.

UNIT – IV

Group Technology: Part families, Parts classification and coding. Production flow analysis, Machine cell design. Computer aided process planning: Difficulties in traditional process planning, Computer aided process planning: retrieval type and generative type, Machinability data systems.

Computer Aided Manufacturing Resource Planning: Material resource planning, inputs to MRP, MRP output records, Benefits of MRP, Enterprise resource planning, Capacity requirements planning

UNIT – V

Flexible Manufacturing System: F.M.S equipment, FMS layouts, Analysis methods for FMS benefits of FMS.

Computer Aided Quality Control: Automated inspection- Off-line, On-line, contact, Non-contact; Coordinate measuring machines, Machine vision.

Computer Integrated Manufacturing: CIM system, Benefits of CIM

Suggested Readings:

1. CAD/CAM Concepts and Applications / Alavala / PHI
2. CAD/CAM Principles and Applications / P. N. Rao / McGraw Hill
3. CAD/CAM/ Groover M.P/ Pearson
4. CAD/CAM/CIM/ Radha krishnan and Subramanian / New Age

Faculty of Engineering & Technology
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Department of Mechanical Engineering

B. Tech. (ME) VII SEMISTER
PC4102ME INDUSTRIAL AUTOMATION
(Professional Core Course)

Course code	PC4102ME				
Category	Professional Core Course				
Course title	Industrial Automation				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT – I

CIM – Definition, scope and elements of CIM system-benefits, Production system facilities – low-medium-high-Manufacturing support systems-Automation in production systems, Automated manufacturing systems, Computerized Manufacturing Support Systems-Reasons for Automating.

UNIT – II

Automation: Automation –definition- Basic elements of an automated system - Levels of automation, Types and strategies of automation, Automation principles and strategies-USA Principle-Ten Strategies for Automation and Production Systems, Automation in machine tools. Mechanical feeding and tool changing and machine tool control transfer of automation.

UNIT-III

Automated Flow Lines: Methods or work part transport transfer Mechanical buffer storage control function, design and fabrication consideration.

Analysis of Automated Flow Lines: General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

Assembly System and Line Balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

UNIT - IV

Material Handling: Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems. Automated storage systems, automated storage and retrieval systems, work in process storage, interfacing handling and storage with manufacturing.

Adaptive Control Systems: Introduction, adaptive control with optimization, Adaptive control with constraints, Application of A.C. in machining operations. Use of various parameters such as cutting force, Temperatures, vibration and acoustic emission.

UNIT-V

Business Process Re-engineering: Introduction to BPE logistics, ERP, Software configuration of BPE, Industry 4.0, concurrent Engineering, Techniques of Rapid Proto typing.

Suggested Readings:

1. Automation, Production Systems and Computer Integrated Manufacturing/M.P. Groover. / Pearson
2. Computer control of Manufacturing Systems by Yoram Coreom / McGraw Hill
3. CAD / CAM/ CIM / Radha krishnan / New Age Advanced Manufacturing Technology/ K Vara Prasada Rao / Kanna Publications

Faculty of Engineering & Technology
KAKATIYA UNIVERSITY, WARANGAL-506 009
Department of Mechanical Engineering

B. Tech. (ME) VII SEMISTER
PC4103ME Advanced Material Science
(Professional Core Course)

Course code	PC4103ME				
Category	Professional Core Course				
Course title	Advanced Material Science				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT – I

Nanotechnology: There's Plenty of Room at the Bottom: History of Nano science, Nanometer, Nano materials and Nanotechnology, Importance of Nano-technology, Nano materials-classification, applications.

Mechanical Behavior of Nano Materials: Effect of Nano scale on mechanical properties. Strength and deformation of Nano Materials, Inverse Hall petch effect, Super Plastic Deformation of Nano Materials. Physical, Electrical and Magnetic Behavior of Nano Materials.

UNIT – II

Nano Materials Synthesis: Methods for creating Nanostructures; Bottom-up and Top-down approaches, **Vapor Phase Processing***:* Physical Vapor Deposition, Chemical Vapor Deposition, Inert Gas Condensation, **Liquid Phase Processing:** Rapid Solidification Process, Atomization, Sonication of Immiscible Liquids, **Solid State Processing***:* Mechanical Alloying, Severe Plastic Deformation, Annealing of Amorphous Precursors. Effect of Process Parameters

UNIT – III

Structural Characterization: Sample preparation, Working Principle and Result Analysis : X-ray diffraction, Small angle X-ray Scattering (GI XRD), Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

UNIT – IV

Special Nano Materials: Nano Composites: Introduction: Definition - characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Classification of Composites Based on Matrix and Reinforcement. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

Manufacturing of Metal Matrix Composites*:* Stir Casting - Solid State diffusion technique, Cladding - Hot isostatic pressing. **Powder Metallurgy process:** steps in powder metallurgy

process, process variables, SWOT analysis of Powder Metallurgy Process. Properties and Applications.

Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering.

UNIT – V

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs hand layup method Autoclave method - Filament winding method Compression moulding - Reaction injection moulding. Properties and applications.

Special Nano Materials: Carbon Nano Tubes: SWCNT, MWCNT: properties and applications
Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, targeted drug delivery.

Suggested Readings:

1. Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007
2. B. S. Murty, P. Shankar, Baldev Raj et al., Textbook on Nano science and Nanotechnology, 1st ed., Springer-Verlag Berlin Heidelberg, 2013Stuart M. Lindsay, Introduction to Nano science, Oxford University Press, 2009
3. Material Science and Technology- Vol 13- Composites by R.W. Cahn-VCH, West Germany.
4. Materials Science and Engineering, An Introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

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Department of Mechanical Engineering

B. Tech. (ME) VII SEMISTER
PE4104 ME Computational Fluid Dynamics
(Professional Elective-IV)

Course code	PE4104ME				
Category	Professional Elective Course				
Course title	Computational Fluid Dynamics				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT-I

Review of Basic Equations of Fluid Dynamics: Continuity, Momentum and Energy equations-Navier Stokes equations, Reynolds and Favre averaged N-S equations. Heat transfer conduction equations for steady and unsteady flows. Steady convection-diffusion equation.

UNIT-II

Introduction to Turbulence: Mixing length model, K-ε turbulence Model. Classification of PDEs-Elliptic, parabolic and hyperbolic equations. Initial and boundary value problems.

UNIT-III

Concepts of Finite Difference Methods: Forward, backward and central difference. Finite difference solutions-Parabolic partial differential equations. Euler, Crank Nicholson, Implicit methods. Higher order difference methods. Errors, consistency. stability analysis- von Neumann analysis. Convergence criteria.

UNIT-IV

Numerical Methods: Jacobi, Gauss Seidel and ADI methods.1D and 2D Elliptic partial differential equations Problems. Viscous incompressible flow, Stream function- Vorticity method. Introduction to Grid Generation- Types of grid- O,H,C.

UNIT- V

Introduction to Finite Volume Method: Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows, Staggered grid, SIMPLE Algorithm.

Suggested Reading:

1. Muralidhar K, Sundararjan T, Computational Fluid Flow and Heat transfer, Narosa Publishing House, 2003.
2. Chung, T J, Computational Fluid Dynamics, Cambridge University Press, 2002.
3. Patankar, S V, Numerical Heat transfer and Fluid flow, Hemisphere Publishing Company, New York, 1980.
4. John D Anderson, Computational Fluid Dynamics, McGraw Hill, Inc., 1995.
5. PradipNiyogi, Chakrabartty S K, Laha M K, Introduction to Computational Fluid Dynamics, Pearson Education, 2005

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B. Tech. (ME) VII SEMISTER
PE4105ME Mechatronics
(Professional Elective-III)

Course code	PE4105ME				
Category	Professional Elective Course				
Course title	Mechatronics				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT I

Introduction: Definition of Mechatronics, Mechatronics in manufacturing, Product, and design. Measuring systems, control systems, Microprocessor based controllers. Comparison between Traditional and Mechatronics approach.

UNIT II

Review of Fundamentals of Electronics: Data conversion devices, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Performance, terminology, displacement, position, proximity, velocity and motion.
Microprocessors controllers and PLCs.

UNIT III

Electrical Actuation Systems: Electrical system, mechanical switches, solid-state switches solenoids, D.C.motors, AC motors and stepper motors. Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems.

UNIT IV

Hydraulic Systems: Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

UNIT V

System Models: Engineering system, rotational-translational system, electro- mechanical systems and hydraulic-mechanical system.
System Transfer Functions: Transfer function, first order system, second order system, system in series and systems with feedback loops. Description of PID controllers. CNC machines and part programming. Industrial Robotics.

Suggested Readings:

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. G.W. Kurtz, J.K. Schueller, P.W. Claar .II, Machine design for mobile and industrial applications, SAE, 1994.
3. T.O. Boucher, Computer Automation in Manufacturing - an Introduction, Chappman and Hall, 1996.
4. Devdas Shetty, Richard Klok "Mechatronic system design", 2nd edition, Cengage Learning,
5. Boltan, W., "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", Longman, Singapore, 1999
6. Krishna Kant; Computer Based Industrial Control ; Prentice Hall of India Pvt. Ltd. 1999.
7. Herbert Taub& Donald Schilling : Digital Integrated Electronics, McGraw Hill International Edition, 1977.
8. David Alciatoare, Michael Histand, "Introduction to Mechatronics and Measurement Systems", McGraw Hill, 2002.
9. Haxkworth, "Programmable Logic Controllers-Programming Methods and its Applications", Pearson India Ltd., 2011.

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B. Tech. (ME) VII SEMISTER
PE4106ME Tool Design
(Professional Elective-III)

Course code	PE4106ME				
Category	Professional Elective Course				
Course title	Tool Design				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

Unit I

Form Fools and Multi Point Cutting Tools: Form tools: Radial and tangential: flat and circular. Form correction and tool holding methods. Drills Geometry: Variation of rake and clearance angles along tips, effect of geometrical parameters on thrust and torque effect of feed rate on rake and clearance, web thinning. Types of drill points, Grinding of drills.

Milling Cutters: Major types, geometry of peripheral, end and face milling cutters. Profile sharpened and form relieved expression for minimum number of teeth. Design features, forces and power estimation, Grinding of milling cutters.
Reamers: Types, geometry, Reaming allowance, design features tolerance disposition.
Broachers: Pull and push types. Internal and External broaches, geometry and design features. Pull force estimation. Keyway, spline, round, square broaches.

Unit II

Press Tools for Sheet Metal Working: Blanking and piercing. Diet set elements. Simple and progressive dies. Estimation of punch load, clearances, centre of pressure, strip layout, methods of reducing punch load. Bending dies: Spring back and bending allowance estimation of punch load. Drawing Dies: Punch load, blank size, number of draws, methods of retaining metal in draw dies. Metal flow during drawing.

Metal Spinning: Configuration and design features of metal spinning, shear forming and flow forming.

Unit III

Jigs & Fixtures: Design principles and construction features. Locating methods associated with flat, cylindrical internal and external surface. Types of locating pins. Requirements and choice of locating systems. Redundant location, fool proofing. Setting blocks, types of clamping devices and their basic elements. Quick action clamps and nuts. Equalising and multiple clamping pneumatics. Hydraulic, magnetic and vacuum clamping. Types of drill jig and their

classification. Types of jig bushes, jig feet. Indexing jigs. Economic analysis of Jigs and Fixtures. Economic tool life for minimum cost maximum production and max profit rate.

Unit IV

Miscellaneous tools: Cam design for single spindle automatics for simple components. Tool layout estimation of cycle time. Gauge design: Taylor's principle, limit gauges for holes and shafts. Estimation of limits on Go and No Go gauges.

Forgoing dies: Draft, parting line, filters. Allowances, sequence in multiple impression forging. Flashing, Trimming.
Tools for Injection Moulding: Basics , Material, Allowances, sequence of operation.

Unit V

Brief Introduction of CNC Machines Work Holding Devices: Tool design for CNC machines- An introduction, Fixture design for CNC Machine, Cutting tools for CNC Machine, Tool holding methods for CNC Machine, ATC and APC for CNC Machine, Tool presetting for CNC Machine

Suggested Readings:

1. Surendra kenav and Umesh Chandra, "Production Engineering Design (Tool Design)",Satya prakashan, New Delhi, 1994.
2. Donaldson, Leain and Goold, "Tool Design", Tata McGraw Hill, New Delhi, 1983.
3. Amitabha Battacharya and Inyong Ham, "Design of Cutting Tools, Use of Metal Cutting Theory", ASTME publication Michigan USA, 1969.
4. F. W. Wilson, "Fundamentals of Tool Design", ASME, PHI, New Delhi,2010.

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B. Tech. (ME) VII SEMISTER
PE4107ME Additive Manufacturing
(Professional Elective-V)

Course code	PE4107ME				
Category	Professional Elective Course				
Course title	Additive Manufacturing				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT – I

Introduction: Additive Manufacturing fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies. Role of AM in Industry 4.0.

UNIT – II

Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies: **Vat Photo polymerization AM Systems:** Photopolymers, photo polymerization Stereo lithography Apparatus (SLA), Direct Light Processing (DLP) and Continuous Direct Light Processing (CDLP).

Material Jetting AM Systems: Material Jetting, Nano particle jetting and Drop-On-Demand (DOD) material jetting, Polyjet.

Binder Jetting AM Systems: Three dimensional Printing (3DP). **Material Extrusion AM Systems:** Fused Deposition Modeling (FDM)

UNIT – III

Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies:

Powder Bed Fusion AM Systems: Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM).

Direct Energy Deposition (DED) AM Systems: Laser Engineered Net Shaping (LENS).

Sheet Lamination AM Systems: Laminated Object Manufacturing (LOM) and Ultrasonic Additive Manufacturing (UAM).

UNIT – IV

AM Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Slicing Algorithms: **Design for AM:** Topology optimization and Additive Manufacturing.

AM Software's: Need for AM software, Features of various AM softwar's like Magics, Mimics, Solid View, View Expert, 3 D Rhino, 3 D doctor, Flash Print, Object Studio, Cura, ITK Snap, 3-matic, Simplant, 3-matic, Simplant, MeshLab, Ansys for Additive Manufacturing.

UNIT –V

Additive Manufacturing Applications: AM Applications in Design, Engineering Analysis and Planning, Aerospace, Automotive, Jewelry, Coin, GIS, Arts, Architecture. Medical and Bioengineering Applications, Forensic Science, Anthropology, Visualization of Biomolecules, Electronic industry and Disaster Management.

Suggested Readings:

1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World Scientific Publications, 2017
2. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Springer, Second Edition, 2010.
3. Frank W.Liou, "Rapid Prototyping & Engineering Applications", CRC Press, Taylor & Francis group, 2011.
4. Rafiq Noorani, "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons, 2006.
5. NPTEL Course on Rapid Manufacturing https://nptel.ac.in/courses/112/104/112104265/

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B. Tech. (ME) VII SEMISTER
PE4108ME Design for Manufacturing
(Professional Elective-V)

Course code	PE4108ME				
Category	Professional Elective Course				
Course title	Design for Manufacturing				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT-I

Introduction: General design principles for manufacturability, strength and mechanical factors, Mechanisms selection, evaluation method, geometrical tolerances, tolerance control and utilization.

Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites.

UNIT-II

Metallic Components Design: Metal extrusion, metal stamping, fine blanking, four slide parts, spring and wire forms, spun metal parts, cold headed parts, extruded parts, tube and section bends, rolled formed parts, forging electro forming parts, specialized forming methods, turned parts, machined round holes, drilled parts, milled parts.

UNIT-III

Metallic Components Design: Planned shaped and slotted parts, screw threaded contoured and internal Ground parts, center less ground, electrical discharged, rolled furnished parts, electro chemical and Advanced machine parts. Sand cast, die cast, investment cast and other cast products.

UNIT-IV

Assembled Parts Design: Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, Bearing assembly.

UNIT-V

Assembled Parts Design: Retension, bolted connection, screwed connections, flanged connections, centred connections, press fitted connections, surface finishing, plated parts, heat treated parts.

Case Studies: Identification of economical design and redesign for manufacture.

Suggested Reading:

1. Assembly, Automation and Product Design/Geoffrey Boothroyd/Marceal Dekker INC, NY 1992
2. James G. Bralla, "Hand book of product design for manufacturing" McGraw Hill Co., 1986
3. K.G. Swift “Knowledge based design for Manufacture", Kogan page Limited, 198

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Department of Mechanical Engineering

B. Tech. (ME) VII SEMISTER
PE4109ME FUEL CELL TECHNOLOGY
(Professional Elective-V)

Course code	PE4109ME				
Category	Professional Elective Course				
Course title	FUEL CELL TECHNOLOGY				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT-I

Fundamentals: Brief history, working principles of fuel cell, components, and relative merits and demerits, classifications of fuel cells: low, intermediate and high temperature fuel cells, comparison of fuel cells with battery and heat engines.

UNIT-II

Fuel Cell Types: Polymer Electrolyte Membrane Fuel Cells (PEMFCs), Alkaline Fuel Cells (AFCs), Phosphoric Acid Fuel Cells (PAFCs), Solid Oxide Fuel Cells (SOFCs), Molten-Carbonate Fuel Cells (MCFCs), Direct Methanol Fuel Cells (DMFCs), Zinc Air Fuel Cells (ZAFCs), Protonic Ceramic Fuel Cells (PCFCs), Biological Fuel Cells (BFCs)

UNIT-III

Fuel Cells Applications: Portable Power, Backup Power, Transportation Applications: Automobiles, Buses, Utility vehicles, Scooters and bicycles, Stationary Power Applications, economic and environmental analysis on usage of fuel cell, future trends of fuel cells, and hybrid electric vehicle

UNIT-IV

Fuel Cell Analysis: Fuel cell thermodynamics, and electrochemistry - Nernst equation, Electrochemical kinetics, Butler-Volmer equation, performance evaluation of fuel cells: current/voltage, voltage efficiency and power density, Fuel cell: charge transport, mass transport, energy balance mass. fuel cell stack, fuel cell heat management..

UNIT-V

Fuel Cell System Design: Fuel Subsystem, Electrical Subsystem, System Efficiency. Fuel Types, Delivery, and Processing, Fuel Cell Operating Conditions, Fuel Cell Testing Setup, Verification of the Assembly, Fuel Cell Conditioning, Fuel Cell Hybrid Power Systems.

Suggested Reading:

1. Ryan O'Hayre, Suk-Won Cha, Whitney G.Colella, Fritz B.Prinz, "*Fuel Cell Fundamentals*", John Wiley & Sons, Inc., 2016.
2. Andrei A Kulikovsky, "*Analytical Modelling of Fuel Cells*", Elsevier, 2010, Vladimir S. Bagotsky, ―*Fuel Cells Problems and Solutions"*, John Wiley & Sons, Inc., 2009
3. Michael Gasik,"*Materials for fuel cells*", Woodhead Publishing Limited, 2008
4. Colleen Spiegel, "*Designing and Building Fuel Cells*", The McGraw-Hill Companies, 2007 W.W. Pulkrabek, Intorduction to IC Engines, PHI, 2004.

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B. Tech. (ME) VII SEMISTER
OE4110EE ENERGY STORAGE SYSTEMS
(Open Elective-II)

Course code	OE4110EE				
Category	Open Elective Course				
Course title	Energy Storage Systems				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT - I

Electrical Energy Storage Technologies: Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable.

UNIT - II

Needs for Electrical Energy Storage: Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

UNIT - III

Features of Energy Storage Systems: Classification of EES systems , Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2), Synthetic natural gas (SNG).

UNIT - IV

Types of Electrical Energy Storage systems: Electrical storage systems, Double-layer capacitors (DLC) ,Superconducting magnetic energy storage (SMES),Thermal storage systems ,Standards for EES, Technical comparison of EES technologies.

UNIT - V

Applications: Present status of applications, Utility use (conventional power generation, grid operation & service) , Consumer use (uninterruptable power supply for large consumers), New trends in applications ,Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems , Aggregating EES

systems and distributed generation (Virtual Power Plant), Battery SCADA– aggregation of many dispersed batteries.

Suggested Readings:

1. Energy Storage Benefits and Market Analysis' by James M. Eyer, Joseph J. Iannucci and Garth P. Corey.
2. The Electrical Energy Storage by IEC Market Strategy Board.
3. Jim Eyer, Garth Corey: Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

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B. Tech. (ME) VII SEMISTER
OE4111EC Optimization Techniques
(Open Elective-II)

Course code	OE4111EC				
Category	Open Elective Course				
Course title	Optimization Techniques				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT – I

Introduction: Definitions, Characteristics, Objective function, Classification of optimization problems, Engineering applications and limitations. Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints and Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Condition

UNIT – II

Linear Programming: Definitions and Formulation of the LPP, Construction of L.P. Models, Slack and surplus variables, Standard form, Canonical form and matrix form of LP Problems. Artificial Variables, solution by the Big-M method, Duality principle, Dual problems and numerical problems.

UNIT – III

Random Search Methods concepts: Direct Search Methods – Uni variate Method, Gradient of a Function, Indirect Search Methods - Gradient of a Function, Steepest Descent (Cauchy) Method, Newton‘s Method.

UNIT – IV

Binary Genetic Algorithm: Genetic Algorithms Natural Selection on a Computer, Components of a Binary Genetic Algorithm. Selecting the Variables and the Cost Function. Variable Encoding and Decoding, the Population, Natural Selection, Selection, Mating. Mutations, the Next Generation and Convergence, Components of a Continuous Genetic Algorithm. With effect from the Academic year 2021-22

UNIT – V

Metaheuristics Optimization: Concepts of Simulated Annealing, Theoretical approaches, Advantages and disadvantages, applications, Ant Colony Algorithms - Introduction, Collective behavior of social insects, Formalization and properties of ant colony optimization.

Suggested Readings:

1. Rao, S.S., "Engineering Optimization: Theory and Practice", John Wiley & Sons, Inc., 2009
2. Taha, H.A., "Operations Research, Pearson Education India", New Delhi, India, 2008.
3. Randy L. Haupt and Sue Ellen Haupt, "Practical genetic algorithms" second edition, a John Wiley& sons, inc., publication -2004.
4. Sharma J.K., ―Operation Research: Theory and Applications" Fifth Edition, Macmillan Publishers, New Delhi, India, 2013.
5. J. Dreo A. Petrowski, P. Siarry E. Taillard, "Metaheuristics for Hard Optimization" Springer.

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B. Tech. (EC) VII SEMISTER
OE4112EC Fundamentals of IOT
(Open Elective-II)

Course code	OE4112EC				
Category	Open Elective Course				
Course title	Fundamentals of IOT				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	-	-	3	External Marks = 70

UNIT- I

Introduction to Internet of Things: IoT vision, Strategic research and innovation directions, IOT Applications, Related future technologies, Infrastructure, Networks and communications, Processes, Data Management, Security, Device level energy issues.

UNIT- II

Internet Principles and communication technology: Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open-Source Vs Closed Source.

UNIT- III

Prototyping for IoT: Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi.

UNIT- IV

Cloud computing and Data Analytics: Introduction to Cloud storage models -SAAS, PAAS, and IAAS. Communication APIs, Amazon web services for IOT.

UNIT- V

IoT Product Manufacturing - From prototype to reality: Business model for IoT product manufacturing, Business models canvas, Funding an IoT Startup.

Suggested Readings:

1. *"Internet of Things"* - Converging Technologies for smart environments and Integrated Ecosystems, River Publishers.
1. Adrian McEwen, Hakim Cassimally, "*Designing the Internet of Things",* Wiley India Publishers
2. Daneil W lewies, "*Fundamentals of embedded software: where C meets assembly",* Pearson.
3. Arshdeep Bahga*, "Internet of things -A hands on Approach"* Universities press.

Faculty of Engineering & Technology
KAKATIYA UNIVERSITY, WARANGAL-506 009
Department of Mechanical Engineering

B. Tech. (ME) VII SEMISTER
PC4113ME Product Design by CAD Lab
(Professional Core Course)

Course code	PC4113ME				
Category	Professional Core Course				
Course title	Product Design by CAD Lab				
Scheme and Credits	L	T	P	Credits	Internal marks = 25
	-	-	2	1	External Marks = 50

Product Design by CAD LAB

List of Experiments

1. To design and implement a program for line drawing using Bresenhams Integer line algorithim.
2. Implementation of general two-dimensional rotation, reflection and scaling in modules, generation of required transformation matrices using the above modules.
3. Curve generation and manipulation program for cubic spline curve.
4. Curve generation and manipulation program for Bezier curve.
5. Orthographic Projections of Standard Mechanical components using AutoCAD.
6. Isometric Projections of Standard Mechanical components using AutoCAD.
7. Solid Part modelling of Simple mechanical components Using CATIA.
8. Assembly of solid models of simple mechanical devices using CATIA
    1. Finite Element Analysis Using ANSYS
    2. Simple 2D Truss problems.
    3. Beam Problems
    4. Plate with Circular Hole.
9. Solid imported from CATIA subjected to simple loads
10. One dimensional Thermal problems
11. Demonistration of 3d Printing
12. To create a Simple Rectangular Box using 3d printer.

Suggested Readings:

1. P. Radha Krishnan, Introduction to CNC Machines, New Age International, New Delhi.
2. Jerry Banks, Introduction to Discrete event simulation, McGraw-Hill, New York
3. James D. Foley, Andries Van Dam, et.al., Computer Graphics-Principles and Practice,2/e, Addison Wesley, 1997.
4. Verification Manual ANSYS

Note: Any ten (10) experiments can be conducted

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Department of Mechanical Engineering

B. Tech. (ME) VII SEMISTER
PW4114ME PROJECT WORK
(PROJECT WORK)

Course code	PW4114ME				
Category	Professional Core Course				
Course title	PROJECT WORK				
Scheme and Credits	L	T	P	Credits	Internal marks = 50
	-	-	3	1.5	External Marks

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
Grouping of students (max 5 in a group) Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide

Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

Each group will be required to:

1. Submit a one page synopsis before the seminar for display on notice board.
2. Give a 30 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

1. Problem definition and specification
2. Literature survey
3. Broad knowledge of available techniques to solve a particular problem.
4. Planning of the work, preparation of bar (activity) charts
5. Presentation- oral and written.