Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore

Shri Vaishnav Institute of Technology and Science

Choice Based Credit System (CBCS) Scheme in light of NEP-2020

B. Tech/B.Tech+MBA in Mechanical Engineering

(2021-2025)

COURSE CODE	CATEGORY	COURSE NAME	TEACHING &EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME501A	DSE	CAD CAM CIM	60	20	20	30	20	3	0	2	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

This course provides a fundamental understanding of (A) The Design concepts with the help of computer Application (B) Comprehensive Knowledge of computer applications including geometric, Modeling, Assemblies and Manufacturing.

Course Outcomes (COs):

After completion of this course the students are expected to be able to demonstrate following knowledge, skills and attitudes

1. Understand the various design concepts with the help of computer application.
2. Familiarized with the computer graphics application in design and understand the basic 2D & 3D commands of CAD and distinguish the CAD from manual paper drafting, in current industrial & product development scenarios.
3. Understand the solid modeling and assembly tools to develop virtual product and part programming and CIM.
4. Understand the CIM and Group Technology and their importance.

Syllabus

Unit – I **(9 Hrs)**

Introduction: Introduction to CAD, Why CAD Software, Scope, objective, benefit , limitation & evaluation; Engineering Design process, Considerations, Formulation Importance, Regulatory and social issues in Indian context; Conceptual Design, Product Design Cycle, Total life cycle, Digital Prototyping, Information requirements of mfg organizations; business forecasting and aggregate production plan; MPS, MRP and Production Activity Control (PAC), introduction of CAD, CAE, CAM, CAP, CAPP, CATD and CAQ.

Unit – II **(9 Hrs)**

Graphics Fundamentals & Standards: Definition, Software configuration of a Graphic system, Functions of a Graphics package, CAD Interface, Coordinate system, Creating Basic Drawings, Creating Additional Drawing Objects, Altering Objects, Drawing Organization and Inquiry Commands, Modify and Manipulating Objects, Construction and Reference Geometry, Hatching Objects, Utility Commands, Layers& Blocks, Text, Table & Dimensions, Introducing Printing, Plotting, and Layouts. Database for graphic modeling; PDM, PIM, EDM; define EDM, features of EDM need for CAD data standardization, data exchange formats; GKS, PHIGS, CORE, IGES, DXF STEP DMIS AND VDI; ISO standard for data exchange.

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Unit – III **(9 Hrs)**

Geometric Modeling & Assembly: Introduction to Geometric Modeling , Types of models, Construction of 3D Solid Primitives , Create 3D Solids from Objects, Extrude , Revolve, Sweep, Loft , Combine or Slice 3D Objects, Move Rotate & Scale 3D Objects, Object Sectioning , Save and Publish Section Objects Wire frame Models, Wire frame Entities, Curve Representation. Assembly Modeling, Mating conditions, Generation of assembling sequences, basics of boundary presentation- Spline, Bezier, B-Spline, and NURBS; Sculpture and Ruled surfaces, Precedence diagram, Liaison-sequence analysis; Mechanical tolerance: Tolerance concepts, Geometric tolerance, Types of geometric tolerances, Location tolerances, drafting practices in dimensioning and Tolerancing, Tolerance Analysis.

Unit – IV **(9 Hrs)**

Computer-Aided Manufacturing & Part Programming: Computer-Aided Manufacturing, Computer Applications in a Manufacturing Plant, Key Aspects of CAM in a Manufacturing System and Manufacturing Control, G Code & M Code generation through CAD CAM software, Feature Technology , NC, DNC, CNC, Programmed Automations, Machine control unit, Part program, NC tooling. NC machine tools: Nomenclature of NC machine axes, Types of NC machine tools, Machining centers, Automatic tool changes (ATC), Turning centers. ISO codes for turning tools and holders; ATC, modular work holding and pallets; time and power estimation in milling, drilling and turning; adaptive control, sequence control and PLC; simple part programming examples.

Unit-V **(9 Hrs)**

Computer Integrated Manufacturing and Group Technology: Introduction to CIM, Scope of Computer integrated Manufacturing; CIM Wheel; Types of Manufacturing systems; Machine tools and related equipment, Material handling systems; Computer control systems, FMS. Importance of batch and job shop production; merits of converting zigzag process layout flow to smooth flow in cellular layout, Production Flow Analysis (PFA) and clustering methods; concept of part families and coding; hierarchical, attribute and hybrid coding; OPITZ, MICLASS and DCLASS coding; FMS; material handling robots, Computer Aided Process Planning (CAPP).

Text and Reference Books:

1. "Automation, production systems, and computer-integrated manufacturing" by M. P. Groover, Prentice Hall Press, 2007.

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2. "CAD/CAM/CIM" by P. Radhakrishnan, Subramanian S and Raju V; New Age Pub., 2008.
3. "Computer integrated manufacturing: from fundamentals to implementation" by A. Weatherall, Butterworth-Heinemann, 2013.
4. "Principles of CIM" by S. Kant Vajpay; PHI, 1995.
5. "CAD/CAM" by P.N. Rao, TMH, 2010.
6. "CAD/CAM Computer Aided Design and Manufacturing" by Mikell P. Groover and Emory W. Zimmer, 2008.
7. "Computer Integrated Design and Manufacturing" by David D. Bedworth, Mark R. Henderson, Philip M. Wolfe, McGraw-Hill, 1991.
8. "Mastering CAD", by George Omura with Brian Benton Autodesk, 2004.
9. "PTC Creo Parametric 3.0 for Designers" byTickoo S, Textbooks Published by BPB, 2015.
10. "SOLIDWORKS 2017 for Designers", by Tickoo S, Textbooks Published by BPB, 2017.
11. "CATIA V5-6R2016 for Designers", by Tickoo S, Textbooks Published by BPB, 2017.
12. "Autodesk Inventor Professional 2017 for Designers", byTickoo S, Textbooks Published by BPB, 2017.

List of Experiments

The students will be required to carry out the following exercises using educational software (Auto CAD, Creo, Solid works, Master CAM etc).

1. Setting up of drawing environment by setting drawing limits, drawing units, naming the drawing, naming layers, setting line types for different layers using various type of lines in engineering drawing, saving the file with .dwg extension.
2. Layout drawing of a building using different layer and line colours indicating all Building details. Name the details using text commands, Make a title Block.
3. To Draw Orthographic projection Drawings (Front, Top and side) of safety valve, knuckle joint, cotter joint & Plummer block etc.
4. Make an Isometric dimensioned drawing from orthographic drawings.
5. Draw different types of bolts and nuts with internal and external threading in Acme and square threading standards. Save the bolts and nuts as blocks suitable for insertion.

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6. Draw 3D models by extruding, revolve, sweep, loft & other 3D Modelling commands in AutoCAD.
7. Prepare Assembled 3d cad models of knuckle joint, cotter joint & Plummer block through Creo cad modelling software.
8. Apply Constraints & Mechanism on 4 bar & piston cylinder mechanism through Creo Mechanism tools.
9. Generate G codes & M codes of any models through CAM tools of Creo Software.
10. Write the program prepare any work piece through CNC Machine.

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BTME501B	DSE	FINITE ELEMENT ANALYSIS	60	20	20	30	20	3	0	2	4

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Course Educational Objectives (CEOs)

The course provides the knowledge of (A) finite element methods. (B) finite element modeling and simulation techniques (C) FEA in structural vibration and thermal Analysis.

Course Outcomes (COs)

After completion of this course the students are expected to be able to demonstrate following knowledge, skills and attitudes

1. Learn concepts of FEM
2. Learn and understand finite element modeling and simulation techniques
3. Use of FEA in structural vibration and thermal Analysis
4. Learn Finite Element Softwares

Syllabus

Unit – I **(9 Hrs)**

Basics of FEM: Basic concept of Finite Element Method, Historical background, FEM Applications, General Description of FEM, Commercial FEM software packages, Spring element-stiffness matrix, boundary conditions, solving equations, Variation formulation approach- Rayleigh-Ritz method, Principle of minimum Potential Energy, Weighted residual methods. Initial value and boundary value problems, weighted residual Galerkin and Raleigh Ritz methods-review of Variation calculus, Integration by parts, Basics of variation formulation.

Unit – II **(9 Hrs)**

Element Types and Characteristics: Discretization of the domain, Basic element shapes, Aspect ratio, Shape functions, Generalized co-ordinates and nodal shape functions; ID bar and beam elements, 2D rectangular and triangular elements; axis-symmetric elements.

Unit – III **(9 Hrs)**

Assembly of Elements and Matrices: Concept of element assembly, Global and local coordinate systems, Band width and its effects, Banded and skyline assembly, Boundary conditions, Solution of simultaneous equations, Gaussian elimination and Chloe's decomposition methods, Numerical integration, One and 2D applications

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BTME501B	DSE	FINITE ELEMENT ANALYSIS	60	20	20	30	20	3	0	2	4

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Unit – IV **(9 Hrs)**

Higher Order and Iso-parametric Elements: One dimensional quadratic and cubic elements, Use of natural co-ordinate system, Area co-ordinate system continuity and convergence requirements, 2D rectangular and triangular requirement.

Unit-V **(9 Hrs)**

Structural Vibration and Dynamic Analysis: Review of basic dynamic equations, Hamilton's principle, element mass matrices, free vibration (normal mode) analysis, Eigen values and Eigen vectors, Introduction to transient response analysis.

Text and Reference Books:

1. "An introduction to the Finite Element Method" by J. N. Reddy, McGraw Hill Education, 2005.
2. "Introduction of Finite elements in Engineering" by Chandrupatla & Belagundu, Pearson, 2011.
3. "Finite Element Method in Engineering" by S.S. Rao, Butterworth-Heinemann, 2010.
4. "Finite Element Analysis- Theory and Programming" by C. S. Krishnamoorthy, Tata McGraw-Hill Education, 2011.
5. "The Finite Element Method" by Zienkiewicz and Taylor, Butterworth-Heinemann, 2000.
6. "Concepts and Applications of Finite Element Analysis" by Cook, Robert Davis at al., John Willy & Sons, 2005.
7. "The Finite Element Method for Engineers" by K. H. Huebner, D. L. Dewhirst, D. E. Smith and T. G. Byron, John Wiley & Sons, 2001.

List of Experiments

1. Study of FEA package. Modeling and stress analysis of Trusses.
2. Analysis of bars of constant cross section area, tapered cross section area and stepped bars.
3. Analysis of various types of beams.
4. Stress analysis of rectangular plate with circular hole

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BTME501B	DSE	FINITE ELEMENT ANALYSIS	60	20	20	30	20	3	0	2	4

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5. Stress analysis of axisymmetric problems – Pressurized cylinder and rotating disc or cylinders (Solid and hollow).
6. Thermal Analysis – 1D and 2D problem with conduction and convection boundary conditions.
7. Fluid flow Analysis
8. Vibration analysis of various elements of structures.
9. Dynamic Analysis 1) Fixed -fixed beam for natural frequency determination 2) Bar subjected to forcing function 3) Fixed -fixed beam subjected to forcing function.

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BTME502A	DSE	ADVANCED MATERIALS	60	20	20	0	0	3	1	0	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):
To introduction and familiar with (A) special steels and their alloys, (B) automation using hydraulic and Pneumatic system (C) automated work handing system (D) applications of automation in manufacturing.

Course Outcomes (COs):
After completion of this course the students are expected to be able to demonstrate following knowledge, skills and attitudes

1. Understand the concept of automation.
2. Design a Pneumatic and Hydraulic system for a given application.
3. Understand the transfer mechanisms in automation and handling system
4. Demonstrate the use of different sensors for automation.
5. Design an AGV system or automated mechanical system.

Syllabus

Unit – I **(9 Hrs)**

Special Steel and Their Alloys

Metallurgical aspects, properties and applications of different types of stainless steels such as: dual phase steels, trip steels, maraging steels, high speed steels, free cutting steels, ausformed steels, tool steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels etc.,.

Unit – II **(9 Hrs)**

Light Metals and Their Alloys

Need of alloying, Aluminium, magnesium and titanium alloys: Metallurgical aspects, Properties and applications.

Super alloys: Iron base, nickel base and cobalt base super alloys, Composition, Properties and their application

Unit – III **(9 Hrs)**

Nano and Smart Materials

Definition, types, properties and applications, carbon nano tubes, methods of production, shape memory alloys, piezoelectric materials, electro-active polymers, electro-rheological fluid, functionally gradient material (FGM), biomaterials, micro-electro mechanical systems (MEMS).

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BTME502A	DSE	ADVANCED MATERIALS	60	20	20	0	0	3	1	0	4

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Unit – IV **(9 Hrs)**

Composite Materials:

Definition, Classification, Composite Materials and Structures, Processing of metal matrix composites, polymer matrix composites, ceramic matrix composites, behavior of composites, orthotropic and laminated composite, failure of composites.

Unit – V **(9 Hrs)**

Miscellaneous Advanced Materials

Magnetic materials, ceramics, biomaterials, polymers, aerospace materials and cryogenic materials, semi conducting and superconducting materials and their applications. Properties and applications: strength, stiffness, creep, fatigue and fracture; thermal, damping and tribological properties.

Text Books:

1. "The Science and Engineering of Materials" by Donald R. Askeland, P.P. Fulay and W.J. Wright, Cengage Learning, 2010.
2. "Advances in Material Science" by R K Dogra and A K Sharma, S.K. Kataria & Sons, 2003.
3. "Engineering Materials: Polymers, Ceramics and Composites" by AK Bhargava, PHI, 2012.
4. "Engineering Materials and their Applications" by R. A. Flinn and P. K. Trojan, JPH, 1999.
5. "Nano Technology" by A.K. Bandyopadhyay, New Age Int. Pub. 2008.

Reference Books:

1. "Smart Materials and Structures" M.V. Gandhi and B.S. Thompson, Chapman and Hall. 1992.
2. "Composite Materials, Science and Engineering" by K.K. Chawla, Springer, 2012.
3. "Advances in Materials and Their Applications" by P. Rama Rao, New Age International (P) Ltd., Publishers, 2012.
4. "Elements of Materials science" by Van Vlack, Pearson, 2002.

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BTME502B	DSE	ROBOTICS AND MACHINE VISION SYSTEM	60	20	20	0	0	3	1	0	4

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Course Educational Objectives (CEOs):

This course provides a fundamental understanding of (A) mechanical design of robots, various sensors and its application in the area of industrial robotics. (B) Sensors and programming of industrial robots. (C) Applications of vision and challenges involved (D) Impart knowledge on imaging, machine vision and its applications.

Course Outcomes (COs):

After completion of this course the students are expected to be able to

1. Explain the various image processing and image analysis algorithms and the issues involved in applying them to various machine vision applications
2. Apply the basic concepts of optics in imaging.
3. Explain the various hardware components of an imaging system for machine vision applications.

Syllabus

Unit-I **(10 Hrs)**

Introduction: Definition, Types of Industrial Robots; classifications based on work envelope – Generations, configurations and control loops; co-ordinate system, need for robot, basic parts and functions, specifications.

Robot motion, Kinematics of Robot motion, Direct and Indirect kinematics; Homogeneous transformations; linkages and joints, mechanism, method for location and orientation of objects; drive systems, end effectors, types, selection, classification and design of grippers, gripper force analysis.

Functions of Sensors, Position and proximity's sensing, tactile sensing, sensing joint forces; vision system, object recognition and image transformation, safety monitoring; sensor systems, image analysis, application of image processing.

Unit-II **(9 Hrs)**

Robot Programming & AI Techniques: Types of Programming; Teach pendant programming; Basic concepts in AI techniques, Concept of knowledge representations, Expert system and its components; Robotic cell layouts, Inter locks, Humanoid robots, Micro-robots; Application of robots in surgery, Manufacturing industries, space and underwater.

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BTME502B	DSE	ROBOTICS AND MACHINE VISION SYSTEM	60	20	20	0	0	3	1	0	4

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Unit-III **(9 Hrs)**

Image Acquisition: Human vision, Machine and Computer vision, Benefits, Block diagram and function; System implementation of industrial machine vision system; Light Physics and Interactions, Refraction at a spherical surface, Thin Lens Equation, Scene constraints, Lighting parameters, Lighting sources; Selection Lighting Techniques, Types and Selection; Machine Vision Lenses and Optical Filters, Specifications and Selection; Imaging Sensors, CCD and CMOS; Specifications Interface Architectures, Analog and Digital Cameras, Digital Camera Interfaces, Camera Computer Interfaces; Specifications and Selection – Geometrical Image, formation models – Camera Calibration.

Unit-IV **(8 Hrs)**

Image Processing: Machine Vision Software, Fundamentals of Digital Image, Image Acquisition Modes, Image Processing in Spatial and Frequency Domain, Point Operation, Thresholding; Grayscale Stretching, Neighborhood Operations, Image Smoothing and Sharpening; Edge Detection, Binary Morphology, Color image processing

Unit-V **(9 Hrs)**

Machine Vision Analysis & Applications: Feature extraction – Region Features, Shape and Size features, Texture Analysis; Template Matching and Classification – 3D Machine Vision Techniques, Decision Making; Machine vision applications in manufacturing, electronics, printing, pharmaceutical, textile etc.; applications in non-visible spectrum, metrology and gauging, OCR and OCV; vision guided robotics – Field and Service Applications, Agricultural, and Bio medical field, augmented reality, surveillance, bio-metrics.

Text Books:

1. "Automation, Production Systems and Computer Integrated Manufacturing" by Mikell P. Grover, Pearson Education Asia, 2001.
2. "Robots and manufacturing Automation" by C. Ray Asfahl, John Wiley and Sons New York, 2002
3. "Introduction to Robotics- mechanics and control" by Craig. J. J., Addison- Wesley, 2001.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME502B	DSE	ROBOTICS AND MACHINE VISION SYSTEM	60	20	20	0	0	3	1	0	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Reference Books:

1. "Industrial Robotics, technology, programming and application", by Groover.M.P. Mc-Graw Hill book and co. 2012
2. "Robotics Control, sensing, vision and intelligence", by Fu.K.S ,Gonzalac R.C ,Lee C.S.G, Mc- Graw Hill book co 2011.
3. "Introductory Techniques For 3D Computer Vision", by EmanueleTrucco, Alessandro Verri, FirstEdition, 2009
4. "Digital Image Processing Publishers", by Rafael C.Gonzales, Richard.E.Woods, Third Edition, 2007

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME502C	DSE	NON-CONVENTIONAL ENERGY SOURCES	60	20	20	0	0	3	1	0	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):
This course provides concepts and knowledge of (a) Solar Energy (b) Wind Energy (c) Bio Energy (d) Ocean Energy & Geothermal Energy.

Course Outcomes (COs):
After learning the course the students should be able to:

1. Understand the basic concept of renewable energy engineering.
2. Acknowledge, access and analysis various renewable energy system & technology.
3. Evaluate renewable energy related system for a particular application.
4. Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.

Syllabus

Unit – I **(9 Hrs)**

Introduction: Needs of Renewable Energy, Advantages and Limitations of Renewable Energy, Present energy scenario of conventional and renewable energy sources, Review of energy sources, Present energy consumption/utilisation pattern sector wise in India ,Environmental impact of fossil fuels, growth of energy sector and its planning in India.

Unit – II **(9 Hrs)**

Solar Energy: Solar radiation at the earth's surface, solar radiation measurements, estimation of average solar radiation, solar thermal flat plate collectors, concentrating collectors, solar thermal applications; heating, cooling, desalination, drying, cooking, etc, principle of photovoltaic conversion of solar energy, photovoltaic applications. Photovoltaic system for power generation, solar cell modules and arrays, solar cell types, material, applications, advantages and disadvantages

Unit – III **(9 Hrs)**

Wind Energy: Power in the wind, Betz limit, site selection, wind energy conversion devices, characteristics, applications, offshore wind energy, Hybrid systems, safety and environmental aspects, wind energy potential and installation in India. basics of wind energy conversion system, effect of density, angle of attack and wind speed, windmill rotors, horizontal and vertical axes rotors, drag, lift, torque and power coefficients, tip speed ratio, solidity of turbine, wind turbine performance curves, wind energy potential and site selection, basics of wind.

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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME502C	DSE	NON-CONVENTIONAL ENERGY SOURCES	60	20	20	0	0	3	1	0	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
*__Teacher Assessment__ shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Unit - IV **(8 Hrs)**

Bio-Energy: Biomass resources and their classification, biomass conversion processes, thermo chemical conversion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, alcohol production from biomass, bio diesel production, urban waste to energy conversion, biomass energy programs in India.

Unit-V **(10 Hrs)**

Ocean Energy: OTEC principle, open, closed and hybrid cycle OTEC system, Energy from tides, estimation of tidal power, tidal power plants, single and double basin plants, site requirements, advantages and limitations wave energy, wave energy conversion devices, advantages and disadvantages, ocean thermal energy.

Geothermal energy: Introduction, vapor and liquid dominated systems, binary cycle, hot dry rock resources, magma resources, advantages and disadvantages, applications

MHD Power generation: concept and working principle

Text and Reference Books:

1. "Solar Energy: Principles of Thermal Collection and Storage", by S. P. Sukhatme and J. K. Nayak, McGraw-Hill (2006).
2. "Solar Engineering of Thermal Processes", by John A. Duffie, William A. Beckman, John Wiley, New York (2013).
3. "Non-conventional energy resources", by Shobh Nath Singh, Pearson India (2015).
4. "Solar Energy Engineering", by Soteris Kalogirou, Elsevier/Academic Press (2009).
5. "Principles of Solar Energy", by Frank Krieth & John F Kreider, John Wiley, New York (2015).
6. "Renewable Energy Engineering and Technology", by Kishore VVN, Teri Press, New Delhi (2010).

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BTME503	DCC	DYNAMICS OF MACHINE	60	20	20	30	20	3	0	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

To introduce basic principles and applications of (A) Engine Mechanisms, (B) Governor Mechanisms, (C) Balancing of Inertia Forces, Friction and Brakes

Course Outcomes (COs):

After completion of this course the students are expected to be able to demonstrate following knowledge, skills and attitudes

1. Understand the need of engine mechanisms and displacement, velocity and acceleration of piston.
2. Understand Governor Mechanisms.
3. Understand and analyse Balancing of masses.
4. Understand utility of Friction in Machine parts and lubrication concepts.
5. Students would be able to analyze Cam movement, belt drives and braking.

Syllabus

Unit – I **(9 Hrs)**

Dynamics of Engine Mechanisms: Displacement, velocity and acceleration of piston; turning moment on crankshaft; turning moment diagram; Fluctuation of crankshaft speed; Analysis of flywheel.

Unit – II **(9 Hrs)**

Governor Mechanisms: Types of governors, characteristics of centrifugal governors, gravity and spring controlled centrifugal governors; hunting of centrifugal governors; inertia governors.

Unit – III **(9 Hrs)**

Balancing of Inertia Forces: Balancing of rotating masses; Two plane balancing; Determination of balancing masses (graphical and analytical methods); Balancing of rotors; Balancing of internal combustion engines, Single cylinder engines, In-line engines, V-twin engines, Radial engines, Lanchester technique of engine balancing.

Unit – IV **(9 Hrs)**

Friction: Frictional torque in pivots and collars by uniform pressure and uniform wear rate criteria, Boundary and fluid film lubrication, friction in journal and thrust bearings, concept of friction circle and axis, rolling friction.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME503	DCC	DYNAMICS OF MACHINE	60	20	20	30	20	3	0	2	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Unit-V **(9 Hrs)**

Belt drives: Velocity ratio, limiting ratio of tension; power transmitted; centrifugal effect on belts; maximum power transmitted by belt; initial tension; creep; chain and rope drives.
Brakes: Band brake; Band and block brakes, Internal and external shoe brakes.
Dynamometer: Different types and their applications.
Dynamic Analysis of Cams: Response of un-damped cam mechanism (analytical method), follower response analysis by phase-plane method, jump and cross-over shock.

Text and Reference Books:

1. "Theory of machines", by Rattan; Publisher: TMH, 2009.
2. "Mechanism and Machine Theory", by Ambekar; Publisher: PHI, 2007.
3. "Theory of Machines", by Thomas Bevan; Publisher: Pearson, 2010.
4. "Theory of Mechanisms and Machines", by Ghosh and Malik; East-West Press, 2015.
5. "Kinematics and dynamics of machinery", by Norton RL; Publisher: TMH, 2009.
6. "Theory of Machines", by P.L. Balaney; Publisher: Khanna, 2003.

List of Experiments

1. To Perform Experiment on Watt and Porter Governors & also Prepare Performance Characteristic Curves in order to find Stability & Sensitivity.
2. To Perform Experiment on Proell Governor & also Prepare Performance Characteristic Curves in order to find Stability & Sensitivity.
3. To Perform Experiment on Hartnell Governor & also Prepare Performance Characteristic Curves in order to find Stability & Sensitivity.
4. To determine gyroscopic couple on Motorized Gyroscope.
5. To study gyroscopic effects through models.
6. To study Dynamically Equivalent System.
7. To study different types of dynamometers.
8. To study different types of clutch.
9. To study different types of Brakes.
10. To Study dynamic behavior of cam & follower under various operating conditions using CAM Analysis Apparatus.

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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME504N	DCC	IC ENGINES AND EV	60	20	20	30	20	3	0	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
*Teacher Assessment shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs)

This course provides a fundamental understanding and impart the knowledge of (A) working of I.C. engines and engine performance (B) fuel injection and ignition system (C) fuel combustion (D) engine cooling, lubrication system and testing of IC engines (E) Electric Vehicle and its components.

Course Outcomes (COs)

After completion of this course the students are expected to be able to demonstrate following knowledge, skills and attitudes

1. Demonstrate the working of IC engines and its performance
2. Describe the fuel injection and ignition system.
3. Explain the fuel combustion within IC engine.
4. Understand the cooling and lubrication system and know various engine performances through testing and measurement.
5. Understand and describe the Electric Vehicles and its systems

Syllabus

Unit – I **(9 Hrs)**

Air Standard Cycles: Internal and external combustion engines, classification and applications of I.C. Engines, IC engine components and terminology, 2S and 4S engines, Assumptions made in air standard cycle, comparison of Otto, diesel and dual combustion cycles, Stirling and Ericsson cycles, air standard efficiency, specific work output, specific weight, work ratio, mean effective pressure, deviation of actual engine cycle from ideal cycle, valve and port timing diagrams. IC engine performance parameters: Engine power, engine efficiencies, mechanical efficiency, brake mean effective pressure and indicative mean effective pressure, torque, specific fuel consumption (BSFC, ISFC), variable affects engine performance, heat balance, engine performance curves.

Unit – II **(9 Hrs)**

Carburetion: factors influencing carburetion; mixture requirements for various operating conditions, types of carburetors.

Fuel Injection System: Functional requirements of an injection system, types of inject systems, components of injection system.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME504N	DCC	IC ENGINES AND EV	60	20	20	30	20	3	0	2	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Ignition System: Requirements of ignition system, battery ignition system, magneto ignition system, electronic ignition system, firing order, ignition timing.

Unit – III **(8 Hrs)**

Combustion in S.I. engines: Stages of combustion in S.I. engines; effect of engine variables on ignition lag, combustion phenomenon; knock in S.I. engines; effects of engine variables on knock, combustion chamber for S.I. engines.

Combustion in C.I. engines: Stages of combustion in C.I. engines; variables affecting delay period; knock in C.I. engines; C.I. engine combustion chambers.

Unit – IV **(10 Hrs)**

Lubrication and Cooling Systems: Functions of a lubricating system, types of lubrication system; mist, wet sump and dry sump systems, crankcase ventilation, properties of lubricant, SAE rating of lubricants, engine performance and lubrication, necessity of engine cooling; effect of engine variables on engine heat transfer, different types of cooling systems.

Engine measurements and Testing: Friction power, indicated power, brake power, fuel and air consumption, speed, temperature of coolant and exhaust, noise and emission measurement.

Pollution and Its Control: Pollutants from S.I. and C.I. engines, Methods of emission control; alternative fuels for I.C. Engines, catalytic convertor.

Unit – V **(9 Hrs)**

Electric Vehicle (EV): Need of EV, Components of Electric Vehicle, Comparison with IC Engine in terms of technology, advantages and disadvantages, EV Classification, EV Terminology, general layout of EV, concept of electric traction, electric drives, energy storage and management system in EVs etc., Indian and global scenario.

Text and Reference Books:

1. "Internal Combustion Engine Fundamentals" by J.B. Heywood, McGraw-Hill, 1988.
2. "Fundamentals of Internal Combustion Engines" by Paul W. Gill & James H. Smith, Oxford & IBH Pub. Ltd., 1986.
3. "A Course in Internal Combustion Engines" by V. M. Domkundwa, Dhanpat Rai Publication, 2013.
4. "Internal Combustion Engines", by V. Ganesan, Tata McGraw-Hill, 2012.

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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME504N	DCC	IC ENGINES AND EV	60	20	20	30	20	3	0	2	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

5. "Internal Combustion Engines", by M.L. Mathur & R.P. Sharma, Dhanpat Rai Publications, 4th edition, 2014.
6. "Electric Vehicle Technology Explained" by James Larminie, John Lowry, John Wiley & Sons Ltd, 2003.
7. "Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Hussein, CRC Press, 2003.
8. "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design" by Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, CRC Press, 2004.

List of Experiments

1. To study the working of 2 stroke and 4 stroke petrol (S.I.) engine
2. To study the working of 2 stroke and 4 stroke diesel (C.I.) engine
3. To study valve/port timing diagram of I.C. Engines.
4. To study fuel injection and ignition system of both S.I. & C.I. engines.
5. To study the different lubrication systems of I.C. engine.
6. Evaluate performance of 4-stroke C.I. engine and prepare heat balance sheet.
7. Evaluate performance of 2-stroke C.I. engine and prepare heat balance sheet.
8. Performance evaluation of four and two stroke S.I. engine.
9. Performance evaluation of multi-cylinder Diesel/Petrol Engine.
10. Study of general layout and components of Electric Vehicle.

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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME506	AESE	PROTOTYPING LAB	0	0	0	30	20	0	0	4	2

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

This course provides a fundamental understanding of (A) The Design concepts with the help of computer and software (B) Comprehensive Knowledge of computer applications including geometric, Modeling, Assemblies and Manufacturing (C) concepts of rapid prototyping and its applications.

Course Outcomes (COs):

After completion of this course

1. Student will be able to understand the various design concepts on computer and role of graphics in CAD CAM.
2. Students would be able to get familiarized with 2D & 3D commands of CAD and distinguish the CAD from manual paper drafting, in current industrial & product development scenarios.
3. Students would be able to understand the Solid and Assembly modeling tools to develop virtual product and part programming for manufacturing in various experiments & real life.
4. Students will be able to acquire knowledge of the applications of computers in design and manufacturing of real world product.
5. Students will understand RP methods and their importance.

Syllabus

Unit – I **(10 Hrs)**

Introduction: Role of Computer Graphics in CAD/CAM; configuration of graphic workstations, menu design and Graphical User Interfaces (GUI), customization and parametric programming.
Geometric Transformations and Projections: Vector representation of geometric entities, homogeneous coordinate systems, fundamentals of 2D and 3D transformations: Reflection, translation, rotation, scaling, and shearing, various types of projections.

Unit – II **(10 Hrs)**

Curves: Modeling planar and space curves, analytical and synthetic approaches, non-parametric and parametric equations.
Surfaces: Modeling of bi-parametric freedom surfaces, Coons, Bezier, B-spline, and NURBS surfaces; surface manipulation techniques.

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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME506	AESE	PROTOTYPING LAB	0	0	0	30	20	0	0	4	2

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Unit – III **(10 Hrs)**

Geometric Modeling: Geometric modeling techniques, wireframe modeling, solid modeling: B-Rep, CSG, hybrid modelers, feature based, parametric and variational modeling.
Data Structure in Computer Graphics: Introduction to product data standards and data structures, data-base integration for CIM.

Unit – IV **(10 Hrs)**

Introduction to Rapid Prototyping: History, Development of RP systems, Applications in Product Development, Reverse Engineering, Rapid Tooling, Rapid Manufacturing Principle, Fundamental; File format, Other translators, medical applications of RP On demand manufacturing , Direct material deposition, Shape Deposition Manufacturing.

Unit-V **(10 Hrs)**

Liquid Based and Solid Based Rapid Prototyping Systems:
Classification, Liquid based system; Stereo-Lithographic Apparatus (SLA), details of SL process; products, Advantages, Limitations, Applications and Uses. Solid based system; Fused Deposition Modeling, principle, process, products, advantages, applications and uses, Laminated Object Manufacturing

Text and Reference Books:

1. "Geometric Modeling" by V Mortenson, M. E., 3rd Ed., Industrial Press, 2006.
2. "Additive manufacturing technologies (Vol. 17)" by Gibson, I., Rosen, D.W. and Stucker, B., Springer, NY, 2014.
3. "Surface Modeling for CAD/CAM", by Choi, B. K., John Wiley & Sons, 2001.
4. "Automation, production systems, and computer-integrated manufacturing" by M. P. Groover, Prentice Hall Press, 2007.
5. "CAD/CAM/CIM" by P. Radhakrishnan, Subramanian S and Raju V; New Age Pub., 2008.
6. "Computer integrated manufacturing: from fundamentals to implementation" by A. Weatherall, Butterworth-Heinemann, 2013
7. "CAD/CAM" by P.N. Rao, TMH, 2010.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME506	AESE	PROTOTYPING LAB	0	0	0	30	20	0	0	4	2

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

8. "CAD/CAM Computer Aided Design and Manufacturing" by Mikell P. Groover and Emory W. Zimmer, 2008
9. "Rapid Manufacturing – An Industrial revolution for the digital age", by N.Hopkinson, R.J.M, Hauge, P M, Dickens, Wiley, 2006,

List of Experiments

1. Write a program to scale a geometric model
2. Write a program to rotate a geometric model
3. To draw a 3D model of mechanical components
4. Virtual Prototype modeling of assemblies by geometric modeling and rendering using commercial CAD/CAM systems
5. Surface modeling and sheet metal features design for industrial components
6. CAD data preparation for Rapid prototyping, Virtual reality and Finite element Solvers
7. Surface reconstruction from point cloud data for reverse engineering and inspection
8. To study Liquid Based and Solid Based Rapid Prototyping Systems

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Choice Based Credit System (CBCS) Scheme in light of NEP-2020

B. Tech/B.Tech+MBA in Mechanical Engineering

(2021-2025)

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			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTME509	DCC	SQC AND TOTAL QUALITY MANAGEMENT	60	20	20	0	0	3	0	0	3

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):
To introduction with (A)Modern quality control techniques to include the design of statistical process control systems, (B) Acceptance sampling and process improvement, (C) Quality Principles, Tools and Techniques.

Course Outcomes (COs):
After completion of this course

1. Student would be able to understand the need of quality, and its concepts.
2. Student would be able to understand various available statistical tools of quality control.
3. Student would be able to analyses basics of quality management and able to understand various management tools and techniques.
4. Students would be able to understand the statistical and economical design issues associated with the monitoring tools.
5. Students will be able to understand the basics of quality function deployment and its tools and techniques.

Syllabus

Unit I **(9 Hrs)**

Introduction of Statistical quality Control & TQM

Quality: Definition, need, evolution, The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management: quality philosophies (Contributions of Deming, Juran and Crosby, links between quality and productivity, quality costs legal aspects of quality implementing quality improvement).

Unit II **(10 Hrs)**

Methods and Philosophy of Statistical Process Control

Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, ARL, sensitizing rules for control charts); Deming's Magnificent Seven Implementing SPC; An Application of SPC; Nonmanufacturing application of SPC.

Unit III **(9 Hrs)**

Control Charts for Variables

Control Charts for $\bar{X}$ and R (statistical basis, development and use, estimating process capability;

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BTME509	DCC	SQC AND TOTAL QUALITY MANAGEMENT	60	20	20	0	0	3	0	0	3

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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interpretation, the effect of non normality on the chart, the OC function, and average run length); Control Charts for $\bar{X}$ and S; Control Chart for Individual Measurements; Applications of Variables Control Charts.

Unit IV **(9 Hrs)**

Inferences about Process Quality

Sampling distributions, estimation and confidence interval for process parameter(s), hypothesis testing on process parameter(s) and power analysis, Process Capability Ratios, Process Capability Analysis, Exponentially Weighted Moving Average Control Chart, Moving Average Control Chart

Unit V **(8 Hrs)**

TQM Tools & Techniques

Seven traditional tools of quality, new management tools, Six-sigma: Concepts, methodology, application to manufacturing, service sector including IT, Bench marking: reason, process. FMEA, Just-In-Time, Kanban system MRP vs JIT system, Waste elimination, workers involvement through JIT. QFD, Taguchi quality loss function, Inspection: acceptance sampling, OC curve, producer and consumer risk, theoretical invalidation of AS, kp rule for stable and chaotic processes.

Text and Reference Books:

1. Introduction of Statistical Quality Control" by Douglas C. Montgomery, John Wiley & Sons, 2009
2. "Statistical Quality Control" by E.L. Grant and R.S. Leavenworth, McGraw-Hill publisher, 2000.
3. "Principles of Quality Control", by Jerry Banks, Wiley publisher, 1999.
4. "Total Quality Management" by D. H. Besterfiled, Pearson Education Asia, Third Edition, Indian Reprint, 2006.
5. "The Management and Control of Quality" by J. R. Evans and W. M. Lindsay; South-Western (Thomson Learning), Sixth Edition, 2005.
6. "Total Quality Management" by Naidu, Babu and Rajendran; New age International pub; First Edition Reprint, 2013.

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Choice Based Credit System (CBCS) Scheme in light of NEP-2020

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BTME510	AESE	DESIGN THINKING AND INNOVATION	60	20	20	0	0	2	0	0	2

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

The objective of this course is to provide (A) the new ways of creative thinking and learn the innovation cycle of design thinking process, (B) understand product design and prototyping and (C) develop innovative product.

Course Outcomes (COs):

After completion of this course student will able to

1. Compare and classify the various learning styles and memory techniques and apply them in their engineering education
2. Analyze emotional experience and inspect emotional expressions to better understand users while designing innovative products
3. Develop new ways of creative thinking and learn the innovation cycle of design thinking process for developing innovative products
4. Propose real-time innovative engineering product designs and choose appropriate frameworks, strategies, techniques during prototype development
5. Perceive individual differences and its impact on everyday decisions and further Create a better customer experience

Syllabus

Unit I **(6 Hrs)**

Learning: understanding the learning process, Kolb's learning styles, assessing and interpreting.

Memory: understanding the memory process, problems in retention, memory enhancement techniques.

Emotions: understanding emotions, experience & expression, assessing empathy, application with peers.

Unit II **(6 Hrs)**

Design Thinking: definition, need, objective, concepts & brainstorming, stages of design thinking process (explain with examples) – **empathize, define, ideate, prototype, test**.

Creative Thinking: understanding creative thinking process, understanding problem solving, creative problem solving test.

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BTME510	AESE	DESIGN THINKING AND INNOVATION	60	20	20	0	0	2	0	0	2

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Unit III **(6 Hrs)**

Product Design: process of engineering product design, design thinking approach, stages of product design, examples of best product designs and functions, assignment – engineering product design. Prototyping: What is prototype? Why prototype? Rapid prototype development process, testing, sample example, test group marketing

Unit IV **(6 Hrs)**

Celebrating the Difference: understanding individual differences & uniqueness, group discussion and activities to encourage the understanding, acceptance and appreciation of individual differences Customer Centricity: practical examples of customer challenges, use of design thinking to enhance customer experience, parameters of product experience, alignment of customer expectations with product design.

Unit V **(6 Hrs)**

Feedback, Re-design & Re-create: feedback loop, focus on user experience, address "ergonomic challenges, user focused design, rapid prototyping & testing, final product, final presentation – **"solving practical engineering problem through innovative product design & creative solution".**

Text and Reference Books:

1. E. Balaguruswamy "Developing Thinking Skills (The way to Success)" Khanna Book Publishing Company, 2022.
2. Gavin Ambrose and Paul Harris "Basics Design 08: Design Thinking" Bloomsbury Publishing India Pvt. Ltd. 2009.
3. Vijay Kumar "101 Design Methods: A Structured Approach for Driving Innovation in Your Organization" Wiley Pub. 2012.
4. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.
5. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011
6. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.

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