Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)

(under Maharashtra Act No. XXIX of 2014)

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Proposed Course Contents for

B. Tech. in Mechanical Engineering

w.e.f. June 2020

7^{th}Semester - 8^{th} Semester

Vision

The vision of the department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need based research and extension.

Graduate Attributes

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate

the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

PEO 1	Graduates should excel in engineering positions in industry and other organizations that emphasize design and implementation of engineering systems and devices.
PEO 2	Graduates should excel in best post-graduate engineering institutes, acquiring advanced degrees in engineering and related disciplines.
PEO 3	Alumni should establish a successful career in an engineering-related field and adapt to changing technologies.
PEO 4	Graduates are expected to continue personal development through professional study and self-learning.
PEO 5	Graduates should be good citizens and cultured human beings, with full appreciation of the importance of professional, ethical and societal responsibilities.

Program Outcomes

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

PO 1	Apply the knowledge of mathematics, basic sciences, and mechanical engineering to the solution of complex engineering problems.
PO 2	Identify, formulate, research literature, and analyze complex mechanical engineering problems reaching substantiated conclusions.
PO 3	Design solutions for complex engineering problems and design mechanical system components that meet the specified needs.
PO 4	Use mechanical engineering research-based knowledge related to interpretation of data and provide valid conclusions.
PO 5	Create, select, and apply modern mechanical engineering and IT tools to complex engineering activities with an understanding of the limitations.
PO 6	Apply reasoning acquired by the mechanical engineering knowledge to assess societal and safety issues.
PO 7	Understand the impact of engineering solutions on the environment, and demonstrate the knowledge for sustainable development.
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large.
PO 11	Understand the engineering and management principles and apply these to the multidisciplinary environments.
PO 12	Recognize the need for life-long learning in the broadest context of technological change.

Program-Specific Outcomes (PSOs)

PSO 1	Make the students employable in engineering industries.
PSO 2	Motivate the students for higher studies and research.

Abbreviations

PEO:	Program Educational Objectives
PO:	Program Outcomes
CO:	Course Outcomes
L:	No. of Lecture hours (per week)
T:	No. of Tutorial hours (per week)
P:	No. of Practical hours (per week)
C:	Total number of credits
BSH:	Basic Science and Humanity
BSC:	Basic Sciences Course
PCC:	Professional Core Course
OEC:	Open Elective Course
PEC:	Professional Elective Course
BHC:	Basic Humanity Course
ESC:	Engineering Science Course
HSMC:	Humanity Science and Management Course
NCC:	National Cadet Corps
NSS:	National Service Scheme
CA:	Continuous Assessment
MSE:	Mid Semester Exam
ESE:	End Semester Exam

B. Tech. Mechanical Engineering

Course Structure for Semester VII [Fourth Year] w.e.f. 2020-2021

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTMEC701	PCC 29	Mechatronics	2	1	--	20	20	60	100	3
BTMEC702	PCC 30	CAD/CAM	2	1	--	20	20	60	100	3
BTMEC703	PCC 31	Manufacturing Processes - III	2	1	--	20	20	60	100	3
BTMEC704A	PEC 2	Fluid Machinery	2	1	--	20	20	60	100	3
BTMEC704B		Industrial Engineering and Management								
BTMEC704C		Finite Element Method								
BTMEC704D		Surface Engineering								
BTMEC704E		Refrigeration and Air Conditioning								
BTAMC704C		Automobile Design (Product Design, PLM, CAE, Catia)								
BTMEC705A	OEC 5	Engineering Economics	3	--	--	--	--	--	--	Audit (AU/ NP)
BTMEC705B		Intellectual Property Rights								
BTMEC705C		Wind Energy								
BTMEC705D		Knowledge Management								
BTMEL706	PCC 32	Manufacturing Processes Lab - II	--	--	2	30	--	20	50	1
BTMEL707	PCC 33	Mechatronics Lab	--	--	2	30	--	20	50	1
BTMEL708	PCC 34	CAD/CAM Lab	--	--	2	30	--	20	50	1
BTMES709	Project 4	Seminar	--	--	2	30	--	20	50	1
BTMEF710	Project 5	Field Training /Internship/Industrial Training III	--	--	--	--	--	50	50	1
BTMEP711	Project 6	Project Stage-I**	--	--	6	30	--	20	50	3
		Total	11	4	14	230	80	390	700	20

***In case of students opting for Internship in the eighth semester, the Project must be industry-based.*

B. Tech. Mechanical Engineering

Course Structure for Semester VIII [Fourth Year] w.e.f. 2020-2021

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTMEC801A	PEC 3	Biomechanics	2	1	--	20	20	60	100	3
BTMEC801B		Power Plant Engineering								
BTMEC801C		Robotics								
BTMEC801D		Tool Design								
BTAMC801C		Body - In - White & Trims								
BTMEC802A	PEC 4	Product Life Cycle Management	2	1	--	20	20	60	100	3
BTMEC802B		Machine Tool Design								
BTMEC802C		Tool Condition Monitoring								
BTMEC802D		Mechanical Vibration								
BTMEC802E		Steam and Gas Turbines								
BTMEC803A	PEC 5	Non-conventional Machining	2	1	--	20	20	60	100	3
BTMEC803B		Cryogenic Systems								
BTMEC803C		Process Equipment Design								
BTMEC804A	PEC 6	Design of Piping Systems	2	1	--	20	20	60	100	3
BTMEC804B		Advanced IC Engines								
BTMEC804C		Design of Air Conditioning Systems								
BTMEC804D		Sheet Metal Engineering								
BTMEC805A	OEC 6	Design of Experiments	2	1	--	20	20	60	100	3
BTMEC805B		Entrepreneurship Development								
BTMEC805C		Plant Maintenance								
BTMEP806	Project 7	Project Stage-II	--	--	12	50	--	100	150	6
		Total	10	5	12	150	100	400	650	21

** In lieu of the Electives, Six months Internship in the industry including project*

Semester - VII

Mechatronics

BTMEC701	PCC 29	Mechatronics	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Define sensor, transducer and understand the applications of different sensors and transducers
CO2	Explain the signal conditioning and data representation techniques
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Write a PLC program using Ladder logic for a given application
CO5	Understand applications of microprocessor and micro controller
CO6	Analyse PI, PD and PID controllers for a given application

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	2				2	1		1
CO2	3	2			3	3	2				1	3
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3			1	3	2	3					2
CO6		3	3		3	3	1	1	3			2

Course Contents:

Unit 1: Introduction
Introduction to Mechatronic systems, elements, advantages; practical examples of Mechatronic systems.
Sensors and Transducers: Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tactile sensors, Selection of sensors.

Unit 2: Signal Conditioning and Data Representation
Types of electronic signals, Need for signal processing,Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Interfacing devices, Electro-magnetic Relays.
Data representation systems, Displays, Seven segment displays, LCD displays, Printers, Data

loggers, Data Acquisition Cards/Systems

Unit 3: Drives

Electrical Drives: Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc.

Pneumatics and Hydraulics: Components of Pneumatic systems, actuators, direction control valves, pneumatic air preparation, FRL unit, methods of actuation of valves, Sequencing of Pneumatic cylinders using Cascade and shift register methods. Electro-pneumatic valves, Electro- pneumatic circuits using single and double solenoid methods.

Hydraulic cylinders, design of cylinder, Design of Piston and piston rod, Valves, poppet valve, house pipes and design of tubing, Meter-in and Meter-out circuits.

Unit 4: Microprocessor and Microcontroller

8085 microprocessor: architecture, various types of registers and their functions in 8085µP, Instruction sets, interfacing, applications. 8081 microcontroller: architecture, Instruction sets, various pins and their functions interfacing, applications.

Programmable Logic Controller: Introduction, Architecture, Types of inputs/outputs, Specifications, guidelines for Selection of PLCs, Programming: Ladder logic and FBD

Unit 5: Control Systems

Open and closed loop system; block diagram manipulation/reduction, Transfer function, modeling of Mechanical Systems using Spring, Dashpot and Mass equivalence.

Unit 6: Stability of Systems

On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers, Introduction to control using state variable system models, Bode Plots and stability criteria.

Texts:

1. HMT Limited, “Mechatronics”, Tata McGraw Hill Publications, 1998.
2. W. Bolton, “Mechatronics; Electronic Control System in Mechanical Engineering”, Pearson Education Asia, 1999.
3. Raven, “Automatic Control Engineering”, Tata McGraw Hill Publications, New York, 1986.

References:

1. R. K. Rajput, “A textbook of Mechatronics”, S. Chand and Co., 2007.
2. Michael B. Histand, David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, Tata McGraw Hill International Editions, 2000.
3. D. A. Bradley, D. Dawson, N. C. Buru, A. J. Loader, “Mechatronics”, Chapman and Hall, 1993

CAD/CAM

BTMEC702	PCC 30	CAD/CAM	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	List and describe the various input and output devices for a CAD work station
CO2	Carry out/calculate the 2-D and 3-D transformation positions (Solve problems on 2-Dand 3-D transformations)
CO3	Describe various CAD modeling techniques with their relative advantages and limitations
CO4	Describe various CAD modeling techniques with their relative advantages and limitations
CO5	Develop NC part program for the given component, and robotic tasks
CO6	Describe the basic Finite Element procedure
CO7	Explain various components of a typical FMS system, Robotics, and CIM
CO8	Classify parts in part families for GT
CO9	Describe and differentiate the CAPP systems

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											1
CO2	3	2	1		2							1
CO3	1		1									1
CO4	3											1
CO5	1	3	3		1							1
CO6	3	1	1		1							1
CO7	3											1
CO8	3	1	2	3	1							1
CO9	2	1										1

Course Contents:

Unit1: ComputerAidedDesign(CAD)

Hardware requiredforCAD:Interactiveinputoutputdevices,Graphicssoftware:general requirementsandgroundrules,2-DcurveslikeLine,Circle,etc.andtheiralgorithms,2-D and 3-DtransformationssuchasTranslation,Scaling,RotationandMirror

Unit2: BezierandB-splinesCurves

EquationsandApplications, window andviewportclipping algorithms,3-Dgeometries,CSG, B-rep, wireframe,surface andsolidmodelingandtheir relativeadvantages,limitationsandapplications.

Unit3: ComputerAidedManufacturing(CAM)

NumericalControl,Elements ofaNC system,StepsinNCbasedmanufacturing,Point to point,straightlineandcontouring control,ManualandComputerAssistedPart Programming,NC and APT programming, Adaptive control, Distributed Numerical Control.

Unit4: FiniteElementMethods
Introduction,Typesofelements,Degreesoffreedom,Fieldvariable,Shapefunction, Boundary conditions,Meshing,Nodaldisplacements,Plainstressandplainstrain problems,1-D,2-Dand3-Dproblems,Static,dynamicandthermalanalysis,Preprocessors –solvers–postprocessor.

Unit5: FlexibleManufacturingSystem
Introduction,ComponentsofFMS,GroupTechnology,Partclassificationandfamilies,Composite part,Typesof FMSlayouts,AdvantagesofFMS
Robotics: Robotconfigurations, Drivesforrobots,Sensors usedinrobotics,Programming technique,Programminglanguages,Applications,Latestdevelopmentin robotics

Unit6: ComputerAidedProcessPlanning
Introduction, RetrievalandGenerativeCAPPsystems, generationofMachiningData.
ComputerIntegratedManufacturing: Introduction,Typesofdata,Typesofinterfaces,Computernetworkstructures, Computerizedproductionmanagementsystems,Inventory management,MRP,Operation scheduling,Processmonitoring,Computeraidedqualitycontrol,Testing/Inspectionmethods.

Texts:
1. IbrahimZeid,“CAD/CAMTheoryandPractice”, TataMcGrawHillPublication,
2. M. P. Grover,Zimmer,“CAD/CAM/CIM”, PrenticeHallIndia.

Manufacturing Processes - III

BTMEC703	PCC 31	Manufacturing Processes - III	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Differentiate clearly between NC and CNC machines
CO2	Prepare and execute a part program for producing a given product
CO3	Select appropriate non-traditional machining process for a given application
CO4	Compare different surface coating techniques
CO5	Explain different rapid prototyping techniques
CO6	Illustrate the working principle of various micro-manufacturing processes

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1									
CO2	1	1			1							
CO3	2	2	2									

CO4	2	2	1			1	1					1
CO5	1	1	1			1	1					
CO6	1	1	1			1						

Course Contents:

Unit1: Introductionto CNC System
NumericalControl,CNC,ClassificationofNC/CNCsystems,Basic componentsofCNCsystem:Design considerations, structure,AntifrictionLM guideways, spindles, ballscrews; CNC Drivesandcontrols: DC motors, AC motors, Stepper motors,Feedback devices: Encoders, tachometers; Servo motors, Linear motors

Unit2:CNCTooling and Programming
CNC Tooling, Toolandworkholdingdevices,AutomaticToolChangers,AutomaticPalletChangers. Partprogramming: Introduction,PartProgramand itselements,MethodsofProgramming:Manualand ComputerAssistedPartprogramming, APT language.

Unit3: Advanced Machining Processes
Introduction; Chemical Machining; Electrochemical Machining: Pulsed, Electrochemical Machining; Electrochemical Grinding; Electrical-discharge Machining: Wire EDM, Electrical-discharge Grinding; Laser-beam Machining; Electron-beam Machining; Water-jet Machining; Abrasive-jet Machining; Hybrid Machining Systems

Unit4: Surface Treatments and Coatings
Introduction; Mechanical Surface Treatments; Mechanical Plating and Cladding; Thermal Spraying, Vapour Deposition: Physical Vapor Deposition, Chemical Vapor Deposition; Ion Implantation and Diffusion Coating; Laser Treatments; Electroplating, Electroless Plating, and Electroforming; Conversion Coatings, Hot Dipping, Porcelain Enamelling: Ceramic and organic coatings; Diamond Coating and Diamond like Carbon; Surface Texturing

Unit 5: Rapid Prototyping
Introduction; subtractive processes; additive processes: Fused-deposition Modeling, Stereolithography, Multijet/Polyjet Modeling, Selective Laser Sintering, Electron-beam Melting, Three-dimensional Printing, Laminated-object Manufacturing, Solid-ground Curing, Laser-engineered Net Shaping; virtual prototyping; direct manufacturing and rapid tooling

Unit 6:Micromanufacturing Technology
Introduction to fabrication of MEMS, micromachining of MEMS devices: Bulk Micromachining, Surface Micromachining; LIGA microfabrication process; Solid free-form fabrication of devices; Nanoscale manufacturing.

Texts:
1. HMTLtd, “Mechatronics”,TataMcGrawHill Publications,NewDelhi,1998.
2. SeropeKalpakjianandStevenR.Schmid, “ManufacturingEngineeringandTechnology”, AddisonWesleyLongman(Singapore)Pte.IndiaLtd.,6thedition,2009

References:
1. JamesMadison, “CNCMachiningHandbook”,IndustrialPressInc., 1996.

2. Gibbs and Crandell, CNC Machining and Programming: An Introduction, IndustrialPressInc, 2003.
3. GaryF.Benedict, “NonTraditionalManufacturingProcesses”,MarcelDekker,1987.

Fluid Machinery

BTMEC704A	PEC 2	Fluid Machinery	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand and apply momentum equation
CO2	Understand and explain Hydrodynamic Machines
CO3	Explain difference between impulse and reaction turbines
CO4	Find efficiencies, draw velocity triangles
CO5	Explain governing mechanisms for hydraulic turbines
CO6	Explain working of various types of pumps, draw velocity diagrams, do simple calculations
CO7	Design simple pumping systems

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									1
CO2	3		3				2					1
CO3	3	2										1
CO4	3	3	2									1
CO5			3									1
CO6	3	3	3	1	1							1
CO7	3	3		3								1

Course Contents:

Unit 1: Momentum Equation and its Applications
Impulse momentum, Principle, Fixed and moving flat inclined plates, Curved vanes, Series of plates and vanes, Velocity triangle and their analysis, Water wheels. Hydrodynamic Machines: Classification, General theory, Centrifugal head, Fundamental equations, and Euler’s equation, Degree of reaction, Head on machine, various efficiencies, Condition for maximum hydraulic efficiency.

Unit 2: Impulse Turbines
Impulse principle, Construction of Pelton wheel, Velocity diagrams and its analysis, Number

of buckets, Jets, Speed ratio, Jet ratio.
Reaction Turbines: Constructional details of Francis, Kaplan and Propeller turbine, Deciaz turbine, and Draft tube types, Efficiencies, Cavitation.

Unit 3: Governing of Turbines
Methods of governing, Performance characteristics, Safety devices, Selection of turbines, Unit quantities, Specific speed, Principles of similarity and model testing.

Unit 4: Centrifugal Pump
Construction, Classification, Terminology related to pumps, Velocity triangle and their analysis, Cavitation, NPSH, Thoma's cavitation factor, Priming, Methods of priming, Specific speed, Performance characteristics, Actual thrust and its compensation, Troubleshooting.
Multistage Pumps: Pump H-Q characteristics and system H-Q Characteristics, Series and parallel operation of pumps, Systems in series and parallel, Principle of model testing and similarity.

Unit 5: Special Purpose Pumps
Chemical pumps, nuclear pumps, Sewage pumps, Submersible deep well pumps, Pump installation, Energy efficient pumps.
Failure of Pumping System: Pump failures, Remedies, Source failure, Causes and remedies, Trouble shooting.

Unit 6: Design of Pumping System
Principles of line layout, Estimation of pressure drops across pipes, Fittings, etc.
Miscellaneous Pumps: Reciprocating pump, Gear pump, Vane pump, Lobe pump, etc., Application field (no mathematical treatment).

Texts:
1. P. N. Modi, S. M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, Rajsons Publications Pvt. Ltd., 20th edition.
2. R. K. Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", Lakshmi Publications Pvt. Ltd., 9th edition.

References:
1. Yunus A. Çengel, John M. Cimbala, Fluid Mechanics: Fundamentals and Applications", McGraw Hill, 3rd edition, 2014.

Industrial Engineering and Management

BTMEC704B	PEC 2	Industrial Engineering and Management	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge ofmathematics, probability and statistics, and the domain knowledge of IndustrialManagement and Engineering
CO2	Produce ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
CO3	Understand the interactions between engineering, businesses, technological and environmental spheres in the modern society.
CO4	Understand their role as engineers and their impact to society at the national and global context.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1											2	1
CO2									2	2	2	
CO3								2				
CO4								2				2

Course Contents:

Unit 1: Introduction
Managing and managers, management- science, theory and practice, functions of management, evolution of management theory, contributions of Taylor, Fayol and others.
Planning: The nature and purpose of planning, objectives, strategies, policies and planning premises, decision making.
Organizing: The nature and purpose of organizing, departmentation, Line/ staff authority and decentralization, effective organizing and organizational culture.

Unit 2: Human Resource Management
Staffing: Human resource management and selection, orientation, apprentice training and Apprentice Act (1961), performance appraisal and career strategy, job evolution and merit rating, incentive schemes.
Leading: Managing and human factor, motivation, leadership, morale, team building, and communication.
Controlling: The system and process of controlling control techniques, overall and preventive control.

Unit 3: Production/Operations Management
Operations management in corporate profitability and competitiveness, types and characteristics of manufacturing systems, types and characteristics of services systems.
Operations planning and Control: Forecasting for operations, materials requirement planning, operations scheduling.

Unit 4: Design of Operational Systems

Product/process design and technological choice, capacity planning, plant location, facilities layout, assembly line balancing, and perspectives on operations systems of the future.

Unit 5: Introduction to Industrial Engineering
Scope and functions, history, contributions of Taylor, Gibreth, Gantt and others.
Work Study and Method Study: Charting techniques, workplace design, motion economy principles.
Work Measurement: Stopwatch time study, micromotion study, predetermined time system (PTS), work sampling.

Unit 6: Ergonomics
Basic principles of ergonomics
Concurrent Engineering: Producibility, manufacturability, productivity improvement.
Total Quality Management: Just in time (JIT), total quality control, quality circles, six sigma.

Texts:

1. H. Koontz, H. Weirich, "Essentials of Management", Tata McGraw Hill book Co., Singapore, International Edition, 5th edition, 1990.
2. E. S. Buffa, R. K. Sarin, "Modern Production/Operations Management", John Wiley and Sons, New York, International Edition, 8th edition, 1987.
3. P. E. Hicks, "Industrial Engineering and Management: A New Perspective", Tata McGraw Hill Book Co., Singapore, International Edition, 2nd edition, 1994.

References:

1. J. L. Riggs, "Production Systems: Planning, Analysis and Control", John Wiley & Sons, New York, International Edition, 4th edition, 1987.
2. H. T. Amrine, J. A. Ritchey, C. L. Moodie, J. F. Kmec, "Manufacturing Organization and Management", Pearson Education, 6th edition, 2004.
3. International Labour Organization (ILO), "Introduction to Work Study", International Labour Office, Geneva, 3rd edition, 1987.

Finite Element Method

BTMEC704C	PEC 2	Finite Element Method	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the basic principle of Finite element methods and its applications
CO2	Use matrix algebra and mathematical techniques in FEA
CO3	Identify mathematical model for solution of common engineering problem
CO4	Solve structural , thermal problems using FEA
CO5	Derive the element stiffness matrix using different methods by applying basic

	mechanics laws
CO6	Understand formulation for two and three dimensional problems

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1		1				1		1	1
CO2	2	3	2	1	2	1		1			2	1
CO3	3	2	2	1	1				1		2	1
CO4	3	3	2	1	2		1		1		2	1
CO5	3	1	1		1		1				2	1
CO6	1	1	1						1		1	1

Course Contents:

Unit1: Introduction
Finiteelementanalysisanditsneed,Advantagesandlimitationsoffinite elementanalysis(FEA),FEAprocedure.

Unit2: ElementsofElasticity
Stressatapoint,Stressequationofequilibrium,2-Dstateof stress,Strainsanddisplacements,Stress-strainrelationshipfor2-Dstateofstress,Plane stressandplanestrainapproach.

Unit3:RelevantMatrixAlgebra
Addition,subtractionandmultiplication ofmatrices, Differentiation andintegrationofmatrices,Inverseofamatrix,Eigenvaluesandeigen vectors,Positivedefinitematrix,Gausselimination.

Unit4: One-DimensionalProblems
Introduction,FEmodeling,Barelement,Shapefunctions,Potentialenergyapproach,Globalstiffnessmatrix,Boundary conditionsandtheir treatments,Examples.

Unit5: TrussesandFrames
Introduction,Planetrusses,Elementstiffnessmatrix,Stress calculations,Planeframes,examples.

Unit6: Two-dimensional Problems
Introductionandscopeof2-DFEA,FEmodelingof2-D problem,Constant straintriangle,otherfiniteelements(nomathematical treatment included),Boundaryconditions.

Texts:

1. T. R. Chandrupatla, A.D. Belegundu, " Introduction toFiniteElementsin Engineering",Prentice Hallof IndiaPvt. Ltd.,3rd edition,NewDelhi,2004.
2. P.Seshu, "ATextbookofFiniteElementAnalysis",Prentice Hallof IndiaPvt. Ltd., NewDelhi,2003.
3. R. D.Cook,D. S.Malkus,M. E.Plesha,R. J.Witt, "ConceptsandApplicationsof FiniteElementAnalysis",JohnWiley&Sons,Inc.

References:

1. K. J.Bathe, "FiniteElementProcedures",PrenticeHallof IndiaPvt. Ltd.,2006.

Surface Engineering

BTMEC704D	PEC 2	Surface Engineering	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Learntheimportance andneedofsurfaceengineering
CO2	Describe various surface cleaning and modification techniques
CO3	Understand the concepts of surface integrity
CO4	Compare various surface coating technologies
CO5	Select appropriate method of coating for a given application
CO6	Apply measurement techniques and carry out characterization of coated surfaces.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		1							1		1
CO2	2				2							
CO3	2	2	1	2						1		
CO4	2				1	1		1		1		
CO5	2	2	1		1		1	1	1	1	1	
CO6	2	2	1	2	2			1	1	1		

Course Contents:

Unit 1: Introduction

Definition, Significance, Role of surface Engineering in creating high performance product, Functional characteristics of a surface, Nature of surfaces: Deformed layer, Beilby layer, chemically reacted layer, Physisorbed layer, Chemisorbed layer; Classification of Surface Engineering Techniques.

Unit 2: Surface Preparation Techniques

Factors affecting selection of cleaning process, Significance of surface preparation, Classification of cleaning processes, Chemical cleaning processes; Mechanical Processes; Substrate considerations, Surface contaminants or soils, Tests for cleanliness.

Unit 3: Surface Integrity

Definition, Importance, Surface alterations, Factors in Surface Integrity: Visual, Dimensional, Residual stress, Tribological, Metallurgical; Measuring Surface Integrity effects: Minimum and Standard data set, Macroscopic and microscopic examination.

Unit 4: Surface Modification Techniques

Classification, Thermal treatments: Laser and electron beam hardening, Mechanical treatments: Short peening: Peening action, surface coverage and peening intensity, Types and sizes of media, Control of process variables, equipment;

Ion Implantation: Basic Principle, Advantages and disadvantages, equipment.

Unit 5: Surface Coating Techniques

Thermal Spraying: Types and applications; Chemical Vapour Deposition: Principles, Reactions, Types and applications; Physical Vapour Deposition: Basic principle, Evaporation, Sputtering, Ion Plating, Applications; Electroplating: Principle of working and applications; Types of Coatings: Hard, Soft, Single layer, Multi-layer.

Unit 6: Characterization of Coatings

Physical characteristics and their measurements: Coating thickness, Surface Morphology and Microstructure. Mechanical properties and their Measurements: Hardness, Adhesion, Friction and Wear.

References:

1. ASM Handbook, “Volume 5: Surface Engineering”, ASM International.
2. K. G. Budinski, “Surface Engineering for Wear Resistance”, Prentice Hall.
3. T. Burakowski, T. Wierschon, “Surface Engineering of Metals: Principles, Equipment, Technologies”, CRC Press.
4. B. Bhushan, B. K. Gupta, “Handbook of Tribology: Materials, Coatings, and Surface Treatments”, Tata McGraw Hill Publications.
5. ASM Handbook, “Volume 16: Machining”, ASM International.

Refrigeration and Air Conditioning

BTMEC704E	PEC 2	Refrigeration and Air Conditioning	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Unit 1: Introduction

History, Fundamentals of refrigeration, Unit, Applications, Methods of producing cooling, Refrigeration systems, Thermodynamics of refrigeration, Primary and secondary refrigeration, Heat Pump

Unit 2: Vapour Compression System

Thermodynamics analysis, theoretical and actual cycle, Use of P-h and T-s diagram for problem solving, COP, Effect of evaporator and condenser temperature on cycle performance, Effects of suction superheating

Liquid sub-cooling, liquid-vapour heat exchanger, estimation of compressor displacement, COP and power requirement, waste heat recover opportunities

Unit 3:

Compound Vapour Compression System: Multi-evaporator, multi-compressor systems, cascade system (no mathematical treatment)

Vapour Absorption System: Aqua-ammonia system, lithium bromide-water system, Electrolux refrigerator, comparison with vapour compression cycle (descriptive treatment only), P-T-ξ chart, thermodynamic analysis, and capacity control, solar refrigeration system

Unit 4:
Refrigerant for Vapour Compression System: Desirable Properties, Selection, Zeotrops and Azeotropes, Necessity for replacement of CFC refrigerants, natural refrigerants
Air Conditioning: Psychrometry, properties of moist air, psychrometric charts.
Thermal comfort: Heat transfer from human body by sensible and latent heat transfer, metabolic heat generation, steady state model for heat transfer, effect of clothing and definition of effective temperatures, comfort conditions, human comfort, comfort chart.

Unit 5: Air Conditioning Process Calculation
Sensible and latent heat loads, SHF, GSHF, RSHF, outside conditions, indoor conditions, estimation of coil capacity required, bypass factor, evaporative cooling

Unit 6: Distribution of Air
Principle of air distribution, duct design methods, friction chart, duct materials, methods of noise control
All air system, all water system, unitary systems; window air-conditioner, split air-conditioners, refrigeration and air-conditioning controls.

Texts:

1. Arora, C.P., Refrigeration and Air Conditioning, Tata McGraw Hills, New Delhi, Second Edition, 2000.
2. Stoeker, W.F. and Jones, J.P., Principles of Refrigeration and Air Conditioning, McGraw Hill, New York, Second Edition, 1982.

References:

1. ASHRAE Handbook – Fundamentals and Equipment, 1993.
2. ASHRAE Handbook – Applications, 1961.
3. ISHRAE Handbook
4. NPTEL Lectures by Prof. RamGopal, IIT Kharagpur
5. Carriern Handbook
6. JordR.C., and Priester, G.B., Refrigeration and Air Conditioning, Prentice - Hall of India Ltd., New Delhi, 1969.
7. Threlkeld, J.L., Thermal Environmental Engineering, Prentice Hall, New York, 1970.

Automobile Design (Product Design, PLM, CAE, Catia)

BTAMC704C	PEC 2	Automobile Design (Product Design, PLM, CAE, Catia)	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:
Domain related training (Approx. 20 Hrs)
Unit 1:
Introduction to Styling, Basic of Design - Introduction to Design, Good Design & it's Examples of All Time, Industrial Design & its use. Design Process - Typical Product Life Cycle, Automotive Design Process (for production release), Design Studio (Automotive studio) Process or Product Conceptualization Process, Case Study. CAS Surfaces or Digital Clay Models, Class A Surfaces - Role of Class A surface Engineer, Requirements for a Surface to fulfill " Class A Surface" Standards, Case Studies for Class A Surfaces, Class A Surface Creation for Bonnet

Unit 2:
Introduction to Body In White: Introduction & familiarization to Body In White (BIW), various type of BIW, Types of BIW sub system, various aggregates of BIW. Bonnet Design Case Study:Function of Bonnet, Defined Input to Bonnet, Intended Input to Bonnet Design. Steps in Bonnet design, Study of Class A Surfaces, Hood Package Layout , Typical Sections, Block Surfaces in 3D, Dynamic Clearance Surfaces in 3D, Hood Structural Members, CAE 1(Durability, Crash), Panel Detail Design, Body Assembly Process, CAE 2(Durability, crash, individual panel level), Design Updating & Detailing Prototypes, Design Updating & Production Release

Unit 3:
Introduction to CAE & its importance in the PLM, Introduction to FEA & its applications (NVH, Durability & Vehicle Crashworthiness). Introduction of Pre-Processor, Post-Processor & Solvers. Importance of discretization & Stiffness Matrix (for automobile components). Importance of oil canning on an automobile hood with Case study related to Durability Domain. Modal analysis on the hood (Case Study related to NVH Domain). Introduction of vehicle crashworthiness & Bio-mechanics (Newtonian laws, energy management, emphasis of impulse in car crashes). Head impact analysis as a Case study on the hood of an automobile (EuroNCAP test regulation). Importance of Head performance criteria (HPC). Introduction to failure criteria (By explaining the analogy of using uni-axial test results for predicting tri-axial results in reality), Mohr's Circle, Von-Mises stress criteria, application of various failure criteria on brittle or ductile materials

Unit 4:
Introduction to CAD,CAM & CAE, FEA - Definition, Various Domains – NVH, Dura, Crash, Occupant Safety, CFD. Implicit vs. Explicit Solvers, Degree of Freedom, Stiffness Matrix, Pre-Post & Solver; Types of solvers, Animation. Durability -Oil Canning, Oil Canning on Hood, Scope of work, Loading, Boundary Conditions, Results & Conclusions. NVH – Constrained Modal Analysis, Constrained Modal Analysis on Hood, Scope of work, Loading, Boundary Conditions, Results & Conclusions. Crash – Vehicle Crashworthiness, Energy Management, Biomechanics, Head Impact Analysis on Hood, Importance of Failure Criteria, Von-Mises Stress

Unit 5:
Sheet metal design & Manufacturing Cycle, Simultaneous Engineering (SE) feasibility study, Auto Body & its parts, Important constituents of an automobile, sheet metal, sheet metal processes. Type of draw dies, Draw Model development & its considerations. Forming Simulations, Material Properties, Forming Limit Curve (FLD), Pre Processing, Post-Processing, Sheet metal formability- Simulation

Unit 6:
Die Design –Sheet metal parts, Sheet metal operations (Cutting, Non-Cutting etc.), Presses, Various elements used in die design, Function of each elements with pictures, Types of dies, Animation describing the working of dies, Real life examples of die design. **Fixture Design -** Welding (Spot/Arc Welding), Body Coordinates, 3-2-1 principle, Need for fixture, Design considerations, Use of product GD&T in the fixture design, fixture elements. Typical operations in Sheet metal Fixture (Manual/Pneumatic/Hydraulic fixture), Typical unit design for sheet metal parts (Rest/Clamp/Location/Slide/Dump units/Base), Types of fixture (Spot welding/ Arc welding/ Inspection fixture/Gauges)

Tools related training (Approx. 20 Hrs):
Depending on the tools available in the college, the relevant tool related training modules shall be enabled to the students.
AutoCAD, AutoCAD Electrical, AutoCAD Mechanical, AutoCAD P&ID, Autodesk 3ds Max, Autodesk Alias, Autodesk SketchBook, Automotive, CATIA V5, CATIA V6, FEA, Autodesk Fusion 360, Autodesk Inventor, Autodesk Navisworks, Autodesk Ravit, Autodesk Showcase, Autodesk Simulation, PTC Creo, PTC ProENGINEER, Solid Edge, SOLIDWORKS.

Texts:

1. Notes of TATA Technologies
2. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)", Right Tech, Inc., Kindle Edition.
3. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 2)", Right Tech, Inc., Kindle Edition.
4. Vukato Boljanovic, "Sheet Metal Forming Processes and Die Design", Industrial press Inc., Kindle Edition.

References:

1. IbrahimZeid,"CAD/CAM TheoryandPractice", TataMcGrawHillPublication,

2. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Education, New Delhi.
3. P. Radhakrishnan & S. Subramanyan "CAD/CAM/CIM" Willey Eastern Limited New Delhi.
4. Onwubiko, C., "Foundation of Computer Aided Design", West Publishing Company. 1989
5. R.W.Heine, C. R.Loper and P.C.Rosenthal, *Principles of Metal Casting*, McGraw Hill, Newyork, 1976.
6. J. H.Dubois And W. I.Pribble, *Plastics Mold Engineering Handbook*, Van NostrandReihnhold, New York, 1987.
7. N. K. Mehta, Machine tool design, Tata Mcgraw-hill, New Delhi, 1989.
8. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
9. C. Howard, *Modern Welding Technology*, Prentice Hall, 1979.
10. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
11. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, SpringerVerlag, 2004. ISBN 1852338105

Engineering Economics

BTMEC705A	OEC 5	Engineering Economics	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, Benefit-cost ratio.
CO2	Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.
CO3	Compare the life cycle cost of multiple projects using the methods learned, and make a quantitative decision between alternate facilities and/or systems.
CO4	Compute the depreciation of an asset using standard Depreciation techniques to assess its impact on present or future value.
CO5	Apply all mathematical approach models covered in solving engineering economics problems: mathematical formulas, interest factors from tables, Excel functions and graphs.Estimate reasonableness of the results.
CO6	Examine and evaluate probabilistic risk assessment methods.
CO7	Compare the differences in economic analysis between the private and public sectors. Recognize the limits of mathematical models for factors hard to quantify.
CO8	Develop and demonstrate teamwork, project management, and professional communications skills

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1											3	
CO2											3	
CO3											3	
CO4											3	
CO5					3						3	
CO6											3	
CO7											3	
CO8									2		3	

Course Contents:

Unit 1: Introduction to Economics
Introduction to Economics: Flow in an economy, Law of supply and demand, Concept of Engineering Economics: Engineering efficiency, Economic efficiency, Scope of engineering economics - Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis: V ratio, Elementary economic Analysis: Material selection for product Design selection for a product, Process planning.

Unit 2: Value Engineering
Make or buy decision, Value engineering: Function, aims, and Value engineering procedure. Interest formulae and their applications: Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor: equal payment series capital recovery factor:
Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

Unit 3: Cash Flow
Methods of comparison of alternatives: present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

Unit 4: Replacement and Maintenance Analysis
Replacement and Maintenance analysis: Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset: capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

Unit 5: Depreciation
Depreciation: Introduction, Straight line method of depreciation, declining balance method of depreciation, sum of the years digits method of depreciation, sinking fund method of depreciation/annuity method of depreciation, service output method of depreciation-

Unit 6: Evaluation of Public Alternatives

Introduction, Examples, Inflation adjusted decisions: procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

Texts:

1. PanneerSelvam R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.

References:

1. Chan S. Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
2. Donald G. Newman, Jerome P. Lavelle, "Engineering Economics and analysis", Engineering Press, Texas, 2010.
3. E. P. Degarmo, W. G. Sullivan and J. R. Canada, "Engineering Economy", Macmillan, New York, 2011.
4. Zahid A. Khan, "Engineering Economy", Dorling Kindersley, 2012.

Intellectual Property Rights

BTMEC705B	OEC 5	Intellectual Property Rights	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	State the basic fundamental terms such as copyrights, Patents, Trademarks etc.,
CO2	Interpret Laws of copy-rights, Patents, Trademarks and various IP registration Processes.
CO3	Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms commercial strategies.
CO4	Create awareness at all levels (research and innovation) to develop patentable technologies.
CO5	Apply trade mark law, copy right law, patent law and also carry out intellectual property audits.
CO6	Manage and safeguard the intellectual property and protect it against unauthorized use.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2								1				
CO3		1						1				
CO4										1		
CO5	1							1				
CO6								2				

Course Contents:

Unit 1:Introduction to Intellectual Property
Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

Unit 2: Trade Marks
Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

Unit 3:Law of Copy Rights
Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Unit 4: Law of Patents
Foundation of patent law, patent searching process, ownership rights and transfer.

Unit 5:Trade Secrets
Trade secretes law, determination of trade secretes status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.
Unfair competition: Misappropriation right of publicity, false advertising.

Unit 6:New Development of Intellectual Property
New developments in trade mark law; copy right law, patent law, intellectual property audits.
International overview on intellectual property, international trade mark law, copy right law, international patent law, and international development in trade secrets law.

Texts:

1. Deborah, E. Bouchoux, "Intellectual Property Right", Cengage learning.
2. PrabuddhaGanguli, "Intellectual property right: Unleashing the knowledge economy", Tata McGraw Hill Publishing Company Ltd.

References:

1. AjitParulekar, Sarita D'Souza, "Indian Patents Law-Legal and Business implications", Macmillan India Ltd., 2006.
2. B. L. Wadhera, "Law related to patents, Trademarks, Copyrights, Designs and Geographical indications", Universal law Publishing Pvt. Ltd., India, 2000.
3. P. Narayanan, "Law of copyright and Industrial Designs", Eastern Law house, Delhi, 2010.

Wind Energy

BTMEC705C	OEC 5	Wind Energy	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Understand historical applications of wind energy
CO2	Understand and explain wind measurements and wind data
CO3	Determine Wind Turbine Power, Energy and Torque
CO4	Understand and explain Wind Turbine Connected to the Electrical Network AC and DC
CO5	Understand economics of wind energy

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							2	2	2	1		1
CO2		3	2	1	3	2	2	2	2			1
CO3	3	3	1	1	2	2	1					1
CO4	3	3		1								1
CO5	3	2	1									1

Course Contents:

Unit 1: Introduction
Historical uses of wind, History of wind electric generations

Wind Characteristics: Metrology of wind, World distribution of wind, Atmospheric stability, Wind speed variation with height, Wind speed statistics, Weibull statistics, Weibull parameters, Rayleigh and normal distribution

Unit 2: Wind Measurements
Biological indicators, Rotational anemometers, other anemometers, Wind direction

Unit 3: Wind Turbine Power, Energy and Torque
Power output from an ideal turbine, Aerodynamics, Power output from practical turbines, Transmission and generation efficiency, Energy production and capacity factor, Torque at constant speeds, Drive train oscillations, Turbine shaft power and torque at variable speeds.

Unit 4: Wind Turbine Connected to the Electrical Network
Methods of generating synchronous power, AC circuits, The synchronous generator, Per unit calculations, The induction machine, Motor starting, Capacity credit features of electrical network

Unit 5: Wind Turbines with Asynchronous Electric Generators
Asynchronous systems, DC shunt generator with battery load, Per unit calculation, Self excitation of the induction generators, Single phase operation the induction generator, Field modulated generators, Roesel generator.
Asynchronous Load: Piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries, Hydrogen economy, and Electrolysis cells.

Unit 6: Economics of Wind Systems
Capital costs, Economic concepts, Revenues requirements, Value of wind generated

electricity

Texts:
1. S. Ahmad, "Wind Energy: Theory and Practice", Prentice Hall of India Pvt. Ltd.

References:

1. Garg L. Johnson, "Wind Energy Systems" Prentice Hall Inc., New Jersey, 1985.
2. Desire Le Gouriers, "Wind Power Plants: Theory and Design" Pergamon Press, 1982.

Knowledge Management

BTMEC705D	OEC 5	Knowledge Management	3-0-0	Audit

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Define KM, learning organizations, intellectual capital and related terminologies in clear terms and understand the role of knowledge management in organizations.
CO2	Demonstrate an understanding of the history, concepts, and the antecedents of management of knowledge and describe several successful knowledge management systems.
CO3	Identify and select tools and techniques of KM for the stages of creation, acquisition, transfer and management of knowledge.
CO4	Analyze and evaluate tangible and intangible knowledge assets and understand current KM issues and initiatives.
CO5	Evaluate the impact of technology including telecommunications, networks, and internet/intranet role in managing knowledge.
CO6	Identify KM in specific environments: managerial and decision making communities; finance and economic sectors; legal information systems; health information systems

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						1						3
CO2												3
CO3												3
CO4								2				3
CO5					3				2			3
CO6												3

Course Contents:

Unit 1: Introduction
Definition, evolution, need, drivers, scope, approaches in Organizations, strategies in organizations, components and functions, understanding knowledge.

Unit 2: Learning Organization
Five components of learning organization, knowledge sourcesand documentation.

Unit 3: Essentials of Knowledge Management
Knowledge creation process, knowledge management techniques, systems and tools.

Unit 4: Organizational Knowledge Management
Architecture and implementation strategies, building the knowledge corporation and implementing knowledge management in organization.

Unit 5: Knowledge Management System
Knowledge management system life cycle, managing knowledge workers, knowledge audit, and knowledge management practices in organizations, few case studies.
Unit 6: Futuristic KM
Knowledge engineering, Theory of computation, data structure.

Texts:

1. Thohothathri Raman, “Knowledge Management: A resource book”, Excel, 2004.
2. M. Elias, AwadHasan, M. Ghazri, “Knowledge Management”,Pearson Education.

References:

1. AmritTiwana, “Strategy &Knowledge Platforms”, The KM Toolkit–Orchestrating IT, Pearson, PHI, 2ndedition.
2. Peter Senge et al., “The Fifth Discipline Field Book–Strategies and Tools for Building A learning Organization”, Nicholas Brealey, 1994.
3. SudhirWarier, “Knowledge Management”, Vikas Publications.
4. MadanmohanRao, “Leading with Knowledge”, Tata McGraw Hill Publications.

Manufacturing Processes Lab - II

BTMEL706	PCC 32	Manufacturing Processes Lab - II	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: Manufacturing Processes - II

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

CO1	
CO2	
CO3	
CO4	

CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

- **Any 8 out of the following should be conducted**

1. Study of types of chips
2. Study of the effect of process parameters on cutting ratio and shear angle in oblique turning process
3. Study of the effect of process parameters on the surface roughness during oblique turning process
4. Study of the effect of cutting fluid on surface roughness during oblique turning process
5. Study of the effect of process parameters on tool wear during oblique turning process
6. Study of the effect of process parameters on cutting forces in oblique turning process
7. Study of the effect of process parameters on cutting forces in end milling process
8. To develop a manual part program of a given component on CNC Lathe using G and M codes.
9. To develop a manual part program of a given component on CNC Lathe using stockremoval cycle.
10. To develop a manual part program of a given component on CNC Lathe using canned cycle.
11. To develop a manual part program of a given component on CNC Milling machine using G and M code.
12. To develop a manual part program of a given component on CNC Milling machine using pocket milling cycle.
13. To develop a manual part program of a given component on CNC Milling machine using canned cycle.

14. To examine the effect of parameters on MRR and TWR in Electro Discharge Machining (EDM).
15. To evaluate machining accuracy in EDM.
16. Demonstration on Wire-EDM
17. Industrial visit to study manufacturing practices.

Mechatronics Lab

BTMEL707	PCC 33	Mechatronics Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: Mechatronics

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

CO1	Understand the various types of sensors and their applications
CO2	Design a pneumatic circuit for a given application
CO3	Design a hydraulic circuit for a given application
CO4	Write a PLC program using Ladder logic
CO5	Experiment PID controller for controlling temperature
CO6	Demonstrate the capacitance sensor for measuring level

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2							3			1
CO2	1	1	3	3	3		3		3			1
CO3	1	1	3	3	3		3		3			1
CO4	2		3	1	3		1		3			1
CO5	1	1	3	3	3	3	2		3			1
CO6	1	1	3	3	2		2		3			1

Listof Practicals/Experiments/Assignments

1. Studyanddemonstrationofvarioustypesofsensors
2. Speedcontrolofvarioustypesof ElectricalMotors
3. MinimumtwocircuitsonPneumaticstobedevelopedonPneumatictrainerkit
4. Minimum two circuits on Electro-Pneumatics to be developed on Electro-Pneumatictrainerkit
5. MinimumtwocircuitsonHydraulicsandElectro-hydraulicstobedevelopedon Hydraulictrainerkit
6. ProgrammingofMicroprocessorandMicrocontroller
7. ProgrammingonPLC

8. DemonstrationofProcesscontrolsuchastemperature,level,flow,etc.control usingPIDcontroller

CAD/CAM Lab

BTMEL708	PCC 34	CAD/CAM Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Construct CAD part models, assembly model and drafting of machine elements using CAD software.
CO2	Evaluate stresses in components subjected to simple structural loading using FE software
CO3	Write NC programs for turning and milling
CO4	Describe case study of industrial robots

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	1	1	3				3	3		2
CO2		3	3	3	3				3	2		2
CO3		1	2	1	3				3	2		2
CO4	1		1		3		3	3	3	3	3	2

Listof Practicals/Experiments/Assignments

1. PartmodelingofmachineelementsusinganyoneoftheCADsoftwareoutof ProE,CATIA,UnigraphicsorAutodeskInventorProfessional.
2. Assemblymodelingofassemblyorsub-assemblyof engineeringproductsusingany oneoftheCADsoftwareoutofProE,CATIA,Unigraphics orAutodeskInventor Professional.
3. DraftingofPartsandAssembly ofengineeringassemblyusinganyoneofthe CADsoftwareoutofProE,CATIA,Unigraphics, orAutodeskInventor Professional.
4. Minimum4structuralanalysisproblemstobesolvedusingaCAEsoftwarelike Ansys,Hyperworks,etc.
5. Minimum2Jobs(Programs)onCNCTurningoperations
6. Minimum2Jobs(programs)onCNCMilling Foperation
7. CaseStudyof anIndustrialRobot

Seminar

BTMES709	Project 4	Seminar	0-0-2	1 Credit

Examination Scheme:
Continuous Assessment: 30 Marks
End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	State the exact title of the seminar
CO2	Explain the motivation for selecting the seminar topic and its scope
CO3	Search pertinent literature and information on the topic
CO4	Critically review the literature and information collected
CO5	Demonstrate effective written and verbal communication

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2					2	2	2	2	1		1
CO2								2		2		1
CO3	2					1	1	1	3	3		3
CO4	2		1			2	1	2	2	2		2
CO5												

Course Contents:

Before the end of Semester VII, each student will have to deliver a seminar on a subject mutually decided by candidate and his/her guide. The student should select the topic for his/her seminar which is latest and relevant. The student, as a part of the term work, should submit the write-up of the seminar topic in duplicate, typed on A4size sheets in a prescribed format and bound at the end of semester.
The performance of the student will be evaluated on the basis of the contents, the presentation and discussion during the delivery of seminar before the evaluation committee appointed by the Department.

Field Training/Internship/Industrial Training - III

BTMEF710	Project 5	Field Training/Internship/Industrial Training - III	---	1 Credit

Examination Scheme:
End Semester Exam: 50 Marks

Pre-Requisites: None

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

CO1	To make the students aware of industrial culture and organizational setup
CO2	To create awareness about technical report writing among the student.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1	1			2		1			3	3
CO2		1	1			2		1			3	2

Students will have to undergo 6 weeks training programme in the Industry during the summer vacation after VIth semester examination. It is expected that students should understand the organizational structure, various sections and their functions, products/services, testing facilities, safety and environmental protection measures etc.

Also, students should take up a small case study and propose the possible solution(s).

They will have to submit a detailed report about the training programme to the facultycoordinator soon after joining in final year B.Tech. Programme. They will have to give a power point presentation in front of the group of examiners.

Project Stage - I

BTMEP711	Project 6	Project Stage - I	0-0-6	3 Credits

Examination Scheme: Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	State the exact title of the project and problem definition
CO2	Explain the motivation, objectives and scope of the project
CO3	Review the literature related to the selected topic of the project
CO4	Design the mechanism, components of the system and prepare detailed drawings.
CO5	Evaluate the cost considering different materials/manufacturing processes

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1								1		
CO2									1	2	2	
CO3		1				1						

CO4			3	2	2		1		1	1	1	1
CO5	1		1					1			2	1

Course Contents:

The students in a group of not more than FOUR will work under the guidance of the faculty member on the project work undertaken by them. The completion of work, the submission of the report and assessment should be done at the end of VII Sem.

The project work should consist of any of the following or appropriate combination:

1. A comprehensive and up-to-date survey of literature related to study of a phenomenon or product.
2. Design of any equipment and / or its fabrication and testing.
3. Critical Analysis of any design or process for optimizing the same.
4. Experimental verification of principles used in applications related to various specializations related to Mechanical Engineering.
5. Software development for particular applications.
6. A combination of the above.

It is expected that the students should complete at least 40% of the total project work in VII Semester. The objective is to prepare the students to examine any design or process or phenomenon from all angles, to encourage the process of independent thinking and working and to expose them to industry.

The students may preferably select the project works from their opted elective subjects. The students should submit the report in a prescribed format, before the end of VII semester. The report shall be comprehensive and presented typed on A_4 size sheets and bound. Number of copies to be submitted is number of students plus two. The assessment would be carried out by the panel of examiners for both, term work and oral examinations.

Semester - VIII

Biomechanics

BTMEC801A	PEC 3	Biomechanics	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Explain various forces and mechanisms and define Newton's law of motion, work and energy, moment of inertia
CO2	Describe forces and stresses in different human joints
CO3	Discuss bio fluid mechanics in cardiovascular and respiratory system in human body
CO4	Differentiate between hard tissues and soft tissues
CO5	Understand concepts of implants and Identify different techniques used in biomechanics implants

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1			1	1	1	1		1	1
CO2	2	2	2			1	2		1		1	1
CO3	2	2	2			1	1	1	1			1
CO4	1	1	1				1	1	1			1
CO5	1	1	2				1	1			1	1

Course Contents:

Unit 1: Introduction
Review of principle of mechanics, vector mechanics-resultant forces of coplanar and non-coplanar and concurrent and non-concurrent forces, parallel forces in planes, equilibrium of coplanar forces, Newton's law of motion, work and energy, moment of inertia.

Unit 2: Biomechanics of Joints
Skeletal joints, forces and stresses in human joints, type of joints, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle.

Unit 3: Bio-fluid Mechanics
Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, cardiovascular and respiratory system.

Unit 4: Hard Tissues

Bone structure and composition, Mechanical properties of bones, cortical and cancellous bones, visco-elastic properties, Maxwell and Vigot model – Anisotropy

Unit 5: Soft Tissues

Structure and functions of soft tissue: cartilage, tendon, ligament and muscle, Material properties of cartilage, tendon and ligament and muscle

Unit 6: Biomechanics of Implant

Specification for prosthetic joints, biocompatibility, requirement of biomaterial, characterization of different type of biomaterials, fixation of implants.

Texts/References:

1. Y. C. Fung, "Biomechanics: Mechanical properties of living tissues", Springer-Verlag, 2nd edition, 1993.
2. D. J. Schneck, J. D. Bronzino, "Biomechanics: Principle and Applications", CRC Press, 2nd edition, 2000.

Power Plant Engineering

BTMEC801B	PEC 3	Power Plant Engineering	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Recognize the current power generation scenario across the globe and compare the different sources used by different nations for power generation. Discuss the most important energy source in India for power generation along with its current status. and the types of power plants
CO2	Describe the fuel handling and ash handling in thermal power plants.
CO3	Explain the working of steam turbine power plant, gas turbine power plant, thermal power plant, diesel power plant, hydroelectric power plant, nuclear power plant and non-conventional power generation plants like wind power plants, tidal power plants, solar photovoltaic power plants and fuel cells, solar thermal power plants. Write functions of their important components.
CO4	Describe different high pressure boilers used in power plants and write their advantages.
CO5	Study Rankine cycle with reheat, regeneration and reheat – regeneration, etc. and analyze their performance.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	2	1				1	1						
CO2	1	1											
CO3	1												
CO4	1	1											
CO5	1	2											

Course Contents:

Unit 1: Sources of Energy for Power Plant

Fossil fuels, petroleum products, Hydel, Nuclear, Wind, Tidal and Geo-thermal energy etc.**Cycle for Steam and Gas Turbine Power Plant:**Rankine cycle, Reheat cycle, Regenerative cycle, Reheat-regenerative cycle, Binary cycle, topping cycle, Cogeneration, Regeneration, and Intercooling.

Unit 2: High PressureBoilers

Introduction, Advantages of high pressure boilers, Lamont boiler, Benson boiler, Loeffler boiler, Schmidt-Hartmann boiler, Velox boiler, super critical boiler, Design consideration for modern boilers, Introduction to IBR.

Unit 3: ThermalPowerPlant

Introduction,generallayoutofmodernthermalpowerplant,working, site selection and material requirements.

Fuel and Ash Handling: Introduction, out-plant and in-plant handling of coal, coal storage, coal crushingandpulverizedcoalsystems,coal burningmethods,overfeedunderfeedstokers, pulverizedfuelsandtheiradvantages,pulverized fuelburners,ashhandlingsystems,different types of dust collectors, ash and dust disposal.

Unit 4: Diesel Power Plant

Introduction, field of use, plant layout, comparison of diesel power plant with other power plants,recent developments.

GasTurbinePowerPlant(GTPP):Introduction,classificationandcomparisonwithother types,typesGTPP,advantages anddisadvantagesoverotherpowerplants,gashandling,present and future trends.

Unit 5: Hydro-ElectricPowerPlant

Introduction,general layoutofhydro-electricpowerplant,Site selection, Classification, Run-off river plants with and withoutpondage, store reservoir plants, pump-storage plants, Advantages of hydro-electric power plant, Safety measures.

NuclearPowerPlant:Introduction,nuclearreactions,nuclearfuels,siteselection,components of reactors, types of reactors, material requirement, effect of nuclear radiation, disposal of nuclear waste, safety requirement of nuclear power plant.

Unit 6: Economy Analysis of Power plants

Introduction, load calculation, load curve, diversity factor, loadfactor,plantusefactor,meetingfluctuatingloadbyvariouspowerplants, costofelectrical energy, performance and operating characteristics of power plants, load division among generators.

Non-conventional Power Generation:SolarEnergyCollectorTypes,Low,mediumandhigh temperaturepowerplants,OTEC,windpowerplants, tidal & geothermalpower plants, solar photovoltaic power plants. Fuel cells.

Texts:

1. P. K. Nag, “PowerPlantEngineering”,TataMcGraw PublishingHillCo.
2. El Wakil, “PowerPlantTechnology”, Tata McGrawHillPublishingCo.

References:

1. S. C. Arora,S. Domkundwar, “ ACourseinPowerPlantEngineering”,DhanpatRai andSons,NewDelhi.
2. FrederickT.Morse, “PowerPlantEngineering”,AffiliatedEast-WestPressPvt. Ltd. NewDelhi.

Robotics

BTMEC801C	PEC 3	Robotics	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	List the various components of a typical Robot, grippers, sensors, drive system and describe their functions
CO2	Calculate the word to joint and joint to word coordinates using forward and reverse transformations
CO3	Calculate the gripper forces, drive sizes, etc.
CO4	Develop simple robot program for tasks such as pick and place, arc welding, etc. using some robotic language such as VAL-II, AL, AML, RAIL, RPL, VAL
CO5	Evaluate the application of robots in applications such as Material Handling, process operations and Assembly and inspection
CO6	Discuss the implementation issues and social aspects of robotics

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1: Introduction
Variousbasic componentsofaRoboticsystem,variousconfigurations,workenvelopes, Manipulators,sensors,controllers,etc.

Unit2: MechanicalSystemin Robotics
Motion conversion,Kinematic chains, position analysis,forwardandbackward transformations,naturalandjointspacecoordinates.

Unit3: DrivesforRobot
Electricaldrives**,**Steppermotor,DCmotors,ACmotors,hydraulicandpneumaticdrives, hybriddrives,driveselectionforroboticsjoints.

Unit4: Sensorsin Robotics
Positionsensor,velocitysensor,proximitysensors,touchsensors,forcesensors,etc.

Unit5: RobotProgramming
Pathplanning,Leadthrough(manualandpowered)programming,teachpendantmode, programminglanguages,AL,AML,RAIL,RPL,VALpmentin robotics
ArtificialIntelligenceforRobots:
KnowledgeRepresentation,Problemrepresentationandproblemsolving,search techniquesinproblemsolving

Unit6: RobotApplications
Applicationofrobotin:Materialhandling,assemblyandinspection,processoperations, etc.

Texts:

1. M. P. Grover,“Industrial Robotics: Technology,Programmingand Applications”,TataMcGrawHillPublication.

References:

1. SaeedB.Niku, “IntroductiontoRobotics,Analysis,Systems,Applications”,Pearson Education.
2. RichardD.Klafter, “RoboticEngineering:AnIntegratedApproach”,PrenticeHallof India.

Tool Design

BTMEC801D	PEC 3	Tool Design	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand ASA and ORS systems of tool geometry.
CO2	Understand the geometry of single point and multi point cutting tool
CO3	Understand principles of locating and clamping systems, and Design jig and fixture for conventional and NC machining
CO4	Select and design progressive, compound or combination dies for press working operations
CO5	Select and design drawing, and bending dies.
CO6	Understand forging operations with single and multi-impression dies

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1			1							1
CO2		1										1
CO3	2	2	3		1							
CO4	1	2	1	1	3		1					2
CO5		2	1		3							2
CO6	1	2	1		1				1			1

Course Contents:

Unit 1: Design of Single Point Cutting Tools
Introduction, designation of cutting tools, ORS and ASA system, Importance of tool angles, design of chip breakers, machining forces and merchant’s circle diagram. Taylor’s tool life equation.

Unit 2: Design of Multipoint Cutting Tools
Drill: Nomenclature, design of drill, moment, thrust force and power required. Milling Cutters: Nomenclature, design of milling cutter, power required for milling. Broaches: Nomenclature, design of broach, broaching power, length of toothed portion.

Unit 3: Design of Jigs and Fixtures
Twelve degree of freedom, 3-2-1, 4-2-1 method of location, Redundancy, fool proofing, locating & clamping**:** locating devices, clamping devices, Quick acting devices, drill bushes, Drilling jigs**:** need, design principles, types of drilling jigs. Milling fixtures**:** essential features of a milling fixtures, types, Indexing of Jigs and Fixtures.

Unit 4: Press Tool Design
Press working equipment, press selection, types of dies, clearance, angular clearance, stripper plate, cutting forces , method of reducing cutting forces , die block design, punch , punch design , methods of holding punch, centre of pressure, scrap strip layout. Blanking die design, piercing die design, design of progressive dies.

Unit 5: Bending and Drawing Dies
Bending Dies: v-bending, bending forces, bend allowance, spring back and its prevention, design principles.

Drawing Dies: introduction , difference between bending , and drawing , metal flow during drawing, design consideration: radius of draw die, punch radius, draw clearance, drawing speed, calculation of blank size, number of draws, drawing pressure, blank hold pressure.

Unit 6: Forging Die Design and Mould Design

Forging dies, single impression dies, multiple impression dies,

Forging design factors: draft, fillet and corner radius, parting line, shrinkage and die wear, mismatch, finish allowances, webs and ribs.

Die design for drop forging and press forging: preliminary forging operation, fullering, edging, bending, flattering, blocking, finishing, cutoff, die block dimensions.

Determination of stock size in closed and open die forging, Mould design: injection mould, mould base, design of simple two plate injection moulds, mould materials.

Texts:

1. P. C. Sharma, “A Text Book of Production Engineering”, S. Chand & company ltd., New Delhi, 2001.
2. P. H. Joshi, “Jigs & Fixtures”, Tata McGraw Hill Publishing Co. New Delhi, 2001.
3. M. H. A. Kempster, “Introduction of Jigs and Fixtures design”, The English Language Book Society and Hodder and Stoughton, London, 3rd edition, 1982.

References:

1. GeofferyBoothroyd, Winston Knight, “Fundamentals of Machining and Machine Tools”, Taylors and Francis, 3rd edition, 2006.
2. E. G. Hoffman, “Jigs and Fixtures”, 5thCengage Learning, 2004.

Body - In - White & Trims

BTAMC801C	PEC 3	Body - In - White & Trims	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												

CO2												
CO3												
CO4												
CO5												

Course Contents:
Domain Related Training (Approx. 40 hrs)
Unit 1:
BIW : Requirement Specification in the Pre-Program Stage, Product Life Cycle & Important Gateways for BIW, Identification of Commodities for BIW, Design Concept & Considerations in BIW, BIW Materials & Grades, GD & T for BIW.

Unit 2:
Sheet Metal Joining – Welds, Adhesives, TWBs. DFMEA, Design Verification – CAE Methods & Gateway supports Part A & B, CAE Analysis – NVH, Crash & Durability, Test Validation & Assessment.

Unit 3:
Manufacturing – Sequence, Welding & Assembly, Future Trends in BIW, BIW: Examples & Case Studies.

Unit 4:
Trims: Requirement Specification in the Pre-Program Stage, Product Life Cycle & Important Gateways for Trims, Identification of Commodities for Trims, Design Requirements & Considerations, Trim Materials in Automotive.

Unit 5:
Design of Plastic Part, DFMEA, Design Verification – CAE Methods & Gateway supports, CAE Analysis – Moldflow, Crash & Durability, Test Validation & Assessment.

Unit 6:
Manufacturing Process, Assembly Sequence, Future Trends & Future Material for Trims, Trims: Examples & Case Studies.

Texts:

1. Notes of TATA Technologies
2. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)", Right Tech, Inc., Kindle Edition.
3. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 2)", Right Tech, Inc., Kindle Edition.

References:

1. Vukato Boljanovic, "Sheet Metal Forming Processes and Die Design", Industrial press Inc., Kindle Edition.
2. R. D. Cook, Concepts and Applications of Finite Element Analysis; John Wiley and Sons, second edition, 1981.
3. K.J. Bathe, Finite Element Method and Procedures; Prentice hall, 1996.
4. IbrahimZeid,"CAD/CAM Theory and Practice", Tata McGraw Hill Publication,

5. J. H.Dubois And W. I.Pribble, *Plastics Mold Engineering Handbook*, Van NostrandReihnhold, New York, 1987.
6. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
7. C. Howard, *Modern Welding Technology*, Prentice Hall, 1979.
8. Jesper Christensen and Christophe Bastien, "Nonlinear Optimization of Vehicle Safety Structures: Modeling of Structures Subjected to Large Deformations, Butterworth-Heinemann, Kindle Edition
9. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
10. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, SpringerVerlag, 2004. ISBN 1852338105

Product Life Cycle Management

BTMEC802A	PEC 4	Product Life Cycle Management	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the need and advantages of PLM
CO2	Describe the various PLM strategies
CO3	Describe the various steps in design and development of product
CO4	Understand the technology forecasting
CO5	Describe the importance of innovation in product design and development
CO6	Apply PLM to at least one product

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1: Introduction and Strategies to PLM

Need for PLM, opportunities and benefits of PLM, different views of PLM, components of

PLM, phases of PLM, PLM feasibility study, PLM visioning, Industrial strategies, strategy elements, its identification, selection and implementation, change management for PLM.

Unit 2: Product Data Management (PDM)
Human resources in product lifecycle, Information, Standards, Vendors of PLM Systems and Components, PDM systems and importance, reason for implementing a PDM system, financial Justification of PDM, barriers to PDM implementation

Unit 3: Product Design
Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product design.

Unit 4: New Product Development
Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program, Concept of redesign of product.

Unit 5: Technology Forecasting
Future mapping, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, combining forecast of different technologies, uses in manufacture alternative.

Unit 6: PLM Software and Tools
Product data security. Product structure, workflow, Terminologies in workflow, The Link between Product Data and Product Workflow, PLM applications, PDM applications

Texts/References:

1. Grieves, Michael, "Product Lifecycle Management", Tata McGraw-Hill, 2006, ISBN 007145230330.
2. AnttiSaaksvuori, AnselmiImmonen, "Product Life Cycle Management", Springer, 1st edition, 2003.
3. Stark, John, "Product Lifecycle Management: Paradigm for 21st Century Product Realization", Springer-Verlag, 2004.
4. Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach", Taylor & Francis, 2006.
5. Robert J. Thomas, "NPD: Managing and forecasting for strategic processes".

Machine Tool Design

BTMEC802B	PEC 4	Machine Tool Design	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Machine design and Manufacturing processes-II

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

CO1	Understand basic motion involved in a machine tool.
CO2	Design machine tool structures for conventional and CNC machines.
CO3	Design and analyze system for specified speeds and feeds.
CO4	Understand control strategies for machine tool operations.
CO5	Design of rotary and linear drive for machine tools.
CO6	Analyze machine tool structure for design accuracy.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	1	1				1	1	1
CO2	3	1	3	1	2	1	1		1	1	1	1
CO3	2	1	2	1	1	1			1	1	1	1
CO4	2	1	1	1	1	1	1			1	1	1
CO5	3	1	3	1	1	1	1		1	1	1	1
CO6	2	1	2	1	1	1	1		1	1	1	1

Course Contents:

Unit 1: Introduction
Kinematics of different types of machine tools, selection of cutting conditions and tools, calculations of cutting force on single point and multipoint tools, hole machining, calculation of power, accuracy requirements and standards.

Unit 2: Design of Rotary Drives
Design of spindle drives, AC motors with stepped drive, DC and AC variable speed drive motor characteristics and selection, principle of speed controllers, timing belts and other types of transmission belting, closed loop operation of mail drives, rotary indexing drives.

Unit 3: Design of Feed Drives
Feed drive using feed boxes, axes feed drive of CNC drives, DC and AC servomotors, characteristics controllers and their selection, Ball screws and friction guide ways, linear motion systems, design calculation of drives, closed loop operations of feed drive, linear indexing drives.

Unit 4: Control Elements
Single and multi-axis CNC controllers, hydraulic control, Pneumatic control limit switches, proximity switches, sequencing control using hardwired and PLC systems.
Design of machine tool structures: Static and dynamic stiffness, dynamic analysis of cutting process, stability, forced vibration, ergonomics and aesthetics in machine tool design.

Unit 5: Design of Spindle and Spindle Supports
Function of spindles, design requirements, standard spindle noses, designcalculation of spindles, bearing selection and mounting.

Finite elements analysis of machine tool structures: Examples of static, dynamic and thermal analysis and optimization of typical machine tool structure like column and using a finite element analysis package.

Unit 6: Design of Special Purpose Machines

Modular design concepts, standard modules, example of design of typical SPM with CNC, transfer machines.

Texts:

1. N. K. Mehta, "Machine Tool Design", Tata McGraw Hill Book Co., 1991.
2. P.C. Sharma, "A Textbook of Machine Tools and Tool Design", S. Chand & Co. Ltd., 1 January 2005.
3. Sen and Bhattacharya, "Principles of Machine Tools", 1 Jan 2009.
4. YoramKoren, "Computer control of manufacturing systems", Tata McGraw Hill Education, 2009.

References:

1. Aacherkan, "Machine Tool Design", Vol. I and Vol. III, Mir Publishers, Moscow,1970.
2. W. L. Cheney, "Details of Machine Tool Design (Classic Reprint)", Forgotten Books, 20 Sep 2016.
3. Central Machine Tool Institute,"Machine Tool Design Handbook", Tata McGraw Hill Education, 1st Edition, 16 June 2001.
4. Nicholas Lisitsyn, Alexis V Kudryashov, Oleg Trifonov, Alexander Gavryusin, N Acherkan, Nicholas Weinstein, "Machine Tool Design", Vol. I, University Press of the Pacific, 20 April 2000.

Tool Condition Monitoring

BTMEC802C	PEC 4	Tool Condition Monitoring	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the need for Tool Condition Monitoring (TCM)
CO2	Describe the different sensors used in TCM
CO3	Apply the TCM Technique to machines like Lathe, Drilling, Milling
CO4	Apply the TCM to EDM, ECM
CO5	Demonstrate the TCM using force , vibration and sound sensors

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	1	2	2						1
CO2	3	3	2	1	2	2	2					1

CO3	1	1	2	2	3	2						1
CO4	1	1	2	2	3	2	3					1
CO5	1	1			3	2	3					1

Course Contents:

Unit1: Introduction
Need androleofmonitoringsystemand differentmethodsoftoolconditionmonitoring.

Unit2: Sensors
Role of sensors in manufacturing, Types of sensors, Principles of sensors for manufacturing.

Unit3: ConditionMonitoring
Conditionmonitoringofmanufacturingsystemsusing:force,vibration,soundandneural networks.

Unit4: AcousticEmission
Toolconditionmonitoringusingacousticemission:principleofworking,typesofAE sensorsandapplicationstometal cuttingprocesses.

Unit5: ApplicationsofSensors
Applicationsofsensorsincastingandforming,Processmonitoringanduseofsensorsin forging,Monitoringofnon-conventionalmanufacturingprocessesuch asEDM,ECM.

Unit6: ToolCondition MonitoringforCNC Machines
Toolcondition monitoringfor CNC machines like lathe,milling machines, drilling machinesusingsensorsforworkpieceandtooling.

Texts:
1. H.K.Tonshoff, I.Inasaki, “SensorsApplications”,Vol.I,SensorsinManufacturing, Wiley-VCH,NewYork,2001.
2. D. M. Considiene,G. D. Considine, “StandardHandbookof IndustrialAutomation”, ChapmanandHall,1975.

References:
1. S.D. Murphy, “In-processMeasurementandControl”,MarcelDekker,1983.
2. S. Soloman, “SensorsandControlsystemsinManufacturing”, Tata McGrawHill InternationalEditions,USA,1987.

Mechanical Vibration

BTMEC802D	PEC 4	Mechanical Vibration	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Theory of Machines - II

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

CO1	Understand the cause and effect of vibration in mechanical system
CO2	Formulate governing equation of motion for physical system
CO3	Understand role of damping, stiffness and inertia in mechanical system
CO4	Analyze rotating system and calculate critical speeds
CO5	Estimate the parameters of vibration isolation system
CO6	Estimate natural frequencies and mode shapes of continuous system

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	2	1	1					2
CO2	3	3	2	1	1							2
CO3	3	2	2	1	1							2
CO4	3	3	2	2	2							2
CO5	3	3	2	2	2		3					2
CO6	3	3	3	2								2

Course Contents:

Unit 1: Single DOF- Free Vibrations
Basic concepts: Causes and effect of vibrations, practical applications, harmonic and periodic motions, vibration terminology, vibration model, Equation of motion -natural frequency, Energy method, Rayleigh method, principle of virtual work, damping model, viscously damped free vibration, Oscillatory, non-oscillatory and critically damped motions, logarithmic decrement. Coulomb's damping.

Unit 2: Single DOF- Forced Vibrations
Analysis of linear and torsional system subjected to harmonic force excitation, force transmissibility, Magnification factor, motion transmissibility, vibration isolation, typical isolator and mounts, critical speed of single rotor, undamped and damped.

Unit 3: Two DOF Systems
Introduction, formulation of equation of motion, equilibrium method, lagrangian method, free vibration response, Eigen values and eigen vector, Normal mode and mode superposition, Coordinate coupling, decoupling equation of motion.

Unit 4: Torsional Vibration
Simplesystem with one or two rotor masses, Multi DOF system: transfer matrix method, geared system, and branched system.

Unit 5: Multi Degree of Freedom System
Formulation of equation of motion, free vibration response, natural mode and mode shapes, orthogonality of model vectors, normalization of model vectors, decoupling of modes, model analysis, mode superposition technique. Free vibration response through model analysis. DF

Unit 6: Continuous Systems
Vibration of strings, longitudinal and transverse vibration of rods, transverse vibrations of

beams, equation of motions and boundary conditions, transverse vibration of beams, natural frequencies and mode shapes.

Texts:
1. L. Meirovich, “Elements of Vibration Analysis”, Tata McGraw Hill.

References:
1. S. S. Rao, “Mechanical Vibrations”, Pearson education.
2. W. T. Thompson, “Theory of Vibration”, CBS Publisher.

Steam and Gas Turbine

BTMEC802E	PEC 4	Steam and Gas Turbine	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	State Various properties of Steam, Draw P-V, T-s, H-s (Mollier) diagrams for steam, Describe Theoretical steam turbine cycle.
CO2	Define and Understand Various Types of Design of Turbines.
CO3	Perform analysis of given steam and gas Turbine power plant (Efficiencies, Power Output, Performance)
CO4	Study and apply various Performance improvement Techniques in steam and gas Turbines
CO5	Assess factors influencing performance of thermal power plants,
CO6	Apply various maintenance procedures and trouble shootings to Turbines.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	1	1										
CO3		2			2							
CO4	1				1	2	2					
CO5	1	2										
CO6	1	1		3								

Course Contents:

Unit 1: Introduction
Properties of steam, Theoretical steam turbine cycle. The flow of steam through Impulse and Impulse–Reaction turbine blades

Unit 2:
Vortex flow in steam turbines, Energy lines, State point locus, Reheat factor and Design procedure. Governing and performance of steam turbine

Unit 3: Gas Turbine
Introduction, simple open cycle gas turbine, Actual Brayton cycle, Means of Improving the efficiency and the specific output of simple cycle,

Unit 4: Gas Turbine Cycle Modifications and Performance
Regeneration, Reheat, Intercooling, closed-cycle gas turbine, turbine velocity diagram and work done.

Unit 5: Turbine Cooling
Turbine blade cooling, material, protective coating, Performance of turbine, Application of turbine.

Unit 6:
Lubrication, cooling, fuel supply and control, Maintenance and trouble shooting.

Texts:

1. W. J. Kearton, "Steam Turbine Theory and Practice", ELBS.

References:

1. R. Yadav, "Steam and Gas Turbine", Central Publishing Home, Allahabad.
2. Jack D. Mattingly, "Elements of Gas Turbine propulsion", Tata McGraw Hill Publications.

Non-conventional Machining

BTMEC803A	PEC 5	Non-conventional Machining	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Manufacturing Processes

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

CO1	Classify Non-conventional machining processes.
CO2	Understand working principle and mechanism of material removal in various non-conventional machining processes.
CO3	Identify process parameters their effect and applications of different processes.
CO4	Summarized merits and demerits of non-conventional machining processes.
CO5	Explain the mechanism to design hybrid processes such as ELID grinding, EDCG, EDCM, etc.

CO6	Understand mechanism and working principle of micro machining using non-conventional processes.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1				1		1
CO2	2	2	1		2	1	1			1		1
CO3	2	2	1	1	2	1	1			1		1
CO4	2	2	1		2	1	1			1		1
CO5	3	2	1	1	2	2	1			1		1
CO6	2	2	1	1	1	2	1			1		1

Course Contents:

Unit 1:Introduction to Non-Conventional Machining Processes
An overview, Trends in manufacturing, Classification of Non-Conventional Machining processes.

Unit 2:Chemical and Electrochemical Processes
Introduction, Types: CHM, ECM, Electrochemical grinding, electrochemical deburring, electrochemical honing, Mechanism of material removal, Process characteristics, Process parameters, Equipment and Tooling (maskantsand etchants), Advantages, applications and limitations.

Unit 3:Thermo-Electrical Processes
Electrical discharge machining, Electron beam machining, Ion beam machining, Plasma arc machining, Hot machining, Mechanism of material removal, Process characteristics, Process parameters, Equipment and Tooling, Advantages, applications and limitations.

Unit 4: Mechanical Processes
Ultrasonic machining, Abrasive jet machining, Abrasive flow machining, Water Jet cutting, Mechanism of material removal, Process characteristics, Process parameters, Equipment and Tooling, Advantages, applications and limitations.

Unit 5: Laser Based Machining Processes
Types of lasers, Laser beam generation, Equipment and machining procedure, Process characteristics, Process parameters, Advantages and limitations of LBM, Applications.

Unit 6:Hybrid Processes
Concept, Mechanism of material removal, Process characteristics, Process parameters, Equipment and Tooling, classification, applications, advantages, Shaped tube electrolytic machining, Electrical discharge wire cutting, ELID grinding, Micro machining: Micro EDM, Micro ECM, Electro discharge chemical grinding (EDCG).

Texts:

1. P. C. Pande, H. S. Shan, “Modern Machining Process”, Tata McGraw-Hill Publications, New Delhi, 1980.
2. V. K. Jain, “Advanced Machining Processes”, Allied Publishers Pvt. Ltd., New Delhi,

2002.
3. P. K. Mishra, “Non-Conventional Machining”, Narosa Publishing House, New Delhi, 2007

References:

1. P. C. Wellar, “Non-Traditional Machining Processes”, SME, Michigan, 1984.
2. Gary F. Benedict, “Non-traditional Manufacturing Processes”, Marcel Dekker, 1987.

Cryogenic Systems

BTMEC803B	PEC 5	Cryogenic Systems	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Refrigeration

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

CO1	Learn the concept of low temperature and its application
CO2	Explain liquefaction systems and cryogenic heat exchangers
CO3	Do the analysis the cryo-coolers
CO4	Design and analysis separation and distillation column
CO4	Define and understand the cryogenic insulation and storage vessel

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1					3	2	1	1			
CO2	3	3							1			
CO3	3	3	1		1	1		1	1			
CO4	3	3	3		2			1	1			
CO5	1					2	1		1			

Course Contents:

Unit1:Introduction

Introduction,Industrialapplications,recentdevelopment,propertiesof cryogenicfluids-oxygen,nitrogen,air,hydrogenandhelium.
BehaviourofstructuralmaterialsatCryogenictemperature:Mechanicalproperties, thermalproperties,thermo-electricproperties.

Unit2: LiquefactionofCryogenicGases

Idealcycle,system performanceparameters,Joule Thomson effect, adiabatic expansion, liquefaction systems; Simple Linde-Hampsonsystem,PrecooledLinde-Hampsonsystem,Cascadesystem,Claudesystem.

Unit3: LiquefactionSystemsforNeon,HydrogenandHelium
PrecooledLinde-Hampsonsystem fprneon and hydrogen, Claude system for hydrogen, Helium refrigerated hydrogenliquefactionsystem

Unit4: CryogenicRefrigerationSystems
Ideal refrigeration systems, Philips refrigerator, Vuilleumierrefrigerator, Solvay refrigerator,Gifford-McMohanrefrigerator,Pulsetuberefrigerator,Magneticcooling

Unit5:SeparationofGases
Principlesofrectification**,**Rectifierscolumn,separationcolumn design;platecalculation,Typesofrectificationcolumns

Unit6: Insulation
Vacuuminsulation, fibrous materials, Solid foams, Gas filledpower, comparison,critical thickness. VacuumTechnology:Importance,Pumpdowntime,Flowregimes,Componentsof vacuumsystems,Vacuumpumps.

Texts:

1. BarronF.Randall**, "**CryogenicSystems",OxfordUniversityPress,NewYork
2. Guy,KWhite, "ExperimentalTechniquesinlowTemperaturePhysics",ClaredonPress,Oxford,1987.
3. "AdvancedCryogenicEngineering",Proceedingsof Cryogenic EngineeringConference,Vol1-145,Plenumpress,NewYork,1968.

References:

1. MarshallSitting,StephenKidd, "CryogenicResearchandApplications",D.Van Nostrand,Inc USA,1963.

Process Equipment Design

BTMEC803C	PEC 5	Process Equipment Design	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the factors influencing design of pressure vessel
CO2	Calculate thickness and thickness variation for cylindrical storage tank
CO3	Estimation of thickness for thin and thick wall pressure vessels
CO4	Design of flange and gasket selection for cylindrical pressure vessels
CO5	Selection of various blade and baffle arrangement for agitators
CO6	Design of support for horizontal and vertical vessel

Mapping of course outcomes with program outcomes

Course	Program Outcomes

Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1			1	1	1				1
CO2	2	2	1			1	1	1				1
CO3	2	2	2			1	1	1				1
CO4	2	2	2			1	1	1				1
CO5	2	2	1			1	1	1				1
CO6	2	2	2			1	1	1				1

Course Contents:

Unit 1: Design Considerations for Pressure Vessel
Selection of type of vessel, Methods of fabrication, Effect of fabrication methods, Various criteria in vessel design, Economic considerations, Types of process equipment, Constructional requirement and applications. Fabrication and testing, Inspection and non-destructive testing of equipment.

Unit 2: Storage Vessel
Design methods of atmospheric storage vessel: storage of fluids, storage of non-volatile liquids, storage of volatile liquids, storage of gases, Optimum tank proportion, Bottom design, Shell design, Wind girder for open top tank, Rub curb angle, Self supported roof, Design of rectangular tank,

Unit 3: Pressure Vessel
Unfired process vessel with internal and external pressure, Operating condition, Selection of material, Design condition, Stresses, Design criteria, Design of shell subjected to internal and external pressure, Cylindrical vessel under combined loading,
Design of heads and closures: flat head and formed heads for vessel. Design consideration for rectors and chemical process vessels. Flange facings, Gaskets, Design of flanged joint, Flange thickness, and Blind flanges.

Unit 4: High Pressure Vessel
Design of thick walled high-pressure vessel, Constructional features, Materials for high-pressure vessels, Multilayer vessel with shrink fit construction, Thermal expansion for shrink fitting, stress in multi shell or shrink fit construction, autofrettage, Pre-stressing. Tall vessels and their design, Stress in shell, Determinations of longitudinal stresses, Longitudinal bending stresses due to eccentric loads, Determination of resultant longitudinal stresses.

Unit 5: Agitated Vessel
Type of agitators, Baffling, Power requirement for agitation, Design based on torque and bending moment, Design based on critical speed, Blade design, Hub and key design, Stuffing box and gland design, Turbine agitator design,

Unit 6: Support for Pressure Vessel
Bracket or lug support: Thickness of the base plate, Thickness of web (gusset) plate, Column support for bracket base plate for column or leg support. Skirt Support: Skirt design, Skirt bearing plate, and Anchor bolt design, Design of bolting chair. Saddle Support: Longitudinal bending moment, Stresses in shell at saddle.

Texts:

1. V. V. Mahajani, S. B. Umarji, “Process Equipment Design”, Macmillan Publisher India

Ltd.
2. L. E. Brownell, E. H. Young, “Process equipment design”, John Wiley and Sons.
3. C. Bhattacharya, “Introduction to process Equipment Design”.

Reference Book:
1. Dennis Moss, “Pressure Vessel Design Manual”, Elsevier.
2. John F. Harvey, “Theory and Design of Pressure Vessels”, CBS Publication.

Design of Piping Systems

BTMEC804A	PEC 6	Design of Piping Systems	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the piping connections, fittings, piping codes, standards and piping representation.
CO2	Describe different piping layouts and understand the design of different piping system
CO3	Analyze and identify the suitable pipe installations
CO4	Calculate different stresses and reactions in given piping layout
CO5	Explain different process auxiliaries in piping systems
CO6	Design of piping in various systems such as refrigeration, steam power plant, underground piping system etc.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1			1	1	1				1
CO2	1	2	1			1	1	1				1
CO3	1	2	1			1	1	1				1
CO4	2	3	2			1	1	1				1
CO5	1	2	2			1	1	1				1
CO6	2	3	2			1	1	1				1

Course Contents:

Unit1: Process Piping
Scope of Piping; Code and Standards; Mechanical Design Fundamentals; Mechanical design of piping system; Wall thickness; Piping size selection;Steelandcastironpipe;Steelandwrought ironpipe;Lightwallpipe;Tubing; Pipeconnectionandfittings;Railfittings;Piping elementsandspecialties;Pipe representation;Weldedandflangedfittings;Valves.

Unit2: PipingSystemLayoutandDesign
Pipinglayout;EquipmentLayout;ProcessPiping Layout;Utility PipingLayout;Pipeflowsheets;Tubefasteningandattachment;Non-ferroustubefittings;Ductsandelbows;Pipeandtubedesigndata;Designofsteam piping;Designofoilpiping;Designofcastironpipe;Miscellaneous designand applications;Pipeline;Flexibility expansiveforcesinpipelines;Expansionstressesand reactionpipelines.

Unit3: PipeInstallation
Selectionof materials;Pipingdesign; Basicprinciple;Pipingsketches; Steamreducingandregulating valves;Selectionofpipesize;Pipe hydraulicsandsizing; Flowofwaterinpipes;Economical pipeselection;Selectionofsteampipesize; Determinationofsteampipesize; Developmentof plotplan; Flexibilityanalysis.

Unit4: ProcessAuxiliaries
Piping;Explanationofcode;Methodsoffabrication;Nominalpipesize;Non-metallicpipingand tubing;Pipesizingbyinternal diameter;Choosingthefinal pipesize;Process steampiping; Pressurereliefsystem; Pressurereliefdevices;Design of pressurereliefsystem;Layoutbyscalemodelmethod.

Unit5: MechanicalPipingDesign
Pipingdrawings;Pipingstressdesign;Internalorexternal fluidpressurestresses;Designofoverheadpiping;Designofunderground piping; Erectionofpipingandsupport;Insulation;Drainagepiping design;Designofnaturalgas pipeline.

Unit6: Designof PipingSystemfortheFollowingApplications
a) Refrigerationpipingsystem,b)Cryogenicpipingsystemic,c)Transmission piping system, d)Steampowerplantpipingsystem, e)Undergroundsteam-pipingsystem, f)Undergroundpetroleumpiping, g)Submergedpiping forpetroleumproducts, h)Piping system sprinklers, i)Non-metallic piping; Selection and joining techniques; Cross CountryPipeTechnology.

Texts/References:

1. J.M.Coulson,R.K.Sinnott,J.F.Richerdson, “ChemicalEngineering”, Vol. VI, MaxwellMcMillan InternationalEdition.
2. SabinCrocker,“PipingHandbook”,Tata McGrawHillPublication, 5thedition.

Advanced IC Engines

BTMEC804B	PEC 6	Advanced IC Engines	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: IC Engines

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

CO1	Define and Distinguish between Spark ignition and Compression ignition system. Describe Air- fuel supply systems in ic engines.
CO2	Identify and Demonstrate normal and abnormal combustion in combustion chambers of IC engines. According to which able to analyse and Design combustion chambers.
CO3	Recognize and discuss engine emissions formation, effects and various methods to reduce emissions and their measuring equipment's.
CO4	Understand combustion and emission characteristics of an alternative energy sources and suggest appropriate applications of alternative fuels such as bio diesels, natural gas, LPG, hydrogen, etc. and their Engine modifications for using these fuels.
CO5	Apply and interpret with the recent trends IC engine techniques such as HCCI, CRDI, GDI, etc. with latest measuring equipments.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		1		1							
CO2		2	3									
CO3		1				2	2					
CO4		1		2	1		1					
CO5					2	2	1					

Course Contents:

Unit 1: Spark Ignition Engines
Mixture requirements, Fuel injection systems, Monopoint, Multipoint & Direct injection, Stages of combustion: Normal and Abnormal combustion, Knock: Factors affecting knock, Combustion chambers.

Unit 2: Compression Ignition Engines
Diesel Fuel Injection Systems, Stages of combustion, Knocking, Factors affecting knock, Direct and Indirect injection systems, Combustion chambers, Fuel Spray behaviour, Spray structure and spray penetration, Air motion, Introduction to Turbo charging.

Unit 3: Pollutant Formation and Control
Pollutant, Sources, Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter, Methods of controlling Emissions, Catalytic converters, Selective Catalytic Reduction and Particulate Traps, Methods of measurement, Emission norms and Driving cycles.

Unit 4: Alternative Fuels
Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel: Properties, Suitability, Merits and Demerits, Engine Modifications.

Unit 5: Recent Trends/Developments

Air assisted Combustion, Homogeneous charge compression ignition engines, Variable Geometry turbochargers, Common Rail Direct Injection Systems, Hybrid Electric Vehicles – NOxAdsorbers, Onboard Diagnostics.

Unit 6: Multi-fuel Engines
Multi-fuel engines, HCCI, GDI, and Exhaust after processing devices.

Texts:

1. V. Ganesan, "Internal Combustion Engines", TMH, 2nd edition, 2002.
2. R. B. Mathur, R. P. Sharma, "Internal Combustion Engines", DhanpatRai& Sons 2007.
3. E. F. Obert, “Internal Combustion Engines”.

References:

1. Duffy Smith, "Auto Fuel Systems", The Good Heart Willcox Company, Inc., 1987.
2. Eric Chowenitz, "Automobile Electronics", SAE Publications, 1995.

Design of Air-Conditioning Systems

BTMEC804C	PEC 6	Design of Air-Conditioning Systems	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Basic Air conditioning

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

CO1	Understand the cooling load calculation
CO2	Explain concept of ventilation and its implementation
CO3	Learn duct design applied to real life situation
CO4	Learn and differentiate the various modern air conditioning systems/units

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2		2	1	1	1			1	
CO2	3	3				1	2					
CO3	3	3	3	2	2	1	1	1			2	
CO4		1	1	1		1	1	1				

Course Contents:

Unit1: Introduction
MoistAirproperties,Psychrometry ofvariousairconditionprocesses,SHF, dehumidifiedairquantity,HVACEquipment

Unit2: HumanComfort

Humancomfort,environment comfortindices,clothing resistance,metabolisms, indoorair quality, ventilationair,insidedesignconditions, outsidedesign conditions.

Unit3: HeatFlow
HeatFlowinBuildings,Building HeatTransfer,CoolingLoadCalculation, Ventilation load,Effective sensible heatfactorand selectionofairconditioning apparatus.

Unit4: AirDiffusion
Roomairdiffusion, filtration,ductdesign,pressuredrop,airdistribution design, outlets

Unit5: Air Conditioning Equipment
Fans,pumpsandblowers,performance&selection

Unit6: AirConditioning Systems
Airconditioning systems;constantvolume,VAV,terminalreheatsystems,single zoneandmultizonesystems,dualductsystem,fancoil unit,noisecontrol.

Texts:

1. W. F. Stoecker, J. P. Jones, "Principles of Refrigeration and Air Conditioning", Tata McGraw Hill Publications.
2. C. P. Arora, "Refrigeration and Air Conditioning",Tata McGraw Hill Publications.
3. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International, 3rd edition, 2011.
4. R. C. Arora, "Refrigeration and Air Conditioning", PHI Learning Pvt. Ltd., 2010.

References:

1. "Handbook of Air Conditioning System Design", Carrier Air Conditioning Co., 1965.
2. W. P. Jones,"AirConditioning Engineering",EdwardArnoldPublishersLtd., London,1984.
3. JamesL. Threlkeld, "ThermalEnvironmentalEngineering",PrenticeHall, New York, 1970.

Sheet Metal Engineering

BTMEC804D	PEC 6	Sheet Metal Engineering	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Recognize common manufacturing processes of Sheet Metal Fabrication
CO2	Understand the principles of design and fabricate of sheet metal products and recognize common material used in the industry
CO3	Distinguish Shearing, Drawing and Pressing etc. processes.
CO4	Know types of dies and formability.
CO5	Select mechanical or hydraulic presses for the given process

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	2				2	1		1
CO2	3			1	3	2	3					2
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3	2			3	3	2				1	3

Course Contents:

Unit1: Introduction
Importanceofsheetmetalengineering,materialsused,desirableproperties ofmaterialsin sheet metalproducts

Unit2: BasicApplications
Shearingprocesseslikeblanking,piercing,andpunching.

Unit3: DrawingProcesses
Shallowanddeepdrawingofcylindricalandrectangularbodies, formingandbendingincludingspring-back.

Unit4: TypesofDies
Compounddies,progressivedies,andcombinationdies

Unit5: Mechanical Presses
Mechanicalandhydraulicpresses,modern developmentsinpresstools, formability.

Unit6: Case Studies
Casestudiesformanufacturingofsheet metalproductsinvariousengineeringapplications

Texts:

1. Donaldsonet al., “ToolDesign”,TataMcGraw-Hill Publications,NewDelhi, 1998.

References:

1. P.N.Rao,“ManufacturingTechnology,Foundry,FormingandWelding”,Vol.I,TataMcGraw HillPublishingCo.Ltd,NewDelhi,3rdedition, 2004.
2. ASMHandbook, “MetalForming”,Vol.XV,ASMPublication,Metals Park, Ohio,10thedition,1989.
3. A. S.Deshpande, “DieDesignHandbook”,ASTME.
4. SheetMetalEngineeringNotes,IITBombay,1999.

Design of Experiments

BTMEC805A	OEC 6	Design of Experiments	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week	Continuous Assessment: 20 Marks

Tutorial: 1 hr/week	Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Engineering mathematics-I

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

CO1	Define Taguchi, factorial experiments, variability, orthogonal array, quality loss.
CO2	Plan and design the experimental investigations efficiently and effectively.
CO3	Understand strategy in planning and conducting experiments.
CO4	Evaluate variability in the experimental data using ANOVA.
CO5	Practice statistical software to achieve robust design of experiments.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		1	1	1				1	1	1
CO2	3	2	1	3	2	1			1	2	1	1
CO3	3	2	1	3	2	1			1	2	1	1
CO4	3	3	1	3	2	1			1	2	1	1
CO5	2	3	1	2	3	2			1	2	1	1

Course Contents:

Unit 1: Introduction
Modern quality control, quality in engineering design, history of quality engineering, The Taguchi Approach to quality: Definition of quality, loss function, offline and online quality control, Taguchi`s quality philosophy.

Unit 2: Full Factorial Designs
traditional scientific experiments, two factor design, three factor design, replicating experiments, factoring reactions, normal plots of estimated effects, mechanical plating experiments, four factor design, Taguchi design and western design.

Unit 3: Fractional Factorial Design
Fractional factorial design base done ightrunexperiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over sixteen run experimental design, blocking two level designs, other two level designs, Necessity to use more than two level, factors at three and four levels.

Unit 4: Taguchi Robust Design
Construction of orthogonal array, Additive model for factor effects, Signal to noise ratios, linear graphs, Taguchi Inner and outer arrays: Noise factors, experimental designs for control and noise factors.

Unit 5: Evaluating Variability
Necessity to analyze variability, measures of variability, the normal distribution, Analysis of variance in engineering design, using estimated effects as test statistics, analysis of variance

for two level designs

Unit 6: Computer Software for Experimental Design
Role of computer software in experimental design, summery of statistical packages, example of use of software packages.

Texts:

1. M. S. Phadke, "Quality Engineering using Robust Design", Prentice Hall, Englewood Cliffs, NewJersey,1989.
2. R.H. Lochnerand J.E. Matar, "Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design", Chapmanand Hall, London, 1983.

References:

1. D.C. Montgomery, "Design and Analysis of Experiments", John Wiley and Sons, New York, 5th edition, 2004.
2. Peter Goos, Bradley Jones, "Optimal Design of Experiments: A Case Study Approach", Wiley Publishers, July 2011.
3. Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, "Response Surface Methodology: Process and Product Optimization Using Designed Experiments", 4th Edition, Wiley, January 2016.

Entrepreneurship Development

BTMEC805B	OEC 6	Entrepreneurship Development	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	enlarge the supply of entrepreneurs for rapid industrial development
CO2	Develop small and medium enterprises sector which is necessary for generation of employment
CO3	Industrialize rural and backward regions
CO4	Provide gainful self-employment to educated young men and women
CO5	Diversify the sources of entrepreneurship.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									2			
CO2									2			
CO3											2	

CO4											2	3
CO5												3

Course Contents:

Unit 1: Introduction to Entrepreneurship
Evolution of the Concept of Entrepreneur Functions of Entrepreneur, Characteristics of an Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship, Growth of Entrepreneurship, Barriers of Entrepreneurship, Role of Entrepreneurship in India, Entrepreneurial Motivation, Major Entrepreneurial Competencies.

Unit 2: Small Scale Industries (SSI)
Characteristics of Small Scale Industry, Basis for Classification of Small Scale Industry: Resource Based, Demand Based, Ancillary, Subsidiary Based or Sub-Controlled Type, Technology Based etc. Government Policy for Small Scale Industry, Growth of SSI in Developing Countries, Role of National and State Agencies Providing Assistance To SSI's, Relationship between Small and Big Industries, Ownership Structure, Registration of SSI.

Unit 3: Project Identification and Project Formulation
Meaning of Project, Project Identification and Selection, Elements of Project Formulation, Concept and Significance of Project Formulation, Meaning, Significance and Contents of Project Report.
Accounting for Small Enterprises: Objective of Accounting, Accounting Process, Journal, Ledger, Preparation of Balance Sheet and Assessment of Economic Viability

Unit 4: Project Appraisal
Concept of Project Appraisal, Project Appraisal Methods, Cash Flows as Costs and Benefits, Payback Period, Average Rate of Return. Discounted Cash Flow Techniques, Working Capital Management, Cost of Capital, Financing of Enterprises, Project Sickness & Corrective Measures.

Unit 5: Marketing Management
Market Segmentation, Marketing Mix, and Packaging, Pricing Policy, Distribution Channels, and Govt. Purchases from SSIS.
Laws Concerning Entrepreneur: Income Tax Laws, Excise Duty ,The Central Sales Tax Act, Professional Tax, Value Added Tax (VAT), Service Tax, The Workmen Compensation Act, The Minimum Wages Act, The Maternity Benefit Act, The Payment of Bonus Act

Unit 6: Institutional Support
Government Policies for Small Scale Entrepreneurs, Institutional Setup, District Industries Centers, Industrial Estates , SIDCO, NSIC, Directorate of Industries, Commercial Banks, New Entrepreneurial Development Agencies.
Women Entrepreneurship: Growth, Problems, Recent Trends.

References:

1. S. S. Khanka, "Entrepreneurial Development", S. Chand and Company Ltd.
2. C. B. Gupta, N. P. Srinivasan, "Entrepreneurship Development in India", S. Chand and Sons.
3. B. Badhai, "Entrepreneurship Development Programme", Mansell Publishing Ltd.
4. V. Desai, "Dynamics of Entrepreneurial Development and Management", Hindustan

Publishing House.
5. David H. Holt, “Entrepreneurship”, PHI Learning.
6. Roy Rajeev, “Entrepreneurship”, Oxford University Press.

Plant Maintenance

BTMEC805C	OEC 6	Plant Maintenance	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Recognize troubles in mechanical elements.
CO2	Assemble, dismantle and align mechanisms in sequential order.
CO3	Carry out plant maintenance using on-line, shut down, corrosion, productive and preventive maintenance.
CO4	Analyze economics of power plants and list factors affecting the power plants
CO5	Explain the linkages between these different aspects and how they impact on overall maintenance effectiveness;

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3		3	3	1	1	3			2
CO2	3			1	3	2	3					2
CO3	3	3	1	1	3		1	1	1			
CO4	1	1		3	3	2	1		3		1	3
CO5	3	2			3	3	2				1	3

Course Contents:

Unit1: Introduction
Introductionto conceptofmaintenance,Typeof maintenance;Preventive,Productive, corrective,online,shut downandtheirsignificance.

Unit2: Preventive Maintenance
Preventive maintenance and its importance, Repair cycle, systematic recording, preventivemaintenance,Programmingandtypesofschedules,Manpowerandmachine planning,Lubricationmethodsandpractice,Colorcodeschedule.

Unit3: Online Maintenance
On-line maintenance,attending tojoints,Valves,Pumpsandotherequipment’s leakages, Makingshaftarrangement,stand-byunit,repairingdamagetoinsulation,etc.without stoppingtheplant,attendingfaultyequipment,Faultfindingandtroubleshoots.

Unit4: ShutdownMaintenance
Shutdownmaintenance,Economicaspectsoftiming,durationofTiminganddduration ofshutdownmaintenance,ExecutionbyusingPERTandCPM.

Unit5:Maintenanceof MechanicalEquipment
Maintenanceofmajor equipmentlikeboiler, furnaces,kilns,shellsandtubeheat exchangers,pumpandcompressor,Towers,Coolingvessels,Valves piping.

Unit6: PlantConditionMonitoring
Plantconditionmonitoringsystems,instrumentation,Datacollectionandanalysis,life expectancyandmaintenancescheduling.Theeconomicsofmaintenancemanagement.

Text:
1. LindleyR.Hinggin,L.C. Morrow, "MaintenanceEngineeringHandbook", Tata McGraw Hill BookCompany.

References:

1. Duncan C. Richardson, PE, "Plant Equipment and Maintenance Engineering Handbook", McGraw Hill Education, New York, Chicago, 2014.

Project Stage - II

BTMEP806	Project 7	Project Stage - II	0-0-12	6 Credits

Examination Scheme:
Continuous Assessment: 50 Marks
End Semester Exam: 100 Marks

Pre-Requisites: None

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

CO1	State the aim and objectives for this stage of the project
CO2	Construct and conduct the tests on the system/product
CO3	Analyze the results of the tests.
CO4	Discuss the findings, draw conclusions, and modify the system/product, if necessary.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2			2	2	2	1	1					
CO3		1			1	2		1		1		
CO4			2	1	2	1	2			3		1

Course Contents:

Since Project Stage II is in continuation to Project Stage I, the students are expected to complete the total project by the end of semester VIII.After completion of project work, they are expected to submit the consolidated report including the work done in stage I and stage II. The report shall be comprehensive and presented typed on A_4 size sheets and bound. The number of copies to be submitted is number of students plus two. The assessment would be carried out by the panel of examiners for both, term work and oral examinations.

List of all UG courses with their equivalent SWAYAM courses:

Sr.No.	Name of Subject as per Curriculum	Equivalent SWAYAM/ NPTEL Courses	Relevance %
1	Manufacturing Processes-III	Manufacturing Processes- I and II	10%
2	CAD-CAM	No	-
3	Sheet Metal Engineering	Metal forming	70%
4	Fluid Machinery	Fluid Machinery	80%
5	Refrigeration and Air conditioning	Refrigeration and Air conditioning	90%
6	Steam and Gas Turbines	Steam and Gas Power system	70 %
7	Automobile Design	No	-
8	Mechanical Vibrations	Mechanical Vibrations	100%
9	Machine Tool Design	No	-
10	Tool Design	No	-
11	Power Plant Engineering	Power Plant Engineering	50%
12	Body - In - White & Trims	No	-
13	Tool Condition Monitoring	No	
14	Design of Piping Systems	No	
15	Process Equipment Design	No	-
16	Product Life Cycle Management	No	-
17	Finite Element Method	Finite Element Method	50%
18	Robotics	Robotics	50%
19	Mechatronics	Mechatronics and manufacturing automation	70%
20	Industrial Engineering and Management	Industrial Engineering	60%
21	Design of Air Conditioning Systems	No	-
22	Biomechanics	Mechanics of human movement	20%
23	Non-conventional Machining	Non-Traditional abrasive machining processes	20%
24	Advanced IC Engines	Engine Combustion	60%
25	Surface Engineering	Fundamentals of Surface Engineering	20%
26	Wind Energy	Wind Energy Technology	90%
27	Sustainable Development	No	-
28	Entrepreneurship Development	No	-
29	Plant Maintenance	No	-
30	Engineering Economics	No	-
31	Biology for Engineers	No	-
32	Intellectual Property Rights	No	-
33	Knowledge Management	No	