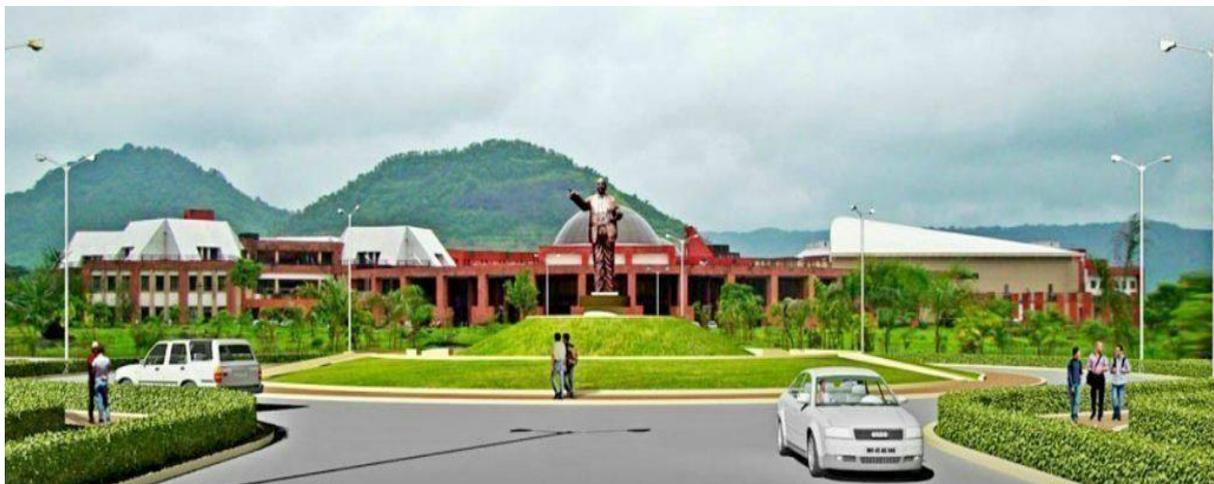


**Dr. Babasaheb Ambedkar Technological University**  
(Established as University of Technology in the State of  
Maharashtra) (Under Maharashtra Act No. XXIX of 2014)  
P.O. Lonere, Dist. Raigad, Pin 402 103,  
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**CURRICULUM**  
**UNDER GRADUATE PROGRAMME**  
**B.TECH.**

**Final Year MECHANICAL**  
**ENGINEERING/MECHANICAL**  
**ENGINEERING(SANDWICH)**  
**ACADEMIC YEAR 2024-2025**



**Abbreviations**

***BSC:*** Basic Science Course

***ESC:*** Engineering Science Course

***PCC:*** Professional Core Course

***PEC:*** Professional Elective Course

***OEC:*** Open Elective Course

***HSSMC:*** Humanities and Social Science including Management Courses

***PROJ:*** Project work, seminar and internship in industry or elsewhere

**Course Structure for Semester VII**

**B. Tech in Mechanical Engineering / B. Tech. in Mechanical Engineering (Sandwich)  
(2024-25)**

Semester VII										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
PCC15	BTMC701	Mechatronics	3	-	-	20	20	60	100	3
HSSMC4	BTHM702	Industrial Engineering and Management	3	-	-	20	20	60	100	3
PEC5	BTMPE703A-G BTPPE703D	Elective-V	3	-	-	20	20	60	100	3
OEC3	BTMOE704A-C	Open Elective-III	3	-	-	20	20	60	100	3
OEC4	BTMOE705A-C	Open Elective-IV	3	-	-	20	20	60	100	3
PCC16	BTMCL706	Mechanical Engineering Lab – V	-	-	4	60	-	40	100	2
PROJ-6	BTMP 707	Mini Project			6	30		20	50	3
PROJ-7	BTMI609	IT – 3 Evaluation	-	-	-	-	-	100	100	1
<b>Total</b>			<b>15</b>	<b>-</b>	<b>10</b>	<b>190</b>	<b>100</b>	<b>460</b>	<b>750</b>	<b>21</b>

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course

PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course

HSSMC = Humanities and Social Science including Management Courses

**Elective V:**

Sr. No	Course code	Course Name
1	BTMPE703A	Design of Air Conditioning Systems
2	BTMPE703B	Biomechanics
3	BTMPE703C	Non-conventional Machining
4	BTMPE703D	Advanced IC Engines
5	BTMPE703E	Additive Manufacturing
6	BTMPE703F	Surface Engineering
7	BTPPE/03D	Processing of Polymers
8	BTMPE/03G	Stress Analysis

**Open Elective III:**

Sr. No	Course code	Course Name
1	BTMOE704A	Sustainable Development
2	BTMOE704B	Entrepreneurship Development
3	BTMOE704C	Plant Maintenance

**Open Elective IV:**

Sr.No	Course code	Course Name
1	BTMOE705A	Engineering Economics
2	BTMOE705B	Biology for Engineers
3	BTMOE705C	Intellectual Property Rights

**Course Structure for Semester VIII**

**B. Tech in Mechanical Engineering / B. Tech. in Mechanical Engineering (Sandwich) 2024-25**

Semester VIII										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
		Choose any two subjects from ANNEXURE-A#				20	20	60	100	3
						20	20	60	100	3
PROJ-8	BTMP801/ BTMI801	Project OR Internship	-	-	16	60	-	40	100	08
<b>Total</b>			-	-	16	100	40	160	300	14

**ANNEXURE-A# (Provisional)**

**Recommendations of 8<sup>th</sup> Semester Courses in Self-study Mode from NPTEL/ SWYAM Platform,  
THE LIST MAY ALTER AND MODIFY AS PER THE AVAILABILITY OF THE SUBJECTS ON THE  
NPTEL/ SWYAM Platform AND USEFULNESS, EVERY YEAR**



**Semester - VII**

**Mechatronics**

BTMC701	PCC15	Mechatronics	3-0-0	3 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/week Tutorial: 0 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**

**[07 Hours]**

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**

**[07 Hours]**

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**

**[07 Hours]**

**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**

**[07 Hours]**

8085 microprocessor: architecture, various types of registers and their functions in 8085 $\mu$ P, 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 and its Stability**

**[07 Hours]**

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

**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. Histan, 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

**Industrial Engineering and Management**

BTHM702	HSSMC4	Industrial Engineering and Management	3-0-0	3 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/week Tutorial: 0 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 of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering
CO2	Produce ability to adopt a system approach to design, develop, implement and innovate

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	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

[07 Hours]

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

[07 Hours]

**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

[07 Hours]

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

[07 Hours]

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 and Ergonomics

[07 Hours]

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.

#### 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:

## Dr. Babasaheb Ambedkar Technological University, Lonere

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

### References:

1. J. L. Riggs, "Production Systems: Planning, Analysis and Control", John Wiley & Sons, New York, International Edition, 4<sup>th</sup> edition, 1987.
2. H. T. Amrine, J. A. Ritchey, C. L. Moodie, J. F. Kmec, "Manufacturing Organization and Management", Pearson Education, 6<sup>th</sup> edition, 2004.

International Labour Organization (ILO), "Introduction to Work Study", International Labour Office, Geneva, 3<sup>rd</sup> edition, 1987.

## Elective V

### Design of Air-Conditioning Systems

BTMPE703A	PEC5	Design of Air-Conditioning Systems	3-0-0	3 Credits
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Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/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

[07 Hours]

Moist Air properties, Psychrometry of various air condition processes, SHF, dehumidified air quantity, HVAC Equipment

#### Unit2: Human Comfort

[07 Hours]

Human comfort, environment comfort indices, clothing resistance, metabolisms, indoor air quality,

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ventilationair,insidedesignconditions, outsidedesign conditions.

### **Unit3: Heat Flow**

**[07 Hours]**

Heat Flow in Buildings, Building Heat Transfer, Cooling Load Calculation, Ventilation load, Effective sensible heat factor and selection of air conditioning apparatus.

### **Unit4: Air Diffusion**

**[07 Hours]**

Room air diffusion, filtration, duct design, pressure drop, air distribution design, outlets

### **Unit 5: Air Conditioning Systems and its equipment**

**[07 Hours]**

Air conditioning systems; constant volume, VAV, terminal reheat systems, single zone and multi zone systems, dual duct system, fan coil unit, noise control.

**Air Conditioning Equipment:** Fans, pumps and blowers, performance & selection

#### **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, 3<sup>rd</sup> 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, "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1984.
3. James L. Threlkeld, "Thermal Environmental Engineering", Prentice Hall, New York, 1970.

## **Biomechanics**

BTMPE703B	PEC 5	Biomechanics	3-0-0	3 Credits
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<b>Teaching Scheme:</b> Lecture: 3 hrs/week	<b>Examination Scheme:</b> Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)
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**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**

**[07 Hours]**

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**

**[07 Hours]**

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**

**[07 Hours]**

Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, cardiovascular and respiratory system.

**Unit 4: Hard Tissues**

**[07 Hours]**

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

**Unit 5: Soft Tissues and Biomechanics of Implant**

**[07 Hours]**

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

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

**Texts/References:**

- Y. C. Fung, “Biomechanics: Mechanical properties of living tissues”, Springer-Verlag, 2<sup>nd</sup> edition, 1993.
- D. J. Schneck, J. D. Bronzino, “Biomechanics: Principle and Applications”, CRC Press, 2<sup>nd</sup> edition, 2000.

**Non-conventional Machining**

BTMPE703C	PEC5	Non-conventional Machining	3-0-0	3Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks

**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 [07 Hours]**

An overview, Trends in manufacturing, Classification of Non-Conventional Machining processes.

**Unit 2: Chemical and Electrochemical Processes [07 Hours]**

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

**Unit 3: Thermo-Electrical Processes [07 Hours]**

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 [07 Hours]**

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 and Hybrid Processes [07 Hours]**

Types of lasers, Laser beam generation, Equipment and machining procedure, Process characteristics, Process parameters, Advantages and limitations of LBM, Applications.

**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.

**Advanced IC Engines**

BTMPE703D	PEC 5	Advanced IC Engines	3-0-0	3 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/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**

**[07 Hours]**

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**

**[07 Hours]**

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**

**[07 Hours]**

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 and Multi-fuel Engines**

**[07 Hours]**

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

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

**Unit 5: Recent Trends/Developments**

**[07 Hours]**

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

**Unit 6: Multi-fuel Engines**

**Texts:**

1. V. Ganesan, "Internal Combustion Engines", TMH, 2<sup>nd</sup> edition, 2002.
2. R. B. Mathur, R. P. Sharma, "Internal Combustion Engines", Dhanpat Rai & 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.

**Additive Manufacturing**

BTMPE703E	PEC5	Additive Manufacturing	3-0-0	3Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/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 importance of Additive Manufacturing
CO2	Classify the different AM processes
CO3	Design for AM processes
CO4	Understand the applications of AM
CO5	Differentiate the post processing 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	3	3	2	2	2	2	2					1
CO2	2	2	3	3	3	3	1					1
CO3	2	2	3	3	3		2					1
CO4	3	3	3	2	2	2	2					1
CO5	2	3	3	2	2	2	2					1

**Course Contents:**

**Unit 1: Introduction to Additive Manufacturing (AM)**

**[07 Hours]**

Introduction to AM, AM evolution, Distinction between AM and CNC machining, Advantages of AM.

**AM process chain:** Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build, removal and clean up, post processing.

**Classification of AM processes:** Liquid polymer system, discrete particle system, molten material systems, and solid sheet system.

**Unit 2: Design for AM**

**[07 Hours]**

Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/numbers etc.

**Unit 3: Guidelines for Process Selection**

**[07 Hours]**

Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control

**Unit 4: AM Applications**

**[07 Hours]**

Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries

**Unit 5: Post Processing of AM Parts and Future Directions of AM**

**[07 Hours]**

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

**Future Directions of AM**

Introduction, new types of products, employment and digipreneurship.

**Texts:**

1. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles and Applications", World Scientific, 2003.
2. Ian Gibson, David W. Rosen, Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2<sup>nd</sup> edition, 2010.

**References:**

1. Ali K. Kamrani, EmandAbouel Nasr, "Rapid Prototyping: Theory and Practice", Springer, 2006.
2. D. T. Pham, S. S. Dimov, "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling", Springer, 2001.
3. Andreas Gebhardt, "Understanding Additive Manufacturing", Hanser Publishers, 2011.

## Surface Engineering

BTMPE703F	PEC5	Surface Engineering	3-0-0	3Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/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	Learn the importance and need of surface engineering
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**

**[07 Hours]**

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**

**[07 Hours]**

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**

**[07 Hours]**

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**

**[07 Hours]**

Classification, Thermal treatments: Laser and electron beam hardening, Mechanical treatments: Shot 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 and Characterization of Coatings [07 Hours]**

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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.

### **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.
- ASM Handbook, "Volume 16: Machining", ASM International.

## **Processing of Polymers**

BTPPE703D	PEC5	Processing of Polymers	3-0-0	3Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

### **Unit 1: Basic Concept:**

**[07 Hours]**

Plastic Additives and Compounding: Various additives and their purpose (e.g. antioxidants, plasticizers, antistatic agents, blowing agents etc.), Principle of mixing and mixers, types.

### **Extrusion**

Basic operation and analysis, solids conveying, drag induced conveying, melting mechanism, power consumption in metering zone. Overall extruder performance. Design of extrusion screws, modeling of extrusion process and computer simulation. Overall working of single screw and twin screw extruders.

### **Unit 2: Polymer Devolatilization**

**[07 Hours]**

Basic analysis of the process, functional design considerations, screw geometry and design. Devolatilization in single screw and twin screw extruders and their design.

### **Extruded products**

Such as films, pipes, profiles, coating, foamed products, design of sizing systems, haul off Systems, cooling and / or chilling units, winders, auxiliary equipment's used, measurement and Control of parameters. Types of dies used for the production of extruded products. Analysis of the flow through the dies. Manufacture of flat films, co extruded films, oriented films, drawing and stretching units.

### **Unit 3: Reactive extrusion and resident time distribution (RTD)**

**[07 Hours]**

Process details, basic principles, equipment used, effective residence time and residence time Distribution (RTD), point measurements: characterization of melting and mixing time with the RTD, applications.

### **Extrusion blow molding**

Types of blow molding techniques, flow analysis in the die, wall thickness control, parison swell, parison sag. Continuous and intermittent blow molding CAE of blow molding operation.

**Unit 4: Thermoforming**

[07 Hours]

Types, various techniques, materials, heat transfer analysis of the process, effect of plugs on article Thickness, continuous heating of a thin moving sheet.CAE in thermoforming.

**Unit 5: Injection molding**

[07 Hours]

Role of rheology in injection molding, melt flow in feed system, flow in mould cavity, mould Filling.Control of politicizing and injection process.

**Reaction injection molding**

Overall molding cycle, metering system for components, mixing head design, mould construction,Materials used and their applications.

Other Processing techniques: Calendering and milling, compression and transfer molding, casting,rotational molding, fabrication, decoration of polymers.

**References:**

1. Handbook of Plastics Test Method, R.B. Brown, George Godwin Limited, 1981.
2. Handbook of Plastic Testing Technology, Brown and Vishnu Shah, A. Wiley, Inter science Publication, 2007
- ME (Polymer Engineering) Syllabus Page 26
3. Handbook of Plastics Test Methods, G.V. Eves, J.A. Mead, M.M. Riky.
4. Volume 8 of ASTM Standards, BIS Standards.
5. Polymer Extrusion, Chris Rauwendal SPE, Hanser Publishers.
6. Polymer Missing and Extrusion Technology – Nich olas Cheremisinoff, Marcel Dekker 1987
7. Modeling Of Polymer Processing, Isayav, Hanser Publishers, 1991.
8. Plastics Waste Management, Mustafa.
9. Plastics Extrusion Technology – Hanser SPE, 199 6
10. Thermoforming – J.L. Throne, Hanser Publishers 1987
11. Blow Molding Handbook – Rosato, Hanser Publish ers 1987
12. Mixing and Compounding of Polymers: Theory and Practice, Ica Manas-Zloczower, Hanser Verlag, 2009.
13. Extrusion of Polymers: Theory and Practice, Chan I. Chung, Hanser Verlag, 01-Apr-2000
14. Rotational Molding of Plastics – R. J. Crawford, Research Studies Press Ltd.
15. Engineering with Polymers - Powell.

**Stress Analysis**

<b>BTMPE703G</b>	<b>PEC5</b>	<b>Stress Analysis</b>	<b>3-0-0</b>	<b>3 Credits</b>
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<b>Teaching Scheme:</b>	<b>Evaluation Scheme:</b>
Lecture: 3 hrs/ week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hours)

**Pre-Requisites:** Strength of Materials, Machine Design-I

**Course Outcome:** At the end of course, student will be able to:

CO1	Explain the concept of stress, strain & their relationships & will also be able to choose suitable coordinate system for problems of stress analysis.
CO2	Explain the concept of Plane stress, plane strain, Stress & Strain at a point & will be able to derive the differential equation of equilibrium, Compatibility equation.
CO3	Apply the concept of stress function to solve the stress analysis problems involving simple

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	components in Cartesian & Polar coordinate systems.
CO4	Explain basic principles of optics, describe polariscope & explain the effect of stressed model on behaviour of light vector in polariscope, compensation technique, separation techniques & Stress Freezing in photoelasticity
CO5	Describe various types of strain gage. Will be also able to describe & apply the theory of Wheatstone bridge for strain measurement using strain gages & to explain the technique for measurement of strain & stresses in rotary components.
CO6	Describe other techniques like Grid technique & Brittle coating method

### 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
CO2	2	2										1
CO3	2	3	3	2								1
CO4	2	1										1
CO5	1	2	1	1								1
CO6	1	2										1

#### Course Contents:

#### UNIT 1: Two dimensional problems in Cartesian coordinate System [7 Hours]

Fundamentals of stress & strain, Stress & strain components, stress-strain relationship, Elastic constant, Plane stress, Plane strain, differential equation of equilibrium, Saint Venant's principle, Compatibility condition, Compatibility equations for plane stress and plane strain conditions, Airys stress function.

#### UNIT 2: Two dimensional problems in Polar coordinate System [7 Hours]

General equations of equilibrium in polar coordinate, compatibility equation, relationship between stress components in polar and rectangular coordinate system, stress distribution about symmetric axis.

#### UNIT 3: Applications of theory of elasticity [7 Hours]

Stress analysis of cantilever subjected to end point load, Stress analysis of simply supported beam subjected to UDL, Stress analysis of cylinder subjected to internal & external pressure, Pure bending of curved beams.

#### UNIT 4: Photoelasticity [7 Hours]

Two-Dimensional Photo elasticity – Introduction to basic optics related to photo elasticity, stress-optic law, plane & circular polariscope arrangements, effect of stressed model in plane & circular polariscope, Isoclinic & Isochromatic, calibration of photo elastic material (determination of fringe constant using circular disk), photo elastic materials & their properties. Casting & preparation of photo elastic models, Tardy's compensation technique. Separation techniques like, shear difference, oblique incidence & electrical analogy.

Introduction to 3 – D photo elasticity - Phenomenon of Stress freezing, Stress freezing cycle, Introduction to Reflection polariscope, fringe sharpening & fringe multiplication.

#### UNIT 5: Strain Gages [7 Hours]

Strain gage technique for stress & strain analysis – Introduction to electrical resistant strain gage, gage factor,

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Wheatstone bridge circuit, bridge balance, output voltage of Wheatstone bridge, various bridge configurations, determination of principle strains & stresses using strain rosettes. Introduction to Strain measurement on rotating components.

Grid technique of strain analysis, Brittle coating method for stress & strain analysis.

### Text Books:

1. Theory of Elasticity, S.P. Timoshenko, Mc-Graw Hill.
2. Experimental Stress Analysis, Daily & Riley, Mc-Graw Hill.

### Reference Books:

1. Experimental Stress Analysis, L.S. Srinath, TMH.
2. Experimental Stress Analysis, T.K. Ray, S. Chand publications.
3. Theory of Elasticity, Sadhu Singh, Khanna publishers.
4. Experimental Stress Analysis, U.C. Jindal, Pearson publications.
5. Experimental Stress Analysis, Sadhu Singh. Khanna publishers.
6. Experimental Stress Analysis, Adel Mubeen, Dhanpat Rai & Sons.

## Open Elective-III

### Sustainable Development

BTMOE704A	OEC3	Sustainable Development	3-0-0	3 Credits
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Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/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 the difference between development and sustainable development
CO2	Explain challenges of sustainable development and climate change
CO3	Explain sustainable development indicators
CO4	Analyze sustainable energy options
CO5	Understand social and economic aspects of sustainable development

### 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	2	3		2	3	3	3	2	2		2
CO2	1	1	3	1	2	3	3	3	2	2		2
CO3	2	1	1				3	2		1		2
CO4	3	3			2	3	3	2				1

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CO5			3			2	3	2				1
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### Course Contents:

#### Unit 1: Introduction

[07 Hours]

Status of environment, Environmental, Social and Economic issues, Need for sustainability, nine ways to achieve sustainability, population, resources, development and environment.

#### Unit 2: Global Warming and Climate Change

[07 Hours]

Global Warming and climate Change since industrial revolution, Greenhouse gas emission, greenhouse effect, Renewable energy, etc.

#### Unit 3: Challenges of Sustainable Development and Global Environmental Issues [07 Hours]

Concept of sustainability, Factors governing sustainable development, Linkages among sustainable development, Environment and poverty, Determinants of sustainable development, Case studies on sustainable development, Population, income and urbanization Health care, Food, fisheries and agriculture , Materials and energy flows.

#### Unit 4: Sustainable Development Indicators and Environmental Assessment [07 Hours]

Need for indicators, Statistical procedures Aggregating indicators, Use of principal component analysis, Three environmental quality indices.

##### Environmental Assessment

National environmental policy act of 1969, Environmental Impact Assessment, Project categories based on environmental impacts, Impact identification methods, Environmental impact assessment process.

#### Unit 5: Environmental Management and Social Dimensions

[07Hours]

Revisiting complex issues, Sector policies concerning the environment, Institutional framework for environmental management, Achievements in environmental management, People's perception of the environment, Participatory development, NGOs, Gender and development, Indigenous peoples, Social exclusion and analysis.

#### Texts:

1. J. Sayer, B. Campbell, "The Science of Sustainable Development: Local Livelihoods and the Global Environment", Biological Conservation, Restoration and Sustainability, Cambridge University Press, London, 2003.
2. J. Kirkby, P. O'Keefe, Timberlake, "Sustainable Development", Earth scan Publication, London, 1993.
3. Peter P. Rogers, Kazi F. Jalal, John A. Boyd, "An introduction to sustainable development", Glen Educational Foundation, 2008.

#### References:

1. Jennifer A. Elliott, "An introduction to sustainable development". London: Routledge: Taylor and Francis group, 2001.
2. Low, N. "Global ethics and environment", London, Rout ledge, 1999.
3. Douglas Muschett, "Principles of Sustainable Development", St. Lucie Press, 1997.

### Entrepreneurship Development

BTMOE704B	OEC 4	Entrepreneurship Development	3-0-0	3 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
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Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)
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**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**

**[07 Hours]**

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)**

**[07 Hours]**

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**

**[07 Hours]**

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**

**[07 Hours]**

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**

**[07 Hours]**

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

**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**

BTMOE704C	OEC3	Plant Maintenance	3-0-0	3Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

**Objectives:** To exemplify different types of plants and its function and analyse the principles used in plants maintenance. To understand various basic aspects related to running of industry the safety methods in plants. This course provides problems based techniques related with location, layout, maintenance, replacement of machines, etc.

**Pre-Requisites:** None

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

CO1	Recognize and enlist probable failures in mechanical elements.
CO2	Dismantle, assemble and align mechanisms in sequential order for given assembly.
CO3	Compare maintenance practices like on-line, shut down, corrosion, productive and preventive maintenance.
CO4	Analyze economics of plants and list factors affecting the maintenance of a plant.
CO5	Correlate the linkages between different maintenance aspects and how they impact on overall maintenance effectiveness.
CO6	Analyze different maintenance techniques and select an appropriate technique for a particular plant.

**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	2	1	1	2			2
CO2	2			1	1	2	2					2

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CO3	2	2	1	1	1		1	1	1			
CO4	1	1		2	1	2	1		2		1	2
CO5	2	2			1	2	2				1	2
CO6	1					1					1	1

### Course Contents:

#### Unit 1: Introduction

Introduction to concept of maintenance, Type of maintenance; Preventive, Productive, corrective, online, shut down and their significance.

#### Unit 2: Preventive Maintenance

Preventive maintenance and its importance, Repair cycle, systematic recording, preventive maintenance, Programming and types of schedules, Manpower and machine planning, Lubrication methods and practice, Color code schedule.

#### Unit 3: Online Maintenance and Shut down Maintenance

On-line maintenance, attending to joints, Valves, Pumps and other equipment's leakages, Making shaft arrangement, stand-by unit, repairing damage to insulation, etc. without stopping the plant, attending faulty equipment, Fault finding and troubleshoots.

#### Shut down Maintenance

Shut down maintenance, Economic aspects of timing, duration of Timing and duration of shut down maintenance, Execution by using PERT and CPM.

#### Unit 5: Maintenance of Mechanical Equipment

Maintenance of major equipment like boiler, furnaces, kilns, shells and tube heat exchangers, pump and compressor, Towers, Cooling vessels, Valves piping.

#### Unit 6: Plant Condition Monitoring

Plant condition monitoring systems, instrumentation, Data collection and analysis, life expectancy and maintenance scheduling. The economics of maintenance management.

### Text:

- Lindley R. Hinggin, L.C. Morrow, "Maintenance Engineering Handbook", Tata McGraw Hill Book Company.

### References:

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

## Open Elective-IV Engineering Economics

BTMOE705A	OEC4	Engineering Economics	3-0-0	3 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/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	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**

**[07 Hours]**

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**

**[07 Hours]**

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**

**[07 Hours]**

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**

**[07 Hours]**

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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 and Evaluation of Public Alternatives [07 Hours]

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-

#### 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

### Biology for Engineers

BTMOE705B	OEC 4	Biology for Engineers	3-0-0	3 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/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 origin of life and Evolution, Cells, Biomolecules-Lipids
CO2	Understand Biomolecules
CO3	Understand Cell structure and function and cell cycle
CO4	Explain Mendelian genetics
CO5	Understand and Explain DNA structure, DNA replication, Transcription, Translation

#### 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	2	3		1		1			1		1
CO2	1	2	3		1		1			1		1
CO3	1	2	3		1		1			1		1
CO4	1	2	3		1		1			1		1
CO5	1	2	3		1		1			1		1

**Course Contents:**

**Unit 1: Introduction**

[07 Hours]

Origin of life and Evolution, Cells, Biomolecules-Lipids

**Unit 2: Biomolecules**

[07 Hours]

Carbohydrates, water, Amino acids and proteins, Enzymes, Nucleotides

**Unit 3: Cell structure**

[07 Hours]

Cell structure and function, Prokaryotes, Eukaryotes

**Unit 4: Cell cycle**

[07 Hours]

Cell division, mitosis, meiosis, culture growth,

**Unit 5: Genetics and DNA**

[07 Hours]

Mendelian genetics, genetic disorders, Mendelian inheritance principle, pedigree analysis, Non- Mendelian inheritance  
**DNA**

Chromatin, DNA structure, DNA replication, Transcription, Translation.

**Texts:**

1. Arthur T. Johnson, "Biology for Engineers", CRC Press.

**References:**

1. N. A. Campbell, J. B. Reece, "Biology", International edition, Benjamin Cummings, New York, 7<sup>th</sup> edition or later, 2007 or later.
2. G. Karp, "Cell and Molecular Biology: Concepts and Experiments", Wiley, New York, 7<sup>th</sup> edition, 2013.

**Intellectual Property Rights**

BTMOE705C	OEC4	Intellectual Property Rights	3-0-0	3 Credits
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Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/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 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**

**[07 Hours]**

Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

**Unit 2: Trade Marks**

**[07 Hours]**

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**

**[07 Hours]**

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 and Trade Secrets**

**[07 Hours]**

Foundation of patent law, patent searching process, ownership rights and transfer.

**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 5: New Development of Intellectual Property**

**[07 Hours]**

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. Prabuddha Ganguli, “Intellectual property right: Unleashing the knowledge economy”, Tata McGraw Hill Publishing Company Ltd.

**References:**

1. Ajit Parulekar, 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.

**Mechanical Engineering Lab –V**

BTMCL706	PCC16		0-0-4	2 Credit
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<b>Practical Scheme:</b>	<b>Examination Scheme:</b>
Practical: 4 hrs/batch	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

**Group A (Mechatronics Lab)**

**List of Practical's/Experiments/Assignments (Any SIX)**

1. Study and demonstration of various types of sensors
2. Speed control of various types of Electrical Motors
3. Minimum two circuits on Pneumatic to be developed on Pneumatic trainer kit
4. Minimum two circuits on Electro-Pneumatics to be developed on Electro- Pneumatic trainer kit
5. Minimum two circuits on Hydraulics and Electro-hydraulics to be developed on Hydraulic trainer kit
6. Programming of Microprocessor and Microcontroller
7. Programming on PLC
8. Demonstration of Process control such as temperature, level, flow, etc. control using PID controller

**Group B**

**Perform any THREE Practical's/ Assignments on Elective – V**

**SEMESTER VII  
Mini Project**

BTMP707	Mini Project	PROJ-6	0L-0T-6P	3 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Practical: 6 hrs/week	Continuous Assessment: 30 Marks Mid Semester Exam: -- End Semester Exam: 20 Marks

**IT – 3**

BTMI608 (IT – 3)	IT – 3 Evaluation	PROJ-7	0L-0T-0P	1 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Practical: -- hrs/week	Continuous Assessment: -- Mid Semester Exam: -- End Semester Exam: 100 Marks

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### SEMESTER VIII Project /Internship

BTMP801/ BTMI801	Project / Internship	PROJ-8	0L-0T-16P	8 Credits
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Teaching Scheme:	Examination Scheme:
Practical: 16 hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks

- BTMP707 Mini Project and BTMP801/ BTMI801 Project /Internship are independent and allotment will also be done independently in respective semester.
- BTMP707 Mini Project will be done in-house only.
- Evaluation of both will be done independently as per the time schedule in AC.
- In case student(s) choose in-house project, it may be an extension of the Mini Project, however, Mini Project should be completed in all respect in semester VII itself.