

Dr. Babasaheb Ambedkar Technological University

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

(Under Maharashtra Act No. XXIX of 2014)

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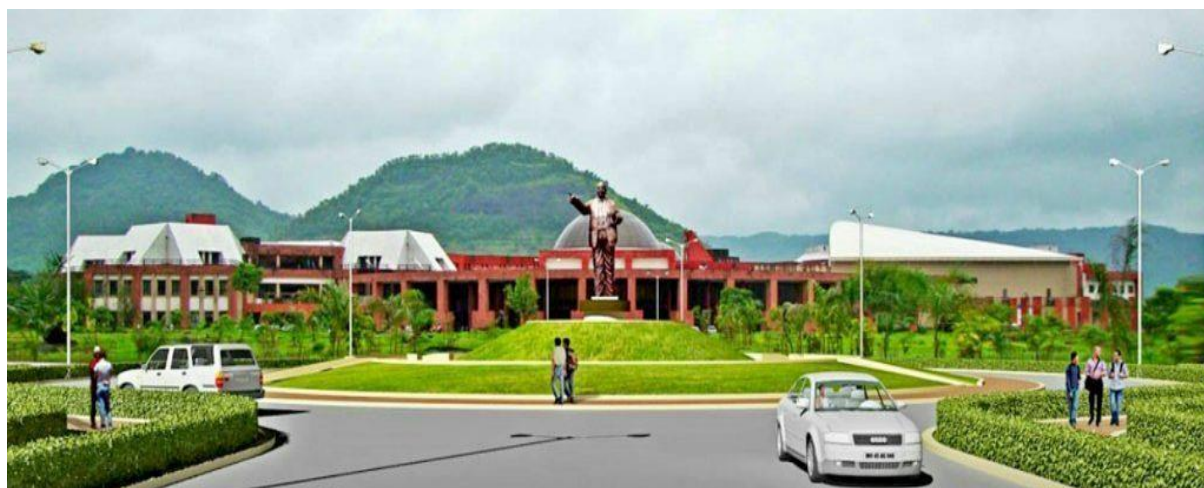
CURRICULUM

UNDER GRADUATE PROGRAMME

B. TECH.

Final year MECHATRONICS ENGINEERING

ACADEMIC YEAR (AFFILIATED INSTITUTES)
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 Mechatronics (w.e.f. 2024-25)

Semester VII										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MS E	ES E	Total	
PCC21	BTMXC 701	Robotics	3	1	-	20	20	60	100	4
PCC22	BTMXC 702	Digital Signal Processing	3	1	-	20	20	60	100	4
PEC5	BTMXPE 703 A, B and BTMPE703C, E	Elective-V	3	-	-	20	20	60	100	3
OEC3	BTMXOE704A-C	Open Elective-III	3	-	-	20	20	60	100	3
OEC4	BTMXOE705A-C	Open Elective-IV	3	-	-	20	20	60	100	3
PCC23	BTMX L706	Robotics Lab	-	-	2	60	-	40	100	1
PCC24	BTMX L707	Computer Aided Manufacturing Lab			2	60		40	100	1
PROJ 7	BTMXP 708	Mini-project 2			6	60		40	100	3
PROJ-6	BTMXI610	IT – 3 Evaluation	-	-	-	-	-	100	100	1
Total			15	2	10	280	100	520	900	23

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	BTMXPE 703A	Digital Image Processing
2	BTMXPE 703B	Modelling and Control of Mechatronic Systems
3	BTMPE703C	Non-conventional Machining
4	BTMPE703E	Additive Manufacturing

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 Mechatronics (w.e.f. 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	4
						20	20	60	100	4
PROJ-8	BTMXP801/ BTMXI801	Project Work OR Internship	-	-	16	60	-	40	100	8
Total			-	-	16	100	40	160	300	16

Six months of Internship in the industry

These subjects are to be studied on self –study mode using SWAYAM/NPTEL/Any other source

Student doing project in Industry will give NPTEL Examination/Examination conducted by the University i.e. CA/MSE/ESE

Students doing project in the Institute will have to appear for CA/MSE/ESE

Semester VII

Robotics

BTMXC 701	PCC21	Robotics	3-1-0	Credits 4
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Teaching Scheme:	Examination Scheme:
Lecture: 3 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 terminologies related to robotics
CO2	Identify gripper, sensor and actuator of a robot
CO3	Apply mathematics for manipulator positioning and motion planning
CO4	Analyse robot mechanism using kinematics
CO5	Acquainted with various applications and futuristic robotic technology

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction to robotics

[11 Hours]

Brief History, Definition, Robot Anatomy, Three laws, Classification of robots, Robot terminologies: work volume, Degree of Freedom, resolution, accuracy, repeatability, dexterity, compliance, payload capacity, speed of response etc., Wrist assembly, Joint notations, Selection criteria of any robot, Industrial applications of robot, Futuristic robotics.

Unit 2: Robot drive systems, End effectors and Automation

[11 Hours]

Types of drives – Hydraulic, Pneumatic and Electric, Comparison of all such drives, DC servo motors, Stepper motors, AC servo motor – salient features and applications, pulse count calculations

Unit 3: Robot sensors and Machine Vision

[10 Hours]

Need for sensors, types of sensors used in Robotics, classification and applications of sensors, Characteristics of sensing devices, Selections of sensors, Robot Vision setup (RVS), block diagram, components, working of RVS, Human vision Vs Robot Vision, Gradient calculations, Applications of RVS

Unit 4: Mathematical Preliminaries of Robotics

[10 Hours]

Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, Homogeneous transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters.

Unit 5: Robot Kinematics

[10 Hours]

Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Forward Kinematics, Inverse Kinematics,

Text Books/References:

1. S. K. Saha, Introduction to Robotics , TATA McGraw Hills Education (2014)
2. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
3. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)
4. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
5. AsitavaGhoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
6. J. Angeles, Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms, Springer (1997)
7. Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, AshishDutta, Industrial Robotics 2nd edition, SIE, McGraw Hill Education (India) Pvt Ltd (2012)
8. R. D. Klafter, Thomas A. Chmielewski, and MechaelNegin, Robotic Engineering An Integrated Approach, EEE, Prentice Hall India, Pearson Education Inc. (2009)

Digital Signal Processing

BTMXC 702	PCC22	Digital Signal Processing	3-1-0	Credits 4
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Teaching Scheme:	Examination Scheme:
Lecture: 3 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 concepts and properties of discrete time signals and system.
CO2	Analyse discrete-time systems using z-transform
CO3	Understand the frequency domain characteristics of discrete time signals and systems.
CO4	Design and implement digital filter design techniques.
CO5	Apply digital signal processing for the analysis of real-life signals.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Basics of Digital Signal Processing

[10 Hours]

Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling, and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

Unit 2: Z transforms

[10 Hours]

z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

Unit 3: Introduction to Discrete Fourier Transform

[11 Hours]

Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT,

Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Unit 4: Design of Digital Filters

[11 Hours]

Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Bandpass, Band-stop and High-pass filters. Introduction to Multi-rate Signal Processing.

Unit 5: Applications of Digital Signal Processing

[10 Hours]

Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text Books/References:

1. S.K. Mitra, Digital Signal Processing: A computer based approach. TMH
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, 1997.
4. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.
5. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
6. D.J. DeFatta, J. G. Lucas and W.S. Hodgkiss, Digital Signal Processing, John Wiley & Sons, 1988.

Digital Image Processing

BTMXPE 703A	PEC5	Digital Image Processing	3-0-0	Credits 3
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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	Understand the basic concepts digital image fundamentals.
CO2	To study the image compression procedures
CO3	Understand the frequency domain characteristics of discrete time signals and systems.
CO4	To study the image segmentation procedures
CO5	To study the Video coding and Segmentation procedures

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Digital Image Fundamentals

[8 Hours]

Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels– neighborhood, adjacency, connectivity, distance measures.

Unit 2: Enhancements and Filtering

[8Hours]

Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.

Unit 3: Color Image Processing-Color models–RGB, YUV, HIS

[8 Hours]

Color transformations– formulation, color complements, and color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation, Image Segmentation- Detection of discontinuities, edge linking and boundary detection, thresholding – global and adaptive, region-based segmentation

Unit 4: Wavelets and Multi-resolution image processing

[7 Hours]

Uncertainty principles of Fourier Transform, Time-frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub band filter banks, wavelet packets.,Image Compression-Redundancy inter-pixel and psycho-visual; Lossless compression – Predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000.

Unit 5: Fundamentals of Video Coding

[8Hours]

Inter-frame redundancy, motion estimation techniques – full search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X.

Text Books/References:

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education 3rd edition 2008
2. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India. 2nd edition 2004
3. Murat Tekalp, Digital Video Processing" Prentice Hall, 2nd edition 2015

Modelling and Control of Mechatronic Systems

BTMXPE 703B	PEC5	Modelling and Control of Mechatronic Systems	3-0-0	Credits 3
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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	Understand the fundamentals of modelling of mechatronic systems
CO2	Understand the laws system model formulation
CO3	Understand the rigid body dynamics and Lagrange's equations
CO4	Understand the role of control in mechatronic systems and control modes.
CO5	Understand the fundamentals of controllers in mechatronic systems

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction, [8 Hours]
mechanical system, modeling in mechatronic system, basic mechanical model components – defining mechanical input and output model elements, dissipative effects in mechanical systems, potential and kinetic energy storage elements, coupling mechanisms, impedance relationships.

Unit 2: Physical laws for model formulation [8 Hours]
kinematic and dynamic laws, energy methods for mechanical, system model formulation – multiport models

Unit 3: Rigid body multidimensional dynamics

[7Hours]

kinematics of a rigid body, dynamic properties of a rigid, body, rigid body dynamics, Lagrange's equations.

Unit 4: Role of control in mechatronic systems

[7Hours]

Time response properties of dynamical systems, Obtaining errors equations, Poles and zeros concept and representation, Step and impulse response of standard first order and second order systems, time-domain specifications and their formulae.

Unit 5: Control system

[8 Hours]

Properties of feedback, Basic idea of feedback control systems, Error analysis, Proportional controller (P), Proportional-Integral controller (PI), Proportional Derivative controller (PD), PID controller, Implementation of the electronics PID, Digital controller, Methods to tune the controllers.

Text Books / Reference Books:

1. Robert H. Bishop, Mechatronics Handbook, second edition, CRC Press, 2008
2. William Bolton, Mechatronics - Electronic control systems in Mechanical and Electrical Engineering, Third edition, Pearson Education Ltd, 2003

Non-conventional Machining

BTMPE703C	PEC5	Non-conventional Machining	3-0-0	Credits 3
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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: 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

[8 Hours]

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

Unit 2: Chemical and Electrochemical Processes

[8 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

[8 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.

4: Mechanical Processes

[7Hours]

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

[8 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.

Additive Manufacturing

BTMPE703E	PEC5	Additive Manufacturing	3-0-0	Credits 3
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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	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												
CO5												

Course Contents:

Unit 1: Introduction to Additive Manufacturing (AM) [8 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 [8 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 [7 Hours]

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

Unit 4: AM Applications

[8 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

[8 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 digiproneurship.

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, 2nd 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.

Sustainable Development

BTMOE704A	OEC3	Sustainable Development	3-0-0	Credits 3
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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
CO5			3			2	3	2				1

Course Contents:

Unit 1: Introduction

[8 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

[7 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 [8 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 [8 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 [8 Hours]

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 3	Entrepreneurship Development	3-0-0	Credits 3
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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	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

[8 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)

[8 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

[7 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

[8 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

[8 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	Credits 3
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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)

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
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 [8 Hours]

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

Unit 2: Preventive Maintenance [8 Hours]

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 [8 Hours]

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 [8 Hours]

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

Unit 4: Maintenance of Mechanical Equipment [8 Hours]

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

Unit 5: Plant Condition Monitoring [7 Hours]

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

Text:

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

References:

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

Engineering Economics

BTMOE705A	OEC4	Engineering Economics	3-0-0	Credits 3
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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	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

[7 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

[8 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

[8 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

[8 Hours]

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

[8 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	Credits 3
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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 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 **[7 Hours]**

Origin of life and Evolution, Cells, Biomolecules-Lipids

Unit 2: Biomolecules **[8 Hours]**

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

Unit 3: Cell structure **[8 Hours]**

Cell structure and function, Prokaryotes, Eukaryotes

Unit 4: Cell cycle **[8 Hours]**

Cell division, mitosis, meiosis, culture growth,

Unit 5: Genetics and DNA **[8 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, 7th edition or later, 2007 or later.
2. G. Karp, “Cell and Molecular Biology: Concepts and Experiments”, Wiley, New York, 7th edition, 2013.

Intellectual Property Rights

BTMOE705C	OEC4	Intellectual Property Rights	3-0-0	Credits 3
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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

[8 Hours]

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

Unit 2: Trade Marks

[8 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

[8 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

[8 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

[7 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.

Robotics Lab

BTMX L706	PCC23	Robotics Lab	0-0-2	Credits 1
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Practical Scheme:	Examination Scheme:
Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

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												
CO6												

List of Practical's /Tutorials:

1. Study of components of real robot and its performance
2. Basics of 3D modeling software
3. Modeling of Robot Joints
4. Assembly of 2DOF/3DOF Robot Manipulator
5. Use of drives for robotic joints and its simulation
6. Rob analyzer: A learning software of robotics study
7. Understanding coordinate frames and transformation
8. Formulation of DH parameters of robot configuration
9. Simulation using open-source software of robot kinematics using DH Parameters
10. Forward kinematic analysis of a robot
11. Inverse kinematic analysis of a robot
12. Introduction of MATLAB/SCILAB and Robotic Toolkit introduction.

Computer Aided Manufacturing Lab

BTMX L707	PCC23	Computer Aided Manufacturing Lab	0-0-2	Credits 1
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Practical Scheme:	Examination Scheme:
Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

Pre-Requisites: None

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

CO1	Explain the manual CNC part programming for milling and turning machines.
CO2	Create part programs using CAM packages for milling and turning Machines.
CO3	Appraise dimensional and geometric measurements of machined features using video measuring system and coordinate measuring machine.
CO4	Construct PLC ladder programming and robot programming.
CO5	The concept of printing parts using additive manufacturing
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												

LIST OF EXPERIMENTS:

1. Programming and simulation for various operations using canned cycle for CNC turning Centre.
2. Programming and simulation for machining of internal surfaces in CNC turning Centre
3. Programming and simulation for profile milling operations
4. Programming and simulation for circular and rectangular pocket milling
5. Programming and simulation using canned cycle for CNC Milling such as peck drilling and tapping cycle
6. CNC code generation using CAM software packages – Milling
7. CNC code generation using CAM software packages – Turning
8. Dimensional and geometric measurement of machined features using VMS and CMM
9. PLC ladder logic programming.
10. Robot programming for Material handling applications.
11. Design and fabrication of a component using extrusion based additive manufacturing.

Mini-Project II

BTMXP 708	PROJ 7	Mini-project 2	-	Credits 3
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Practical Scheme:	Examination Scheme:
Practical: -	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

- BTMXP708 Mini Project and BTMP801/ BTMI801 Project /Internship are independent and allotment will also be done independently in respective semester.
- BTMXP708 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.

Industrial Training -III Evaluation

BTMXI610	PROJ 6	IT – 3 Evaluation	-	Credits 1
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Examination Scheme:

End Semester Exam: 100 Marks

Project

BTMXP801/ BTMXP801	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

- BTMXP708 Mini Project and BTMP801/ BTMI801 Project /Internship are independent and allotment will also be done independently in respective semester.
- BTMXP708 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.