Dr. Babasaheb Ambedkar Technological University, Lonere

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

Maharashtra Act No. XXIX of 2014)

P.O. Lonere, Dist. Raigad, Pin 402 103, MaharashtraTelephone and Fax.: 02140 - 75142

www.dbatu.ac.in

Curriculum for Undergraduate Degree Programme

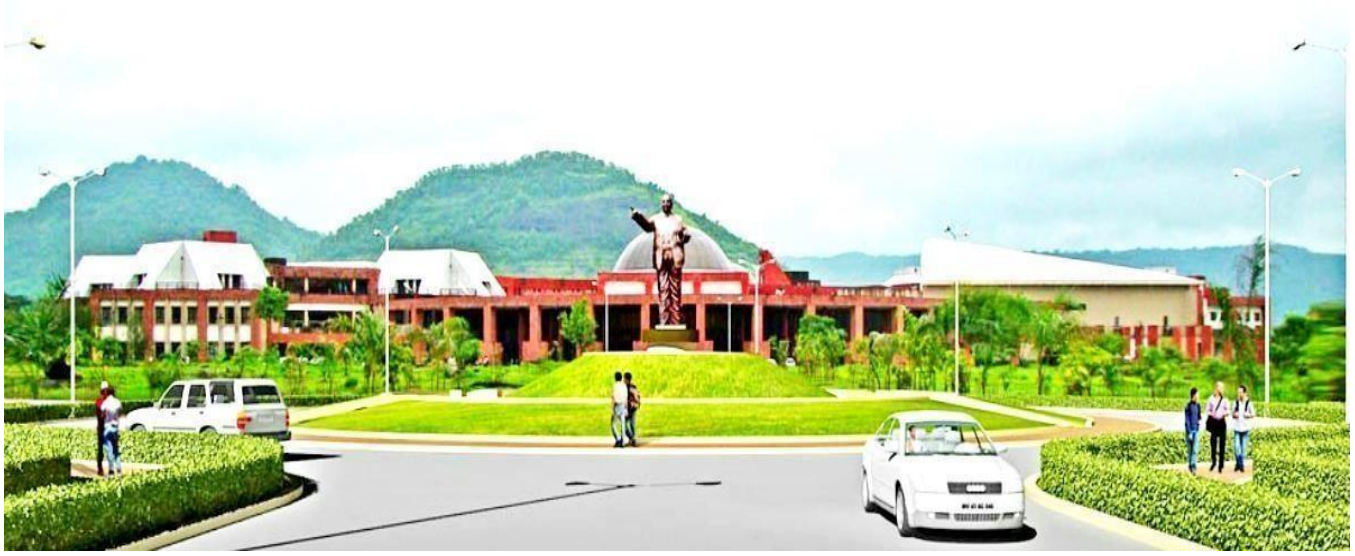
B. Tech in Automation & Robotics

and

B. Tech in Robotics

(Third Year) AY 2024-25

(Affiliated Institutes)



Dr. Babasaheb Ambedkar Technological University, Lonere

Course Structure for Semester V

B. Tech in Automation & Robotics and B. Tech in Robotics (2023-24)

Semester V									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**No. of Credits**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 10	BTMXC 501	Metrology and Measurements	3	1	-	20	20	60	100	4
PCC 11	BTMXC502	Manufacturing Technologies	3	1	-	20	20	60	100	4
PCC 12	BTARC503	Hydraulics, Pneumatics and Industrial Automation	3	1	-	20	20	60	100	4
PEC 2	BTARPE504 (A/B)/ BTMXPE504C	Elective-II	3	-	-	20	20	60	100	3
OEC 1	BTMOE505B/ BTMOE505D/ BTMXOE505A/ BTAROE505A	Open Elective-I	3	-	-	20	20	60	100	3
PCC13	BTMXL506	Metrology and Measurements Lab	-	-	2	60	-	40	100	1
PCC14	BTARL507	Hydraulics and Pneumatics Lab			2	60		40	100	1
PROJ-3	BTARI408	IT – 2 Evaluation	-	-	-	-	-	100	100	1
		Total	**15**	**3**	**4**	**220**	**100**	**480**	**800**	**21**

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 II

Sr. No	Course code	Course Name
1	BTARPE504A	Wireless less Sensor Network
2	BTARPE504B	Industrial Robot and Material Handling
3	BTMXPE504C	Python Programming

Open Elective I

Sr. No.	Course code	Course Name
1	BTMOE505B	Renewable Energy Sources
2	BTMOE505D	Product Design Engineering
3	BTMXOE505A	Internet of Things and Cloud based Manufacturing
4	BTAROE505A	Entrepreneurship Development and Industrial Management

Course Structure for Semester VI
B. Tech in Automation & Robotics and B. Tech in Robotics (2023-24)

		Semester VI								
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**No. of Credits**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC15	BTARC 601	Robotics Programming	3	1	-	20	20	60	100	4
PCC16	BTMXC602	Design of Machine Elements	3	1	-	20	20	60	100	4
PEC3	BTARPE603 (A/B/C)	Elective-III	3		-	20	20	60	100	3
PEC4	BTMXPE604A/ BTMPE604B/ BTMPE604C	Elective-IV	3		-	20	20	60	100	3
OEC2	BTMOE605A/ BTMOE605C/ BTMOE605E/ BTMXOE605 A	Open Elective-II	3		-	20	20	60	100	3
PCC17	BTARCL606	Robotics Programming Lab			2	60		40	100	1
PCC18	BTARCL607	Automation Design Lab			2	60		40	100	1
PROJ-4	BTARS608	B Tech Seminar	-	-	2	60		40	100	1
PROJ-5	BTARP609	TPCS	-	-	2	60	-	40	100	1
PROJ-6	BTARI610 (IT-3)	Field Training / Industrial Training (minimum of 4 weeks which can be completed partially in fifth semester and sixth semester or in one semester itself).	-	-	-	-	-	-	-	Credits to be evaluated in Sem VII
		Total	**15**	**2**	**08**	**340**	**100**	**460**	**900**	**21**

SC = 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 III:

Sr. No	Course code	Course Name
1	BTARPE603A	Control Systems
2	BTARPE603B	Data Analytics and Machine Learning
3	BTARPE603C	Smart Manufacturing

Elective IV:

Sr. No	Course code	Course Name
1	BTMXPE604A	Computer Integrated Manufacturing
2	BTMPE604B	Product Life Cycle Management
3	BTMPE604C	Finite Element Method

Open Elective II:

Sr. No	Course code	Course Name
1	BTMOE605A	Quantitative Techniques and Project Management
2	BTMOE605C	Energy Conservation and Management
3	BTMOE605E	Introduction to Probability Theory and Statistics
4	BTMXOE605A	Industrial Engineering

Metrology and Measurements

BTMXC501	PCC 10	Metrology and Measurements	3-1-0	4 Credits

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	Identify techniques to minimize the errors in measurement
CO2	Understand methods and devices for measurement of length, angle, and gear and thread parameters, surface roughness and geometric features of parts.
CO3	Choose limits for plug and ring gauges.
CO4	Explain methods of measurement in modern machineries
CO5	Illustrate the gear metrology and describe working of measuring machines
CO6	Identify various measurement methods for thermo-mechanical properties and geometrical forms

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Measurement Standard and Comparators **[07 Hours]**

Measurement Standard, Principles of Engineering Metrology, Line end, wavelength, Traceability of Standards. Types and Sources of error, Alignment, slip gauges and gauge block, Linear and Angular Measurement (Sine bar, Sine center, Autocollimator, Angle Dekker, and Dividing head), Calibration. Comparator: Mechanical, Pneumatic, Optical, Electronic (Inductive), Electrical (LVDT).

Unit 2: Interferometry and Limits, Fits, Tolerances **[07 Hours]**

Principle, NPL Interferometer, Flatness measuring using slip gauges, Parallelism, Laser Interferometer, Surface Finish Measurement: Surface Texture, Measuring Surface Finish by Stylus probe, Tomlinson and Talysurf. Design of Gauges: Types of Gauges; Limits, Fits, Tolerance; Terminology for limits and Fits.Indian Standard (IS 919-1963), Taylor‟s Principle.

Unit 3: Metrology of Gears and Measuring Machines **[07 Hours]**

Gear Metrology: Gear error, Gear measurement, Gear Tooth Vernier; Profile Projector, Tool marker‟s microscope. Advancements in Metrology: Universal Measuring Machine, Lasers in Metrology.

Unit 4: Measurement of Thermo-Mechanical Properties **[07 Hours]**

Measurement of temperature, pressure, velocity, Measurement of heat flux, volume/mass flow rate, temperature in flowing fluids, Measurement of thermo-physical properties, radiation properties of surfaces, vibration and noise.

Unit 5: Measurement of Geometrical Forms **[07 Hours]**

Measurement of geometric forms, straightness, flatness, roundness, etc. Mechanical and optical methods - optical projectors, tool maker‟s microscope, and autocollimators, Introduction to CMM, probes for CMM, CMM Software.

Texts:

1. C. Gupta, “Engineering Metrology”, Dhanpat and Rai Publications, New Delhi, India.
2. R. K. Jain, “Engineering Metrology”, Khanna Publications, 17th edition, 1975.
3. K. L. Narayana, “Engineering Metrology”, Scitech Publications, 2nd edition.

References:

1. Ernest O. Doebelin; Measurement Systems: Application and Design; McGraw-Hill, 2004
2. K. J. Hume, “Engineering Metrology”, McDonald Publications, 1st edition, 1950.
3. A. W. Judge, “Engineering Precision Measurements”, Chapman and Hall, London, 1957.
4. J. F. Galyer, C. R. Shotbolt, “Metrology for Engineers”, Little-hampton Book Services Ltd.,5th edition, 1969.
5. V. A. Kulkarni, A. K. Bewoor, “Metrology & Measurements”, Tata McGraw Hill Co. Ltd.,1st edition, 2009.
6. Richard S. Figliola, D. E. Beasley, “Theory and Design for Mechanical Measurements”,Wiley India Publication

Manufacturing Technologies

BTMXC502	PCC 11	Manufacturing Technologies	3-1-0	4 Credits

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	Identify castings processes, working principles and applications and list various defects in metal casting
CO2	Understand the various metal forming processes, working principles and applications
CO3	Classify the basic joining processes and demonstrate principles of welding, brazing and soldering.
CO4	Understand center lathe and its operations including plain, taper turning, work holding devices and cutting tool.
CO5	Understand milling machines and operations, cutters and indexing for gear cutting.
CO6	Know shaping, planing and drilling machines

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction and Casting Processes **[07 Hours]**

What is manufacturing? Selection of manufacturing processes, Introduction to casting; solidification of metals: Pure metals, Alloys; fluid flow; fluidity of molten metal; heat transfer: Solidification time, Shrinkage, Porosity; Metal casting processes: Sand casting, shell molding, investment casting; Permanent-mold casting, vacuum casting, die casting, centrifugal casting.

Unit 2: Metal Forming **[07Hours]**

a) Rolling and Forging Processes

Introduction to Rolling; Various Rolling Processes and Rolling Mills. Introduction to forging, Open-die forging; Impression-die and Closed-die forging; various forging Operations; Forging Machines.

b) Extrusion and Drawing

Introduction; Extrusion Process; Hot Extrusion; Cold Extrusion: Impact extrusion, Hydrostatic Extrusion; Extrusion Defects; Extrusion Equipment; Drawing Process; Drawing Practice; Drawing Equipment.

Unit 3: Joining Processes **[07Hours]**

Oxy-fuel-gas Welding; Arc-Welding Processes: Non consumable Electrode; Arc-welding Processes: Consumable Electrode, Shielded Metal-arc Welding, Submerged-arc Welding, Gas Metal-arc Welding.

Introduction to solid state welding, Friction Welding, Resistance Welding: Spot, Seam, Projection Welding. Introduction to brazing and soldering.

Unit 4: Machining Processes: Turning and Hole Making **[07 Hours]**

Introduction; The Turning Process; Lathes and Lathe Operations: Lathe Components, Work holding Devices and Accessories, Lathe Operations, Types of Lathes. Boring and Boring Machines; Drilling Machines: Drills, Drill Materials and Sizes, Types of Drilling Machines, Reaming operation, and Reamers; Tapping and Taps.

Unit 5: Machining Processes: Milling, Broaching and Gear Manufacturing **[07 Hours]**

Introduction, Milling and Milling Machines: Peripheral Milling, Face Milling, End Milling, Other Milling Operations and Milling Cutters, Tool holders, Milling Machines;

Planning and Shaping: Operations and machines; Broaching and Broaching Machines; Gear Manufacturing by Machining: Form Cutting, Gear Generating by hobbing.

Text:

1. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology",Addison Wesley Longman (Singapore) Pte. India Ltd., 6th edition, 2009.

References:

1. Milkell P. Groover, " Fundamentals of Modern Manufacturing: Materials, Processes, andSystems", John Wiley and Sons, New Jersey, 4th edition, 2010.
2. Paul DeGarmo, J.T. Black, Ronald A. Kohser, "Materials and Processes in Manufacturing", Wiley, 10th edition, 2007.

Hydraulics, Pneumatics and Industrial Automation

BTARC503	**PCC 12**	**Hydraulics, Pneumatics and Industrial Automation**	**3-1-0**	**4 Credits**

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)

Course Outcomes: Students will be able to

CO1	Exemplify the basic principles of Industrial fluid power.
CO2	Select and specify various components for hydraulic and pneumatic systems.
CO3	Execute PLC program for electro-hydraulic circuit applications.
CO4	Organize hydraulic and pneumatic circuits for given application.
CO5	Evaluate the hydraulic and pneumatic systems based on various evaluation criteria.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction to fluid power and automation (7 Hours)

Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations. Properties of fluids, Fluids for hydraulic systems, governing laws.

Unit 2: Hydraulic pumps and actuators pumps (7 Hours)

Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps. Design of reservoir capacity. Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors).

Unit 3: Control Components in hydraulic system (7 Hours)

Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Unit 4: Hydraulic Circuit Design and Analysis (7 Hours)

Control of Single and Double -Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Speed Control of Hydraulic Cylinder and motors, Safety circuit, Accumulators, types, construction and applications with circuits, Intensifier circuits and their applications, Proportional control valves and servo valves.

Unit 5: Introduction to Pneumatic system (7 Hours)

Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. Pneumatic Actuators: Linear cylinder Types, Cascade design of Pneumatic circuit, Use of Logic gates - OR and AND gates in pneumatic applications.

References:

1. Esposito Anthony, Fluid power with Applications, Pearson, ISBN: 978-81-7758- 580-3
2. Mujumdar S.R., Pneumatic Systems, Tata McGraw Hill, 2002 Edition. ISBN: 9780074602317
3. Bolton W., Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering,
4. Pearson, Education (Singapore) Pvt Ltd.
5. Industrial hydraulics manual by Vickers, Inc.
6. Fluid Power: Generation, Transmission and Control, Wiley, 2018, ISBN:9788126539543
7. Peter Rohner, Industrial hydraulic control, Hydraulic Supermarket, 2005, ISBN 978-0958149310

Wireless Sensor Network

BTARPE504A	PEC 2	Wireless Sensor Network	3-0-0	3 Credits

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)

Course Outcomes: Students will be able to

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction to WSN **(7 Hours)**

Introduction to Sensor networks, Protocols for wireless sensor networks , Sensor network architecture smart transportation, smart cities, smart living, smart energy, smart health, and smart learning , Sensor network architecture.

Unit 2: Sensor Network Systems **(7 Hours)**

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture -Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

Unit 3: Networking Sensors **(7 Hours)**

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses,

Unit 4: Infrastructure Establishment **(7 Hours)**

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control, Routing Protocols.

Unit 5: Sensor Network Platforms and Tools **(7 Hours)**

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

Reference Books:

1. Holger Karl & Andreas Willig, " Protocols and Architectures for Wireless Sensor Networks" , John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks- Technology, Protocols, And Applications”, John Wiley, 2007.
4. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

Industrial Robot and Material Handling

BTARPE504B	PEC 2	Industrial Robot and Material Handling	3-0-0	3 Credits

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)

Course Outcomes: Students will be able to

CO1	Understand material handling system.
CO2	Understand storage and data capturing system
CO3	Describe the basic concepts, parts of robots and types of robots.
CO4	Select the robots according to its usage.
CO5	Describe various applications of robots, justification and implementation of robot.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I: Introduction to Material handling **(7 Hours)**

Principles of Material Handling, Unit load concept, Material Handling equipment, Material transport systems: AGVs, Monorails, Conveyor systems, Cranes and hoists, Analysis of material transport systems: Charting technique, analysis of vehicle-based systems, Conveyor analysis.

Unit II: Storage and Data capturing systems **(7 Hours)**

Conventional storage methods and equipments Storage system performance, Analysis of Automated storage/retrieval systems (ASRS) and Carousel Storage system. Automatic data capturing system (ADC), Bar coding, Radio frequency identification (RFID), Optical character recognition, Magnetic stripes.

Unit III: Introduction Industrial Robots **(7 Hours)**

Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell.

Unit IV: End Effectors **(7 Hours)**

Classification, Design consideration, Materials for hostile operation. Cylindrical Cam type; Grippers using pneumatic, hydraulic, and electrical motor for transmission; Vacuum Grippers, Ultrasonic grippers. Gripper force analysis and gripper design, design of multiple degrees of freedom, active and passive grippers. Selection of Robot: Factors influencing the choice of a robot, robot performance testing, economics of robotisation, Impact of robot on industry and society.

Unit V: Applications of Robots in Manufacturing **(7 Hours)**

Pick and place Robot, Application of Robots in Arc Welding Robots, Assembly and mega-assembly Robots continuous arc welding, Spot welding, Spray painting, assembly operation, Other industrial applications: Coating, Deburring, cleaning,Die Casting, Moulding, Material handling, Picking, Palletizing, Packaging

R**eferences Books:**

1) Groover M. P., “Automation, Production Sysytems, and Computer –Integrated Manufacturing”, Pearson.
2) Education,ISBN-81-7808-511-9 3. Deb S.R., “Robotics”, Tata McGraw Hill Publications, New Delhi. ISBN 13: 9780070077911
3) Yoram Koren, & quot; Robotics for Engineers", McGraw Hill Book Co. SBN-10: 0070353999, ISBN-13: 978-0070353992
4) Groover M.P., Weiss M., Nagel R.N., Odrey N.G., "Industrial Robotics Technology - Programming and Applications & quot;, McGraw Hill Book Co. ISBN-10: 1259006212, ISBN-13: 978-1259006210
5) Fu K.S., Gonzalex R.C., Lee C.S.G., "Robotics Control Sensing, Vision and intelligence", McGraw Hill Book Co. ISBN 10: 0070226253 / ISBN 13: 9780070226258
6) Hall A.S., & quot; Kinematics and Linkage Design", Prentice Hall. ISBN-10: 0881332720, ISBN-13: 978- 0881332728
7) Todd D.J., “Fundamentals of Robot Technology”, Wiley Publications, ISBN:978-0-470-20301-9

Python Programming

BTMXPE504C	PEC2	Python Programming	3-0-0	3 Credits

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	Read, write, execute by hand simple Python programs
CO2	Structure simple Python programs for solving problems
CO3	Decompose a Python program into functions
CO4	Represent compound data using Python lists, tuples, dictionaries
CO5	Read and write data from/to files in Python Programs

Mapping of course outcomes with program outcomes

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

Course Contents

Unit1 Introduction to Python Programming (7 Hours)

Introduction to the Python Programming Language, Working with Python, Numeric Data Types, String Data Type and Operations, Standard Data Types, Data Type Conversions, Commenting in Python

Unit 2 Variables and Operators (7 Hours)

Understanding Python Variables, Multiple Variable Declarations, Python Basic Statements, Python Basic Operators, Precedence of Operators, Expressions

Unit 3 Control flow and loops (7 Hours)

Conditional Statements, Loops in Python, While Loop, Loop Manipulation

Unit 4 Functions (7 Hours)

Defining Your Own Functions, Calling Functions, Passing Parameters and Arguments, Python Function Arguments, Anonymous Functions (Lambda Functions), Fruitful Functions (Function Returning Values), Scope of Variables in a Function, Powerful Lambda Functions in Python

Unit 5 I/O and Error handling in Python (7 Hours)

Introduction to I/O (Input/Output), Writing Data to a File, Reading Data from a File, Additional File Methods, Introduction to Errors and Exceptions, Handling I/O Exceptions, Runtime Errors and Handling Multiple Exceptions

Text Book(s)

1. Core Python Programming" by R. Nageswara Rao (Dreamtech)
2. Think Python: How to Think Like a Computer Scientist" (2nd Edition) by Allen B. Downey (Shroff/O,,Reilly Publishers, 2016)
3. Python Programming: A Modern Approach" by Vamsi Kurama (Pearson)
4. Data Structures and Algorithmic Thinking with Python" by Narasimha Karumanchi

Reference Books

1. "Core Python Programming" by Wesley J. Chun (Pearson)
2. Introduction to Python" by Kenneth A. Lambert (Cengage)
3. "Learning Python" by Mark Lutz (O'Reilly)

Renewable Energy Sources

BTMOE505B	OEC 1	Renewable Energy Sources	3-0-0	3 Credits

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 renewable and non-renewable energy
CO2	Describe working of solar collectors
CO3	Explain various applications of solar energy
CO4	Describe working of other renewable energies such as wind, biomass

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

Course Contents:

Unit 1: Introduction **(7 Hours)**

Energy resources, Estimation of energy reserves in India, Current status of energy conversion technologies relating to nuclear fission and fusion, Solar energy.

Unit 2: Solar Radiations **(7 Hours)**

Spectral distribution, Solar geometry, Attenuation of solar radiation in Earth‟s atmosphere, Measurement of solar radiation, Properties of opaque and transparent surfaces.

Unit 3: Solar Collectors **(7 Hours)**

Flat Plate Solar Collectors: Construction of collector, material, selection criteria for flat plate collectors, testing of collectors, Limitation of flat plate collectors, Introduction to ETC.

Concentrating type collectors: Types of concentrators, advantages, paraboloid, parabolic trough, Heliostat concentrator, Selection of various materials used in concentrating systems, tracking.

Unit 4: Solar Energy, Wind Energy and Biomass **(7 Hours)**

Air/Water heating, Space heating/cooling, solar drying, and solar still, Photo-voltaicconversion. Types of windmills, Wind power availability, and wind power development in India. Evaluation of sites for bioconversion and bio-mass, Bio-mass gasification with special reference to agricultural waste.

Unit 5: Introduction to Other Renewable Energy Sources (7 Hours)

Tidal, Geo-thermal, OTEC; Mini/micro hydro-electric, Geo-thermal, Wave, Tidal System design, components, and economics.

Texts:

1) Chetan Singh Solanki, "Renewable Energy Technologies", Prentice Hall of India, 2008.

References:

1) S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publications, New Delhi, 1992.
2) G. D. Rai, "Solar Energy Utilization", Khanna Publisher, Del

Product Design Engineering

BTMOE505D	OEC1	Product Design Engineering	3-0-0	3 Credits

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: Knowledge of Basic Sciences, Mathematics and Engineering Drawing
Course Outcomes: At the end of the course, students will be able to

CO1	Understand the need for product design
CO2	Apply various methods of idea generation
CO3	Understand various types of prototypes and testing methods
CO4	Understand the product economics at production scale
CO5	Appreciate the environmental concerns in product lifecycle

Mapping of course outcomes with program outcomes

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

Course Contents

Unit 1: Introduction to Engineering Product Design [07 Hours]

Trigger for Product/Process/System, Problem solving approach for Product Design, Disassembling existing product(s) and understanding relationship of components with each other, identifying materials and their processing for final product, fitting of components, understanding manufacturing as scale of the components, Reverse engineering concept,

Unit 2: Ideation and Conceptualization [07 Hours]

Generation of ideas, funneling of ideas, Short-listing of ideas for product(s) as an individual or group of individuals, Market research for need, competitions, Product architecture, Designing of components, Drawing of parts and synthesis of a product from its component parts, 3-D visualization,

Unit 3: Testing and Evaluation Prototyping [07 Hours]

Design Automation, Prototype testing and evaluation, Working in multidisciplinary teams, Feedback to design processes, Process safety and materials, Health and hazard of process operations.

Unit 4: Manufacturing **[07 Hours]**

Design models and digital tools, Decision models, Prepare documents for manufacturing in standard format, Materials and safety data sheet, Final Product specifications sheet, Detail Engineering Drawings (CAD/CAM programming), Manufacturing for scale, Design/identification of manufacturing processes

Unit 5: Environmental Concerns **[07 Hours]**

Product life-cycle management, Recycling and reuse of products, Disposal of product and waste. Case studies.

Reference:

1) Model Curriculum for "Product Design Engineer – Mechanical", NASSCOM (Ref. ID: SSC/Q4201, Version 1.0, NSQF Level: 7)
2) Eppinger, S., & Ulrich, K.(2015). Product design and development. McGraw-Hill Higher Education.
3) Green, W., & Jordan, P. W. (Eds.).(1999).Human factors in product design: current practice and future trends. CRC Press.
4) Sanders, M. S., & McCormick, E. J. (1993). Human factors in engineering and design. McGRAW-HILLbookcompany.
5) Roozenburg, N. F., &Eekels, J. (1995). Product design: fundamentals and methods (Vol. 2). John Wiley & Sons Inc.
6) Lidwell, W., Holden, K., & Butler, J.(2010). Universal principles of designs,revised and updated: 125 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design. Rockport Pub.

Internet of things and Cloud based Manufacturing

BTMXOE505A	OEC 1	Internet of things and Cloud based Manufacturing	3-0-0	3 Credits

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	Able to understand the application areas of IOT
CO2	Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
CO3	Able to understand building blocks of Internet of Things and characteristics.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: IoT and Cloud Computing [07 Hours]

Introduction, Physical design of IoT, Logical design of IoT, IoT enabling technologies, Domain specific IoTs, IoT design methodology, logical design, IoT physical devices (such as Raspberry Pi, pcDuino, Beaglebone black, Cubieboard) , Introduction to cloud computing: cloud models, cloud service examples, cloud based services & applications, Cloud service and platforms

Unit 2: Applied Machine to Machine Communication [07 Hours]

Introduction to M2M, Description of M2M Market, Segments/Applications – Automotive, Smart Telemetry, Surveillance and Security, M2M Industrial Automation, M2M Terminals and Modules.

Unit 3: Information Systems in Manufacturing [07 Hours]

Manufacturing organizations, management, and the networked enterprises, Globalization challenges and opportunities, Dimensions of Information systems, Approaches to study information system , Technical and Behavioral approach, Information Technology Infrastructure.

Unit 4: Introduction to Smart Manufacturing [07 Hours]

Introduction; Demand Driven and Integrated Supply Chains; Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations); Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization and reduction of GHG), Online Predictive Modeling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes.

Unit 5: Internet of Things Privacy, Security and Governance [07 Hours]

Introduction, Overview of Governance, Privacy and Security Issues, Security, Privacy and Trust in IoT-Data-Platforms for Smart manufacturing, First Steps Towards a Secure Platform, Data Aggregation for the IoT in Smart manufacturing.

Texts:

1. Bahga and V. Madisetti, Internet of Things, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515.

References:

1. Bahga and V. Madisetti, Cloud Computing, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2013, ISBN: 978-1494435141
2. D. Boswarthick, O. Elloumi, and O. Hersent, M2M communications: A systems approach, Wiley, 1st edition, 2012, ISBN: 978-1119994756
3. J. Edward Carryer, et al., Introduction to Mechatronic Design, Prentice Hall, 1st edition, 2010, ISBN: 978- 8131788257.
4. K. Laudon and J. Laudon, Management Information Systems, 14th edition, Pearson Higher Education, 2016, ISBN: 9780136093688.

Entrepreneurship Development and Industrial Management

BTAROE505A	OEC 1	Entrepreneurship Development and Industrial Management	3-0-0	3 Credits

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)

Course Outcome:

CO1	Recognize comprehensive theoretical knowledge about Entrepreneurship Development, Management.
CO2	Explain principle role & operation of Business sectors & organizations.
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

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

Course Contents:

UNIT 1. Entrepreneurial Competence (7 Hours)

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful Entrepreneurs – Knowledge and Skills of an Entrepreneur.

UNIT 2. Entrepreneurial (7 Hours)

Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organizational Services - Central and State Government Industrial Policies and Regulations.

UNIT 3. Business Plan Preparation (7 Hours)

Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital Budgeting- Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT 4. Management (7 Hours)

Introduction-Thought and its Development, Scope and Functional areas of management, Management as a science, art of profession Management and Administration Roles of Management, Levels of Management, functions of Management, Contribution of F.W.Taylor,

Henri Fayol, Elton Mayo, Structure of an industrial organization, Hierarchy of various job positions in Electronics & IT industries, Functions of different departments. Relationship between individual departments.

UNIT 5. Business sectors & organizations (7 Hours)

Private sector, Cooperative sectors, public sector, joint sector, Services sector, Various forms of business organizations – Sole Proprietorship, Partnership firms, Joint stock companies – their features, relative merits, demerits& suitability. Charter documents of Companies Decisions in setting up an Enterprise – opportunity and idea generation, Business Plan, Business size and location decisions, Challenges in business sectors.

Reference Books :

1. M.Y. Khan and P. K. Jain, “Financial Management”, Tata McGraw Hill, New Delhi
2. Ravi M. Kishore, “Project Management”, Tata McGraw Hill, New Delhi
3. Dinesh Seth and Subhash C. Rastogi, “Global Management Solutions”, Cengage Learning, Second Edition, USA.
4. B. Davis and Margrethe H. Olson, "Management Information Systems", Mc-Graw-Hill International Editions.
5. Azar Kazmi , “Strategic Management & Business Policy “, Tata McGraw Hill, New Delh

Metrology and Measurements Lab

BTMXL506	PCC 13	Metrology and Measurements Lab	0-0-2	1 Credit

Teaching Scheme:	Examination Scheme:
Practicals: 2 hrs./week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

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

CO1	
CO2	
CO3	

Mapping of course outcomes with program outcomes

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

Course Contents:

List of Practical's/Experiments (Minimum 08 experiments out of the following):

1. Calibration of pressure gauge using a dead weight gauge calibrator.
2. Measurement of displacement using LVDT .
3. Calibration of strain gauge .
4. Measurement of flow rate using orifice, venturi - and Rota- meters and their error analysis.
5. Measurement of flow rate using microprocessor based magnetic flow meter, vortex, ultrasonic, turbine flow meters.
6. Determination of characteristics of thermocouples, RTD, themistors
7. To calibrate the given micrometer using slip gauge as standard
8. Measurement of taper by sine bar.
9. To calibrate a dial gauge indicator.
10. Study and use of optical flat.
11. Surface roughness measurement.
12. Measurements using Tool makers‟ microscope.

13. To measure the major, minor and effective diameter by using floating carriage diameter measuring machine.
14. Inspection of gear by Gear Rolling Tester

Hydraulics and Pneumatics Lab

BTARL507	PCC 14	Hydraulics and Pneumatics Lab	0-0-2	1 Credits

Teaching Scheme:	Examination Scheme:
Practicals: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

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

CO1	
CO2	
CO3	

Mapping of course outcomes with program outcomes

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

Course Contents:

List of practical:

1. Experiment on measurement of hydraulic pump efficiency.
2. Experiment on design of speed control hydraulic circuits.
3. Experiment on design of regenerative circuits
4. Experiment on design of electro-hydraulic sequencing circuits
5. Experiment on pneumatic circuits by demonstrating logic gates.
6. Experiment on electro-pneumatic circuits
7. Experiment on programmable logic controllers: Ladder logic programming.
8. Microprocessor programming for basic operations

Industrial Training – II Evaluation

BTARI408 (IT – II)	**Industrial Training – II Evaluation**	**PROJ-3**	**--**	**1 Credit**

Teaching Scheme:	**Examination Scheme:**
Lecture: --	End Semester Exam: 100 Marks

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

CO1	
CO2	
CO3	

Mapping of course outcomes with program outcomes

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

Semester VI
Robotics Programming

BTARC601	PCC 15	Robotics Programming	3-1-0	4 Credits

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)

Course outcomes: Student will be able to:

CO1	Explain robot programming methods.
CO2	Understand the components of robot programming.
CO3	Develop simple programs to simulate robot movements.
CO4	Develop robot programs for specific application.
CO5	Describe the safety rules in robot handling.

Mapping of course outcomes with program outcomes

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

Course Contents:

UNIT 1: Introduction to Robot Programming **(7 Hours)**

Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands- Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands.

UNIT 2: VAL Language **(7 Hours)**

Robot Languages-Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications.

UNIT 3: VAL-II **(7 Hours)**

VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot.

UNIT 4: RAPID Language **(7 Hours)**

RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command-based programming. Move master command language-Introduction, syntax, simple problems.

UNIT 5: AML Language **(7 Hours)**

General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor Commands-Data processing, Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot studio online software- Introduction, Jogging, components, work planning, program modules

Reference Books:

1. S. R.Deb, Robotics technology and flexible automation, Tata McGraw Hill publishing company limited, 1994.
2. Mikell. P. Groover, Industrial Robotics Technology, Programming and Applications, McGraw HillCo, 1995. 3)
3. Klafter. R.D, Chmielewski.T.A. and Noggin‟s., Robot Engineering : An Integrated Approach
4. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., Robotics control, sensing, vision and intelligence, McGrawHill Book co, 1987.
5. Craig. J. J. Introduction to Robotics mechanics and control, Addison-Wesley, 1999.

Design of Machine Elements

BTMXC602	PCC16	Design of Machine Elements	3-1-0	4 Credits

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	Recognize the stress state (tension, compression, bending, shear, etc.) and calculate the value of stresses & strains developed in the components.
CO2	Design of machine elements against static & fluctuating Loads
CO3	Design of components like shaft, key and select the rolling contact bearing for given application
CO4	Select belt drives & chain drives for given power rating
CO5	Design of different types of gears like Spur gears & Helical Gears etc.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Simple Stresses and Strains [07 Hours]

Mechanical properties of materials, analysis of internal forces, simple stresses and strains, stress-strain curve, Hooke‟s law, modulus of elasticity, shearing, Hoop stress, Poisson‟s ratio, volumetric stress, bulk modulus, shear modulus, relationship between elastic constants. Principal Stresses and Strains: Uni-axial stress, simple shear, general state of stress for 2-D element, ellipse of stress, principal stresses and principal planes, principal strains.

Unit 2: Design of Machine Elements against Static & Fluctuating Loads [07 Hours]

Theories of Failure (Yield and Fracture Criteria): Maximum normal stress theory, Maximum shear stress theory, Maximum distortion energy theory, comparison of various theories of failure, Direct loading and combined loading,

Design against Fluctuating Loads: Stress concentration, stress concentration factors, fluctuating stresses, fatigue failure, endurance limit, notch sensitivity, approximate estimation of endurance limit, design for finite life and finite life under reversed stresses, cumulative damage in fatigue, Soderberg and Goodman diagrams, fatigue design under combined stresses.

Unit 3: Shafts & Bearings **[07 Hours]**

Various design considerations in transmission shafts, splined shafts, spindle and axles strength, lateral and torsional rigidity, ASME code for designing transmission shaft. Types of Keys: Classification and fitment in keyways, Design of various types of keys.

Rolling Contact Bearings: Types, Static and dynamic load carrying capacities, Equivalent load, load and life relationship, selection of bearing life, Load factor, selection of bearing from manufacturer's catalogue, Cyclic loads and speeds, Design for probability of survival other than 90% Lubrication and mountings of rolling contact bearings.

Unit 4: Belt and Chain Drives **[07 Hours]**

Flat and V belts, Geometric relationship, analysis of belt tensions, condition for maximum power, Selection of flat and V belts from manufacturer"s catalogue, Adjustment of belt tensions. Roller chains, Geometric relationship, polygonal effect, power rating of roller chain, sprocket wheels, and Silent chains.

Unit 5: Gears **[08 Hours]**

Spur Gear: Terminology of spur gear, Standard system of gear tooth force analysis, gear tooth failures, Selection of materials Constructional, Number of teeth, Face with, Beam strength equation, Effective load on gear tooth, Estimation of module based on beam strength. Design for maximum power capacity, Lubrication of gears.

Helical Gears: Terminology, Virtual number of teeth, Tooth proportions, Force analysis, Beam strength equation, Effective load on gear tooth, Wear strength equation.

Texts:

1. S. Ramamrutham, "Strength of Materials", Dhanpat Rai and Sons, New Delhi.
2. F. L. Singer, Pytle, "Strength of Materials", Harper Collins Publishers, 2002.
3. S. Timoshenko, " Strength of Materials: Part-I (Elementary Theory and Problems)", CBS Publishers, New Delhi.
4. V. B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publications, New Delhi, 2008.
5. R. L.Nortan, " Machine Design: An Integrated Approach", Pearson Education Singapore, 2001.

References:

1. E. P.Popov, "Introduction to Mechanics of Solid", Prentice Hall, 2nd edition, 2005.
2. S. H. Crandall, N. C. Dahl, T. J. Lardner," An introduction to the Mechanics of Solids", Tata McGraw Hill Publications, 1978.
3. S. B. Punmia, "Mechanics of Structure", Charotar Publishers, Anand.
4. R. C. Juvinall, K. M. Marshek, " Fundamental of machine component design", John Wiley & Sons Inc., New York, 3rd edition, 2002.
5. B. J. Hamrock, B. Jacobson and Schmid Sr., " Fundamentals of Machine Elements", International Edition, New York,2nd edition, 1999.
6. S. Hall, A. R. Holowenko, H. G .Langhlin ,"Theory and Problems of Machine Design", Schaum"s Outline Series, Tata McGrawHill book Company,NewYork,1982.
7. J . E. Shigley and C. Mischke, "Mechanical Engineering Design", Tata McGrawHill Publications,7th edition, 2004.
8. M. F.Spotts, "Design of Machine Elements", Prentice Hall of India, New Delhi.

Control System

BTARPE603A	PEC3	Control system	3-0-0	3 Credits

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 concept of control engineering
CO2	Understand the modelling of linear invariant systems using transfer function and state space representations.
CO3	Understand the concept of stability and its assessment for linear time invariant systems.
CO4	Design simple feedback controllers
CO5	Represent the system in the state space form for the analysis

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 I: **(7 Hours)**

Introduction to control problem, Industrial Control examples, Transfer function, System with dead-time, System response, Control hardware and their models, potentiometers, synchro‟s, LVDT, dc and ac servomotors, tacho-generators, electrohydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators, closed-loop systems: Block diagram and signal flow graph analysis.

Unit II: **(7 Hours)**

Feedback control systems stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. proportional, integral and derivative systems. feed-forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion.

Unit III: **(7 Hours)**

Time response of second-order systems, steady-state errors and error constants, Performance specifications in time-domain, Root locus method of design., Lead and lag compensation.

Unit IV: **(7 Hours)**

Frequency-response analysis- Polar plots, Bode plot, stability in frequency domain, Nyquist plots, Nyquist stability criterion, Performance specifications in frequency-domain, Frequency- domain methods of design, Compensation & their realization in time & frequency domain, Lead and Lag compensation, Op-amp based and digital implementation of compensators, Tuning of process controllers, State variable formulation and solution.

Unit V: **(7 Hours)**

State variable Analysis- Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability.

Text Books/References:

1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997.
2. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
3. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
4. Nagrath & Gopal, "Modern Control Engineering", New Age International, New Delhi.
5. Ambikapathy A., Control System, Khanna Book Publishing Company, 2018.

Data Analysis and Machine Learning

BTARPE603B	**PEC3**	**Data Analysis and Machine Learning**	**3-0-0**	**3 Credits**

Teaching Scheme	**Teaching Scheme**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

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

CO1	Effectively visualize and interpret the data.
CO2	Apply predictive and prescriptive techniques for production engineering. applications
CO3	Use data analysis for engineering applications through the powerful tools of data application.
CO4	Use of ML algorithms for engineering applications through the powerful tools of data application

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												

Course Contents

Unit 1: Introduction to data analytics **(7 Hours)**

Introduction to AI, Data science, Significance & applications of data analytics, Data collection, data processing, data transformation, data integration, data visualization, basic statistics, inferential statistics

Unit 2: Descriptive analytics & Predictive analytics **(7 Hours)**

Univariate/multi-variate statistics, bi-variate associations, correlations, covariance, analysis of variance (ANOVA) , Multiple regression, conjoint analysis, neural networks, data clustering, Data mining

Unit 3: Classification techniques & Prescriptive analytics **(7 Hours)**

Linear classifiers, Quadratic classifiers, Support vector machines, Random forests., Decision tree analysis, Expert system, principal component analysis, genetic algorithms

Unit 4: ML Algorithms: (7 Hours)

Types of Machine Learning Algorithms, Supervised Learning, Unsupervised Learning , Reinforcement learning , Classification, Regression, Clustering , Association, Linear Regression , Logistic Regression , Naïve Bayes, KNN , K-Means Clustering, Apriori , PCA

Unit 5: Introduction to DL and DL Algorithms: (7 Hours)

Introduction to DL, DNLP, MLP, CNN, RNN, RBMs, Use of ML and DL in robotics .

Reference Books:

1. Acharya Seema and Chellappan, Big Data and Analytics, Willey India Pvt. Ltd. (2015), ISBN: 9788126554782
2. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services,
3. Willey India Pvt. Ltd. (2016), ISBN: 978-1-118-87622-0
4. Michael Minelli, Michale Chambers, Ambiga Dhiraj, Big
5. Data Analytics: Emerging Business Intelligence and analytics trends for today,,s business, Willey India Pvt. Ltd. (2015)

Smart Manufacturing

BTARPE603C	PEC3	Smart Manufacturing	3-0-0	3 Credits

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)

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

CO1	Comfortable with terminology and practices in Smart Manufacturing
CO2	Able to face the challenges in Industry & also contribute towards advancement.
CO3	Active part of Industry 4.0 (Fourth Industrial Revolution)
CO4	
CO5	

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 **(7 Hours)**

Introduction to Industry 4.0, Historical Background , Nine Pillars of Smart Manufacturing Big Data & analytics , Processing and Analysis of Data Use of statistics for data analysis.

Unit 2: Advanced Methods **(7 Hours)**

Autonomous Robots, Simulation , Universal System Integration , IIOT – Industrial Internet of Things , 3 D Printing – Additive Manufacturing

Unit 3: Smartness to Manufacturing **(7 Hours)**

Cloud Computing , Augmented Reality , Convergence of Nine Pillars , Business Propositions delivered with Smart Manufacturing , Adding Smartness to Manufacturing – Adoption & Scaling

Unit 4: Smart Systems **(7 Hours)**

Economic Aspects , Ecosystem Required for Smart Manufacturing , Skill set Required for Smart Manufacturing , Effects on 4 M- Man, Machine, Materials & Methods in Smart Manufacturing.

Unit 5: Analysis and Network **(7 Hours)**

Measures of central tendency, dispersion, skewness and relationship. Sampling distributions, sampling theory, deter mination of sample size, chi-square test, analysis of variance, multiple regression analysis, neural networks.

Reference books:

1. Hughes Edward, Electrical & Electronic Technology, Pearson Education, 2007.
2. Hambley. A, Electrical Engineering Principles and Applications: International Version, Pearson Education, 4 Edn, 2007.
3. Alexander.C. K. & Mathew. N. O. Sadiku, Fundamentals of Electrical circuits, Tata McGraw Hill, 2008
4. Hayt. W. W, Kemmerly. J.E, and Durbin. S.M, Engineering Circuits Analysis, Tata McGraw Hill, 2008

Computer Integrated Manufacturing

BTMXPE604A	**PEC4**	**Computer Integrated Manufacturing**	**3-0-0**	**3 Credits**

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	Graduates will demonstrate knowledge of mathematics, science and engineering.
CO2	Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
CO3	Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data.
CO4	Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
CO5	Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
CO6	Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.

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												
CO6												

Course Contents:

Unit 1: Introduction **[07 Hours]**

Brief introduction to CAD and CAM; Manufacturing Planning, Manufacturing control Introduction to CAD/CAM; Concurrent Engineering - CIM concepts; Computerized elements of CIM system; Types of production - Manufacturing models and Metrics; Mathematical models of Production Performance; Simple problems; Manufacturing Control; Simple Problems; Basic Elements of an Automated system; Levels of Automation; Lean Production and Just-In Time Production.

Unit 2: Production Planning and Control and CAPP **[07 Hours]**

Process planning; Computer Aided Process Planning (CAPP); Logical steps in Computer Aided Process Planning; Aggregate Production Planning and the Master Production Schedule; Material Requirement planning; Capacity Planning- Control Systems-Shop Floor Control Inventory Control; Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP).

Unit 3: Cellular Manufacturing **[07 Hours]**

Group Technology (GT), Part Families; Parts Classification and coding; Simple Problems in Opitz Part Coding system; Production flow Analysis; Cellular Manufacturing; Composite part concept; Machine cell design and layout; Quantitative analysis in Cellular Manufacturing; Rank Order Clustering Method - Arranging Machines in a GT cell.

Unit 4: Flexible Manufacturing System (FMS) and Automated Guided Vehicle System(AGVs) **[07 Hours]**

Types of Flexibility - FMS; FMS Components; FMS Application & Benefits; FMS Planning and Control– Quantitative analysis in FMS; Simple Problems. Automated Guided Vehicle System (AGVS); AGVS Application; Vehicle Guidance technology; Vehicle Management & Safety.

Unit 5: Industrial Robotics **[07 Hours]**

Robot Anatomy and Related Attributes; Classification of Robots- Robot Control systems; End Effectors; Sensors in Robotics; Robot Accuracy and Repeatability - Industrial Robot Applications; Robot Part Programming; Robot Accuracy and Repeatability; Simple Problems.

Texts:

1. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
2. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

Product Life Cycle Management

BTMPE604B	PEC4	Product Life Cycle Management	3-0-0	3 Credits

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	Outline the concept of PLM.
CO2	Illustrate the PDM system and its importance.
CO3	Illustrate the product design process.
CO4	Build the procedure for new product development.
CO5	Classify and compare various technology forecasting methods.
CO6	Outline the stages involved in PLM for a given product.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction and strategies to PLM **[07 Hours]**

Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study, PLM visioning, Industrial strategies, strategy elements, its identification, selection, and implementation, change management for PLM.

Unit 2: Product Data Management (PDM) **[07 Hours]**

Human resources in product lifecycle, Information, Standards, Vendors of PLM Systems and Components, PDM systems and importance, reason for implementing a PDM system, financial Justification of PDM, barriers to PDM implementation.

Unit 3: Product Design **[07 Hours]**

Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for „X" and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product design.

Unit 4: New Product Development **[07 Hours]**

Structuring new product development, building decision support system, estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program, Concept of redesign of product

Unit 5: Technology Forecasting and PLM Software and Tools **[07 Hours]**

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

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

Texts/References:

1. Grieves, Michael, "Product Lifecycle Management", Tata McGraw-Hill, 2006, ISBN007145230330.
2. Antti Saaksvuori, Anselmi Immonen, "Product Life Cycle Management", Springer, 1st edition, 2003.
3. Stark, John, "Product Life cycle Management: Paradigm for 21st Century Product Realization", Springer-Verlag, 2004.
4. Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach", Taylor & Francis, 2006.
5. Robert J. Thomas, "NPD: Managing and forecasting for strategic processes.

Finite Element Method

BTMPE604C	PEC4	Finite Element Method	3-0-0	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the basic principle of Finite element methods and its applications.
CO2	Use matrix algebra and mathematical techniques in FEA.
CO3	Identify mathematical model for solution of common engineering problem.
CO4	Solve structural, thermal problems using FEA.
CO5	Derive the element stiffness matrix using different methods by applying basic mechanics laws.
CO6	Understand formulation for two- and three-dimensional problems.

Mapping of course outcomes with program outcomes

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

Contents:

Unit 1: Introduction **[07 Hours]**

Finite element analysis and its need, Advantages and limitations of finite element analysis (FEA), FEA procedure.

Unit 2: Elements of Elasticity **[07 Hours]**

Stress at a point, Stress equation of equilibrium, 2-D state of stress, Strains and displacements, Stress-strain relationship for 2-D state of stress, Plane stress and plane strain approach.

Unit 3: Relevant Matrix Algebra **[07 Hours]**

Addition, subtraction and multiplication of matrices, Differentiation and integration of matrices, Inverse of a matrix, Eigen values and eigen vectors, Positive definite matrix, Gauss elimination.

Unit 4: One-Dimensional Problems **[07 Hours]**

Introduction, FE modeling, Bar element, Shape functions, Potential energy approach, Global stiffness matrix, Boundary conditions and their treatments, Examples.

Unit 5: Trusses and Frames and Two-dimensional Problems **[07 Hours]**

Introduction, Plane trusses, Element stiffness matrix, Stress calculations, Plane frames, examples. **Two-dimensional Problems:** Introduction and scope of 2-D FEA, FE modeling of 2-D problem, Constant strain triangle, other finite elements (no mathematical treatment included), Boundary conditions.

Texts:

1. T. R. Chandrupatla, A.D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall of India Pvt. Ltd., 3rd edition, New Delhi, 2004.
2. P. Seshu, "A Textbook of Finite Element Analysis", Prentice Hall of India Pvt. Ltd., New Delhi,2003.
3. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, "Concepts and Applications of FiniteElement Analysis", John Wiley &Sons, Inc.

References:

1. K. J. Bathe, "Finite Element Procedures", Prentice Hall of India Pvt. Ltd., 2006.

Quantitative Techniques and Project Management

BTMOE605A	OEC 2	Quantitative Techniques and Project Management	3-0-0	3 Credits

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: Engineering Mathematics-I/II/III

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

CO1	Define and formulate research models to solve real life problems for allocating limited resources by linear programming.
CO2	Apply transportation and assignment models to real life situations.
CO3	Apply queuing theory for performance evaluation of engineering and management systems.
CO4	Apply the mathematical tool for decision making regarding replacement of items in real life.
CO5	Determine the EOQ, ROP and safety stock for different inventory models.
CO6	Construct a project network and apply CPM and PERT 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	1	1	3	2				3	1	3	1
CO2	3	1	1	3	2				3	2	3	1
CO3	3	1	1	3	2				3	2	3	1
CO4	3	1	1	3	2	1			3	2	3	1
CO5	3	1	1	3	2	1			3	2	3	1
CO6	3	1	1	3	2	2			3	2	3	1

Course Contents:

Unit 1: Introduction **[07 Hours]**

Introduction to Operations Research, Stages of Development of Operations Research, Applications of Operations Research, Limitations of Operations Research Linear programming problem, Formulation, graphical method, Simplex method, artificial variable techniques.

Unit 2: Assignment and Transportation Models **[07 Hours]**

Transportation Problem, Northwest corner method, Least cost method, VAM, Optimality check methods, Stepping stone, MODI method, Assignment Problem, Unbalanced assignment problems, Travelling salesman problem.

Unit 3: Waiting Line Models and Replacement Analysis [07 Hours]

Queuing Theory: Classification of queuing models, Model I (Birth and Death model) M/M/I (∞, FCFS), Model II - M/M/I (N/FCFS). Replacement Theory, Economic Life of an Asset, Replacement of items that deteriorate with time,Replacement of items that failed suddenly.

Unit 4: Inventory Models [07 Hours]

Inventory Control, Introduction to Inventory Management, Basic Deterministic Models, Purchase Models and Manufacturing Models without Shortages and with Shortages, Reorder level and optimum buffer stock, EOQ problems with price breaks.

Unit 5: Project Management Techniques and Time and Cost Analysis [07 Hours]

Difference between project and other manufacturing systems. Defining scope of a project, Necessity of different planning techniques for project managements, Use of Networks for planning of a project, CPM and PERT.

Time and Cost Analysis: Time and Cost Estimates: Crashing the project duration and its relationship with cost of project, probabilistic treatment of project completion, Resource allocation and Resource leveling.

Texts:

1. P. K. Gupta, D. S. Hira, "Operations Research", S. Chand and Company Ltd., New Delhi, 1996.
2. L. C. Jhamb, "Quantitative Techniques for managerial Decisions", Vol. I and II, Everest Publishing House, Pune, 1994.
3. N. D. Vohra, "Operations Research", Tata McGraw Hill Co., New Delhi.

References:

1. H. Taha, "Operations Research–An Introduction", Maxwell Macmillan, New York.
2. J. K. Sharma, "Operations Research–An Introduction", Maxwell Macmillan, New Delhi.
3. Harvey M. Wagner, "Principles of Operations Research with Applications to Managerial Decisions", Prentice Hall of India Pvt. Ltd., New Delhi, 2nd edition, 2005.
4. Rubin and Lewin, "Quantitative Techniques for Managers", Prentice Hall of India Pvt. Ltd.,New Delhi.

Energy Conservation and Management

BTMOE605C	OEC2	Energy Conservation and Management	3-0-0	3 Credits

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 energy problem and need of energy management
CO2	Carry out energy audit of simple units
CO3	Study various financial appraisal methods
CO4	Analyze cogeneration and waste heat recovery systems
CO5	Do simple calculations regarding thermal insulation and electrical energy conservation

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

Course Contents:

Unit 1: Introduction **[07 Hours]**

General energy problem, Energy use patterns and scope of conservation. Energy Management Principles: Need, Organizing, Initiating, and managing an energy management program.

Unit 2: Energy Auditing **[07 Hours]**

Elements and concepts, Types of energy audits, Instruments uses in energy auditing.
Economic Analysis: Cash flows, Time value of money, Formula is relating present and future cash flows-single amount, uniform series.

Unit 3: Financial Appraisal Method **[07 Hours]**

Payback period, Net present value, Benefit-cost ratio, Internal–rate of return, Lifecycle costs / benefits. Thermodynamics of energy conservation, Energy conservation in Boilers and furnaces, Energy conservation in Steam and condensate system.

Unit 4: Cogeneration and Insulation and Heating **[07 Hours]**

Concept, Types of cogeneration systems, performance evaluation of a cogeneration system. Waste Heat Recovery: Potential, benefits, waste heat recovery equipment's. Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building, Transfer of heat, Space heating methods, Ventilation and air conditioning, Heat pumps, Insulation, Cooling load, Electric water heating systems, Electric energy conservation methods.
Insulation and Heating Industrial Insulation: Insulation materials, Insulation selection, Economical

thickness of insulation. Industrial Heating: Heating by indirect resistance, direct resistance heating (salt bath furnace), and Heat treatment by induction heating in the electric arcfurnace industry.

Unit5: Energy Conservation in Electric Utility and Industry [07 Hours]

Energy costs and two-part tariff, Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors, Energy conservation in illumination systems, Importance of Power factoring energy conservation, Power factor improvement methods, Energy conservation in industries.

Texts:

1. Callaghan, "Energy Conservation".
2. D.L. Reeg, "Industrial Energy Conservation", Pergamon Press.

References:

1. T.L. Boyen, "Thermal Energy Recovery", Wiley Eastern.
2. L.J. Nagrath ,"System Modeling and Analysis", Tata Mc Graw Hill Publications.
3. S.P. Sukhatme, "Solar Energy", Tata Mc Graw Hill Publications.

Introduction to Probability Theory and Statistics

BTMOE605E	Introduction to Probability Theory and Statistics	OEC 2	3-0-0	3 Credits

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

CO1	Apply the concepts to find the measure of the central tendency, dispersion and momentsfor grouped data.
CO2	Make use of the correlation, and regression analyses to find the correlation and regression Coefficients.
CO3	Observe and analyze the behavior of various discrete and continuous probability Distributions.
CO4	Investigate the properties such as mathematical expectation and variance of the randomVariables.

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

Course Contents:

Unit 1: Probability **[07 Hours]**

Probability Theory: Definition of probability, Addition theorem of probability, Multiplication theorem of probability, Conditional probability, Bayes‟ theorem of inverse probability, Properties of probabilities with proofs.

Unit 2: Theoretical Probability Distributions **[07 Hours]**

Theoretical Probability Distributions: Binomial distribution, Poisson distribution, Normal distribution, Fitting of binomial distributions, Properties of Binomial, Poisson and normal distributions, Relation between binomial and normal distributions, Relation between Poisson and normal distributions, Importance of normal distribution, Examples.

Unit 3: Moments, Skewness and Kurtosis **[07 Hours]**

Moments about mean and an arbitrary point; Skewness: positive skewness, negative skewness, symmetric frequency distribution, Bowley‟s coefficient of skewness, Karl Pearson's coefficient of skewness, Measures of skewness based on moments ($\beta 1$, $\gamma 1$); Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions.

Unit IV: Correlation and Regression **[07 Hours]**

Correlation: Types of correlation, Karl Pearson's correlation coefficient (Covariance Method), Spearman's rank correlation method, Regression: lines of regression, fitting of lines of regression by the least squares method, interpretation of slope and intercept, properties of regression coefficients.

Unit V: Sampling Theory and Testing of Hypothesis **[07 Hours]**

Introduction to sampling distributions, Population and sample, Null hypothesis, and Alternative hypothesis, Single and two tailed test, Testing of hypothesis, Level of significance, Critical region, Procedure for testing of hypothesis.

Text Books:

1. Fundamentals of Statistics by S. C. Gupta, Himalaya Publishing House Pvt. Ltd., New Delhi.
2. Probability and Statistics by Dr. B. B. Singh, Synergy Knowledge ware, Mumbai.
3. Mathematical Statistics by P. Mukhopadhyay, New Central Book Agency, Kolkata.
4. Fundamentals of Mathematical Statistics by S. C. Gupta and V. K. Kapoor, S. Chand andSons, New Delhi.
5. An Introduction to Probability and Statistics by V. K. Rohatgi and A. K. Md. Ehsanes Saleh, Wiley Intercedence Publication, New York.
6. Introduction to Probability and Statistical Applications by P. L. Meyer, Addison WesleyPublishing Co., Massachusetts.

Reference Books:

1. Probability, Statistics with Reliability, Queuing and Computer ScienceApplications by KishorS. Trivedi, Wiley India Pvt. Ltd., Mumbai.
2. Probability, Queuing Theory and Reliability Engineering by G. Haribaskaran, Laxmi Publications, New Delhi.
3. Probability and Statistics by R. S. Murray, J. S. John, R. Alu Srinivasan and D. Goswami, Schaum"s Outlines series, McGraw Hill Publications, New Delhi.
4. Introduction to Theory of Statistics by A. M. Mood, F. A. Graybill and D. C.Boes, tata McGraw – Hill Publications,

Industrial Engineering

BTMXOE605A	OEC2	Industrial Engineering	3-0-0	3 Credits

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	Recognize comprehensive theoretical knowledge about Management & Organization.
CO2	Explain principle role & operation of Business sectors & organizations.
CO3	Recognize the need for work-study and importance of quality control.
CO4	Discuss role of supply chain management, role of IT tools in SCM.
CO5	Describe management information system (MIS) & government policies

Mapping of course outcomes with program outcomes

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

Course Contents

Unit 1 Introduction **[07 Hours]**

Chronological Developments in IE, Objectives, & Functions of IE, Industrial Management - Principles (e.g., planning, organizing, motivational theory), Tools of management (e.g., MBO, reengineering, organizational structure), Project management (e.g., scheduling, PERT, CPM), Productivity measures

Unit 2 Manufacturing, Production, and Service Systems **[07 Hours]**

Manufacturing systems (e.g., cellular, group technology, flexible), Process design (e.g., resources, equipment selection, line balancing), Inventory analysis (e.g., EOQ, safety stock), Forecasting, Scheduling (e.g., sequencing, cycle time, material control), Aggregate planning, Production planning (e.g., JIT, MRP, ERP), Lean enterprises, Automation concepts (e.g., robotics, CIM),Sustainable manufacturing (e.g., energy efficiency, waste reduction), Value engineering

Unit 3 Facilities and Logistics **[07 Hours]**

Flow measurements and analysis (e.g., from/to charts, flow planning), Layouts (e.g., types, distance metrics, planning, evaluation), Location analysis (e.g., single- and multiple-facility location, warehouses), Process capacity analysis (e.g., number of machines and people, trade-offs), Material handling capacity analysis, Supply chain management and design

Unit 4 Human Factors, Ergonomics, and Safety [07 Hours]

Hazard identification and risk assessment, Environmental stress assessment (e.g., noise, vibrations, heat), Industrial hygiene, Design for usability (e.g., tasks, tools, displays, controls, user interfaces), Anthropometry, Biomechanics, Cumulative trauma disorders (e.g., low back injuries, carpal tunnel syndrome), Systems safety, Cognitive engineering (e.g., information processing, situation awareness, human error, mental models)

Unit 5 Quality and Systems Engineering [07 Hours]

Quality - Six sigma, Management and planning tools (e.g., fishbone, Pareto, QFD, TQM), Control charts, Process capability and specifications, Sampling plans, Design of experiments for quality improvement, Reliability engineering

Systems Engineering - Requirements analysis, System design, Human systems integration, Functional analysis and allocation, Configuration management, Risk management, Verification and assurance, System life-cycle engineering

Text Book(s)

1. Introduction to Industrial Engineering by Avraham Shtub, Yuval Cohen, 2nd Edition, 2016, CRC Press, Boca Raton. ISBN: 9781498706018

Reference Books

1. Handbook of Industrial Engineering: Technology and Operations Management, Editor - Gavriel Salvendy, Print ISBN:9780471330578, Online ISBN:9780470172339, DOI:10.1002/9780470172339, Copyright © 2001 John Wiley & Sons, Inc.

Robot Programming Lab

BTARCL606	PCC 17	Robot Programming Lab	0-0-2	1 Credits

Teaching Scheme:	Examination Scheme:
Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

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

CO1	
CO2	
CO3	

Mapping of course outcomes with program outcomes

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

Course Contents:

List of Practical's:

1. Programming using the teach pendant method.
2. Programming on VAL Language
3. Programming the robot for path following operation using any robot
4. Programming the robot for palletizing operation using any robot
5. Programming the robot for pick and place operation using any robot
6. Robot Programming for Color identification/shape identification/path tracking
7. Industrial visit and its report on industrial applications of robots

Automation Design Lab

BTARCL607	PCC 18	Automation Design Lab	0-0-2	1 Credit

Teaching Scheme:	Examination Scheme:
Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

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

CO1	
CO2	
CO3	

Mapping of course outcomes with program outcomes

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

Course Contents:

List of Experiments

1. Identify the components and performance characteristics of the PLC and industry 4.0.
2. Introduction to the touch panel HMI and SCADA.
3. Operating simple loads using relays, switches, and push buttons.
4. Control of speed, direction, and angular displacement of servo motor.
5. Study of selection of materials for given applications.
6. Calculate the value of diameters of shaft for given loads and layout.
7. Find the value of dimensions of rigid coupling.
8. To determine the critical speed of the shaft
9. Study of selection and design procedure for belt drives and ropes drives.

B. Tech Seminar

BTARS608	B. Tech Seminar	PROJ-4	0-0-2	1 Credit

Teaching Scheme:	Examination Scheme:
Practical: 2hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks

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

CO1	
CO2	
CO3	

Mapping of course outcomes with program outcomes

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

Objective:

- To expose and make students aware with latest research and research publications
- To understand the research and research publication, references, citation
- To enhance the presentation skill
- To enhance the report writing
- To make the student aware about research publication sites

Students are expected to prepare a seminar report on the chosen topic/area selected with the discussion of chosen guide based on the available literature on the chosen topic.

Technical Project for Community Services

BTARP609	PROJ-5	TPCS	0-0-2	1 Credit

Teaching Scheme:	Examination Scheme:
Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

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

CO1	
CO2	
CO3	

Mapping of course outcomes with program outcomes

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

Course Contents:

Course context, Relevance, Practical Significance: The problem-based project-oriented model for learning is recommended. The model begins with the identifying of a problem, often growing out of a question, or "wondering". This formulated problem then stands as the starting point for learning. Students design and analyze the problem within an articulated interdisciplinary or subject frame. A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific and grows out of students‟ wondering within different disciplines and professional environments. A chosen problem has to be exemplary. The problem may involve an interdisciplinary approach in both the analysis and solving phases. By exemplarity, a problem needs to refer back to a particular practical, scientific, social and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry. There are no commonly shared criteria for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content and structure of the activity.

A few hands-on activities that may or may not be multidisciplinary.

Use of technology in meaningful ways to help them investigate, collaborate, analyze, synthesize, and present their learning.

Activities may include- Solving real life problems, investigation /study and Writing reports of in-depth study, field work.