

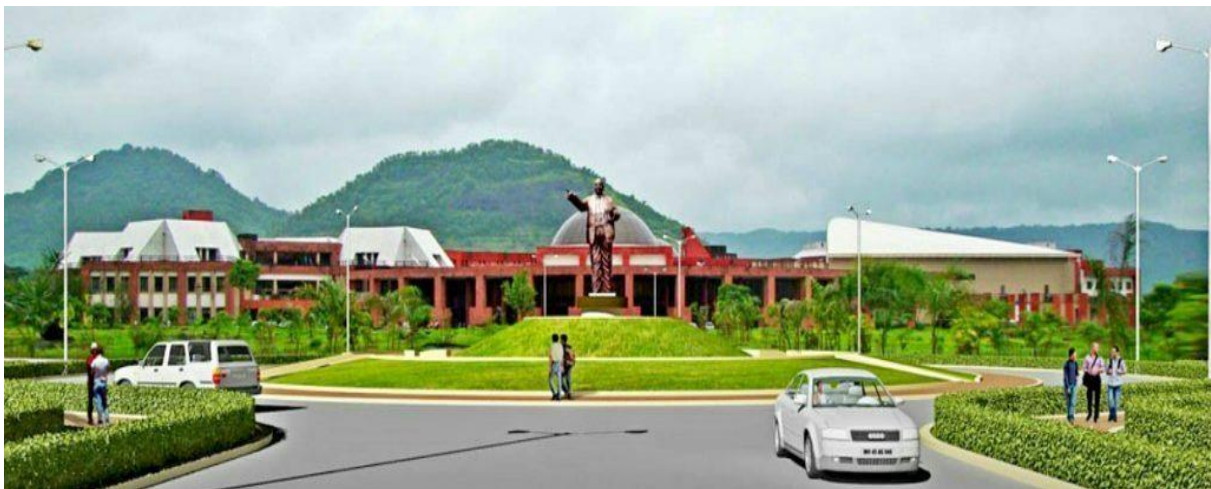
**Dr. Babasaheb Ambedkar Technological University**  
**(Established as University of Technology in the State of Maharashtra)**  
**(Under Maharashtra Act No. XXIX of 2014)**  
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**CURRICULUM**  
**UNDER GRADUATE PROGRAMME**  
**B. TECH.**

**2<sup>nd</sup> year III and IV Sem. MECHATRONICS ENGINEERING**

**ACADEMIC YEAR**  
**2022-2023**



**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 III  
B. Tech in Mechatronics (2022-23)**

Semester III										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
BSC7	BTBS301	Engineering Mathematics – III	3	1	-	20	20	60	100	4
PCC1	BTMXC302	Thermal & Fluids Engg.	3	1	-	20	20	60	100	4
PCC2	BTMXC303	Basic Concepts of Mechatronics	3	1	-	20	20	60	100	4
PCC3	BTMXC304	Electrical Machines and Drives	3	1	-	20	20	60	100	4
PCC4	BTMXC305	Microprocessor and Microcontroller	3	1		20	20	60	100	4
PCC5	BTMXCL306	Basic Mechatronics Lab	-	-	2	60	-	40	100	1
PCC6	BTMXCL307	Electrical Machines Lab			2	60	-	40	100	1
PROJ-2	BTES209P	IT – 1 Evaluation	-	-	-	-	-	100	100	1
<b>Total</b>			<b>15</b>	<b>5</b>	<b>4</b>	<b>220</b>	<b>100</b>	<b>480</b>	<b>800</b>	<b>23</b>

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course  
 PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course  
 HSSMC = Humanities and Social Science including Management Courses

Semester IV										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
			L	T	P	CA	MSE	ESE	Total	
PCC 7	BTMXC 401	Analog and Digital Electronics	3	1	-	20	20	60	100	4
PCC 8	BTMXC 402	Low Cost Automation	3	1	-	20	20	60	100	4
HSSMC3	BTHM403	Basic Human Rights	3	-	-	20	20	60	100	3
PCC9	BTMXC404	Theory of Machines and Mechanisms	3	1	-	20	20	60	100	4
PEC 1	BTMXPE405A, B/ BTMPE405A	Elective-I	3	-	-	20	20	60	100	3
PCC10	BTMXCL406	Analog and Digital Electronics Lab	-	-	2	60	-	40	100	1
PCC11	BTMXCL407	Automation Lab			2	60		40	100	1
PROJ-3	BTMXI408	Field Training /Industrial Training (minimum of 4 weeks which can be completed partially in the third and fourth semester or	-	-	-	-	-	-	-	Credits to be evaluated in Sem V

		in one semester itself)								
<b>Total</b>			<b>15</b>	<b>4</b>	<b>4</b>	<b>220</b>	<b>100</b>	<b>380</b>	<b>700</b>	<b>20</b>

**Course Structure for Semester IV**

**B. Tech in Mechatronics (2022-23)**

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 I**

<b>Sr. No</b>	<b>Course code</b>	<b>Course Name</b>
1	BTMPE405A	Numerical Methods in Engineering
2	BTMXPE405A	Embedded Systems
3	BTMXPE405B	Signals & Systems

**Semester III**  
**Engineering Mathematics-III**

BTBS301	Engineering Mathematics-III	BSC 7	3L-1T-0P	4 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/week Tutorial: 1hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

**Course Objectives:**

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Linear differential equations of higher order using analytical methods and numerical methods applicable to Control systems and Networkanalysis.
2. Transforms such as Fourier transform, Laplace transform and applications to Communication systems and Signalprocessing.
3. Vector differentiation and integration required in Electro-magnetics and Wavetheory.
4. Complex functions, conformal mappings, contour integration applicable to Electrostatics, Digital filters, Signal and Image processing.

**Course Outcomes:**

On completion of the course, students will be able to:

- Solve higher order linear differential equation using appropriate techniques for modeling and analyzing electrical circuits.
- Solve problems related to Fourier transform, Laplace transform and applications to Communication systems and Signal processing.
- Obtain Interpolating polynomials, numerically differentiate and integrate functions, numerical solutions of differential equations using single step and multi-step iterative methods used in modern scientific computing.
- Perform vector differentiation and integration, analyze the vector fields and apply to Electromagnetic fields.
- Analyze conformal mappings, transformations and perform contour integration of complex functions in the study of electrostatics and signal processing.

**Course Contents:**

**Unit 1: Laplace Transform [09 Hours]**

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by  $t^n$ , scale change property, transforms of functions divided by  $t$ , transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

**Unit 2: Inverse Laplace Transform [09 Hours]**

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients

**Unit 3: Fourier Transform [09 Hours]**

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms ; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

**Unit 4: Partial Differential Equations and Their Applications[09 Hours]**

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation  $(\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2})$ , and one dimensional wave equation (i.e.  $\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$ ).

**Unit 5: Functions of Complex Variables [09 Hours]**

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs).

**Text Books**

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

**Reference Books**

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. ,Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi.
4. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledge ware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill , New York.

**General Instructions:**

1. The tutorial classes in Engineering Mathematics-III are to be conducted batchwise. Each class should be divided into three batches for the purpose.
2. The internal assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.
3. The minimum number of assignments should be eight covering all topics.

### Thermal and Fluid Engg.

BTMXC302	PCC 1	Thermal and Fluid Engg.	3-1-0	4 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
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	
CO2	
CO3	
CO4	
CO5	
CO6	
CO7	

#### 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												
CO7												

**Course Contents:**

**Unit 1: Thermodynamics**

Thermodynamic system and its type; Macroscopic vs. Microscopic viewpoint, properties, processes and cycles, point function, path function. Thermodynamic equilibrium, Quasi-static process. temperature and its measurement (principle of measurement, various instruments etc.). Zeroth law of thermodynamics, First law of thermodynamics for a closed system undergoing a cycle and change of state, SFEE, Limitation of first law of thermodynamics, cycle heat engine, refrigerator and heat pump, Carnot cycle

**Unit 2: Fluid properties & Hydrostatic**

Fluid properties & its definitions, definition of fluid, Viscosity, Bulk modulus of elasticity, Vapour pressure, Surface tension, Capillarity, Manometers (No numerical on manometers ),



Pascal's law, Hydrostatic law its derivation, Total pressure & Centre of pressure on vertical, horizontal, inclined, curved surface its derivation, Concept Of buoyancy & flotation Meta centre, metacentric height its derivation. Stability, instability, equilibrium of floating & submerged body

### **Unit 3: Fluid Kinematics and Dynamics**

Types of flow, Definition of steady, Unsteady, Uniform, Non uniform, Laminar, Turbulent, Compressible, incompressible, rotational, Irrotational flow, 1D-2D flows, Stream line, Streak line, Path line, concept of Velocity, potential & stream function flow net (no numerical treatment), Continuity equation for steady, Unsteady, Uniform, Non uniform, Compressible incompressible, 2D Euler's equation, Bernoulli's equation along a stream line for incompressible flow, Practical applications of Bernoulli's equation - Pitot tube, Venturi meter, Orifice meter.

### **Unit 4: Viscous Flow and Turbulent Flow**

Introduction to flow of viscous fluid through circular pipes, two parallel plates derivation and numerical.

Turbulent Flow: Reynolds's experiment, frictional loss in pipe flow, shear stress in turbulent flow, major and minor losses.

### **Unit 5: Dimensional Analysis and Flow through Pipes**

Introduction to dimensional analysis, dimensional homogeneity, methods of dimensional analysis- Rayleigh's method, Buckingham's  $\pi$ -theorem, dimensionless numbers. ( No numerical treatment), Loss of energy in pipes, loss of energy due to friction, minor energy losses, concept of HGL and TEL, flow through syphon, flow trough pipes in series or compound pipes, equivalent pipe, parallel pipes, branched pipes, Power transmission through pipes. Water hammer phenomenon (No numerical on water hammer)

### **Texts:**

1. P. N. Modi, S. M. Seth, "Fluid Mechanics and Hydraulic Machinery", Standard Book House, 10<sup>th</sup> edition, 1991.
2. Robert W. Fox, Alan T. McDonald, "Introduction to Fluid Mechanics", John Wile and Sons, 5<sup>th</sup> edition.
3. Fluid mechanics and Hydraulic machines, Dr. R. K. Bansal , Laxmi Publication, Delhi, 2005
4. Thermodynamics, P. K. Nag, TMH

### **References:**

1. V. L. Streeter, K. W. Bedford and E. B. Wylie, "Fluid Dynamics", Tata McGraw-Hill, 9<sup>th</sup> edition, 1998.
2. S. K. Som, G. Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 2<sup>nd</sup> edition, 2003.

### Basic Concepts of Mechatronics

BTMXC303	PCC2	Basic Concepts of Mechatronics	3-1-0	4 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
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	
CO2	
CO3	
CO4	
CO5	

#### Mapping of course outcomes with program outcomes

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

**Course Contents:**

**Unit I:** Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface.

**Unit II:** Sensors and transducers: classification, Development in Transducer technology, Opto-Electronics-Shaft encoders, CD Sensors, Vision System, etc.

**Unit III:** Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems

**Unit IV:** Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators:



CO5												
CO6												

**Course Contents:**

**Unit I:** DC Machines-I: Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

**Unit II:** DC Machines –II: Motoring and generation Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines.

**Unit III:** Induction Machines: Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

**Unit IV:** Single-phase induction motors: Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications.

**Unit V:** Synchronous machines: Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

**Text/Reference Books:**

1. A. E. Fitzgerald and C. Kingsley, “Electric Machinery”, McGraw Hill Education, 2013.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. P. S. Bhimbhra, “Electrical Machines”, Khanna Book Publishing House, 2018.
4. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.
5. A. S. Langsdorf, “Alternating current Machines”, McGraw Hill Education, 1984.
6. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007.
7. P. S. Bhimbhra, “Power Electronics”, Khanna Publishers, 2017.

Alternative NPTEL/SWAYAM Course

**Microprocessor and Microcontroller**

BTMXC305	PCC4	Microprocessor and Microcontroller	3-1-0	4 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Practical: 4 hrs/week	Continuous Assessment: 60 Marks External 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												

**Unit I: 8085 MICROPROCESSOR:** History and Evolution of Microprocessor and their Classification, Architecture of 8085 Microprocessor, Address / Data Bus multiplexing and demultiplexing. Status and Control signal generation, Instruction set of 8085 Microprocessor, Classification of instructions, addressing modes, timing diagram of the instructions.

**Unit II: Hardware Interfacing with 8085:** Methods of data Transfer and Interrupts of 8085 microprocessors: Classification of interrupts, Programming using interrupts, Direct Memory Access, Serial and parallel data transfer, Interfacing of Memory Chips with 8085 Microprocessor, Interfacing of 8085 with 8155/8156 (RAM), 8355/8755 (ROM). Interfacing of Programmable Devices with 8085 Microprocessor, 8279 programmable Keyboard/Display interface, 8255A programmable Parallel interface, 8254 programmable Interval Timer, 8259A programmable Interrupt Controller, Assembly language programming.

**Unit III: 16-bit low power MCU:** Introduction to microcontrollers and embedded systems, Von Neumann (Princeton) and Harvard architecture, RISC and CISC machine, Architecture,

Programming Techniques, Addressing Modes, Programming System registers and configuration I/O ports pull up/down registers concepts, Low Power aspects of MSP430: low power modes, Active vs Standby current consumption.

**Unit IV:** Configuring Peripherals in MSP430: External interrupts and software interrupt, interrupt programming, Watchdog timer, Clock Tree in MSP430, Timer/ counter interrupt, Programming MSP430 timer, counter programming, Real Time Clock (RTC), PWM control, timing generation and measurements. Analog interfacing and data acquisition: ADC and Comparator in MSP430, data transfer using DMA.

**Unit V:** Serial Communication Interfaces in MSP430: Basics of serial communication, mode of serial communication, RS232, serial communication issue, Serial port programming. Implementing and programming UART, I2C, SPI interface using MSP430, interfacing external devices, external memory, keyboards, display devices, DAC/ADC, DC Motor, Stepper Motor, Servomotor, power management, Sensor Interfacing and signal conditioning. Case Study: MSP430 based embedded system application using the interface protocols for communication with external devices: “A Low- Power Battery less Wireless Temperature and Humidity Sensor with Passive Low Frequency RFID.

**Text Books:**

1. Ramesh Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publication (India) Pvt. Ltd. AICTE Model Curriculum for UG Degree Course in Mechatronics 121
2. DV Hall, “Microprocessors Interfacing”, Tata McGraw Hill Publication.
3. N. Senthil Kumar, M. Saravanan, S. Jeevananthan, “Microprocessors and Microcontrollers”, Oxford University Press Publication.
3. Getting Started with the MSP430 Launchpad by Adrian Fernandez, Dung Dang, Newness publication ISBN-13: 978-0124115880 5. MSP430 microcontroller basics 1st Edition by John H. Davies (Author), Newnes Publication ISBN-13: 978-0750682763

**References:**

1. [http://processors.wiki.ti.com/index.php/MSP430\\_LaunchPad\\_Low\\_Power\\_Mode](http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_Low_Power_Mode).
2. [http://processors.wiki.ti.com/index.php/MSP430\\_16-t\\_UltraLow\\_Power\\_MCU\\_Training](http://processors.wiki.ti.com/index.php/MSP430_16-t_UltraLow_Power_MCU_Training).
3. AK Roy & KM Bhurchandi, “Advance Microprocessor and Peripherals (Architecture, Programming & Interfacing)”, Tata McGraw Hill Publication..

### **Basic Mechatronics Lab**

BTMXCL306	PCC5	Basic Mechatronics Lab	0-0-2	1 Credit
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<b>Practical Scheme:</b> Practical: 2 hrs/batch	<b>Examination Scheme:</b> Continuous Assessment: 60 Marks External Exam: 40 Marks
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**List of Experiments:**

1. Identification and familiarization of the following components: resistors, inductors, capacitors, diodes, transistors, LED's.
2. Familiarization with the following components: CRO, transformer, function generator, Multimeter, power supply.
3. Familiarization with the following electrical machines: Induction motors, DC motors, synchronous motors, single phase motors.
4. Familiarization with the following mechanical components: gears, gear train, bearings, couplings, tachometer
5. To study and design the PN junction diode and its use as half wave and full wave rectifier.
6. To design a voltage regulator using zener diode. Discuss the behavior of the regulator for various loads.
7. To verify truth tables of various logic gates and flip flops.
8. To study various sensors and transducers and compare with ideal characteristics.
9. To measure the characteristics of LVDT using linear displacement trainer kit.

**Text/Reference Books:**

1. Bolton, "Mechatronics", Pearson, Singapore.
2. Mahalik, "Principles, concepts and applications Mechatronics", TMH.
3. Ramesh Gaonkar, "Introduction to 8085-PENRAM", International Publishing.
4. Muzumdar, "Pneumatics" –Tata McGraw-Hill Education.

### **Electrical Machines Lab**

BTMXCL307	PCC6	Electrical Machines Lab	0-0-2	1 Credit
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<b>Practical Scheme:</b> Practical: 2 hrs/batch	<b>Examination Scheme:</b> Continuous Assessment: 60 Marks External Exam: 40 Marks
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**List of Experiments:**

- 1 Performance characteristics of a D.C. Shunt motor.
2. Speed control of dc shunt motor by varying armature circuit and field circuit method.

3. Load test of D.C. shunt motor.
4. Perform an open circuit test and block rotor test on a 3 phase IM to draw equivalent circuit.
5. Perform load test on a universal motor and determine the performance with dc/ac supply voltage.
6. Speed control of 3 phase Induction Motor.
7. Determination of the performance characteristics of a three-phase induction motor by load test.
8. Obtain a circle diagram of the given three-phase induction motor by conducting no load and blocked motor test and to determine the maximum torque, maximum power output.

**Text/Reference Books:**

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bhimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current Machines", McGraw Hill Education, 1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.

**IT – 1 Evaluation**

BTES209P (IT – 1)	IT– 1 Evaluation	PROJ-1	OL-OT-OP	1 Credits
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<b>Teaching Scheme:</b> Lecture: --	<b>Examination Scheme:</b> Continuous Assessment: -- Mid Semester Exam: -- End Semester Exam: 100 Marks
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**Semester IV**  
**Analog and Digital Electronics**

BTMXC401	PCC 7	Analog and Digital Electronics	3-1-0	4 Credits
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**Pre-Requisites:** None

<b>Teaching Scheme:</b> Lecture: 3 hrs/week Tutorial: 1 hr/week	<b>Examination Scheme:</b> Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)
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**Pre-Requisites:** None

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



CO1	
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												

**Course Contents:**

**Unit-I:** Field Effect Transistors: Junction Field Effect Transistors, MOSFETs, Differences between JFETs and MOSFETs, Biasing MOSFETs, FET Applications, CMOS Devices. Wave-Shaping Circuits: Integrated Circuit(IC) Multi vibrators. Introduction to Operational Amplifier: Ideal v/s practical Op Amp, Performance Parameters, Operational Amplifier Application Circuits: Peak Detector Circuit, Comparator, Active Filters, Non Linear Amplifier, Relaxation Oscillator, Current-To-Voltage Converter, Voltage-To Current Converter.

**Unit-II:** The Basic Gates: Review of Basic Logic gates, Positive and Negative Logic, Introduction to HDL. Combinational Logic Circuits: Sum-of-Products Method, Truth Table to Karnaugh Map, Pairs Quads, and Octets, Karnaugh Simplifications, Don't-care Conditions, Product-of-sums Method, Product-of-sums simplifications, Simplification by Quine-McClusky Method, Hazards and Hazard covers, HDL Implementation Models.

**Unit-III:** Data-Processing Circuits: Multiplexers, Demultiplexers, 1-of-16 Decoder, BCD to Decimal Decoders, Seven Segment Decoders, Encoders, Exclusive-OR Gates, Parity Generators and Checkers, Magnitude Comparator, Programmable Array Logic, Programmable Logic Arrays, HDL Implementation of Data Processing Circuits. Arithmetic Building Blocks, Arithmetic Logic Module.

**Unit-IV:** Flip- Flops: FLIP-FLOP Timing, JK Master-slave FLIP-FLOP, Switch Contact Bounce Circuits, Various Representation of FLIP-FLOPs, HDL Implementation of FLIPFLOP. Registers: Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In - Serial Out, Parallel In - Parallel Out, Universal Shift Register, Applications of Shift Registers, Register implementation in HDL.

**Unit-V:** Counters: Decade Counters, Preset table Counters, Counter Design as a Synthesis

problem, A Digital Clock, Counter Design using HDL. D/A Conversion and A/D Conversion: Variable, Resistor Networks, Binary Ladders, D/A Converters, D/A Accuracy and Resolution, A/D Converter-Simultaneous Conversion, A/D Converter-Counter Method, Continuous A/D Conversion, A/D Techniques, Dualslope A/D Conversion, A/D Accuracy and Resolution.

**Text/Reference Books:**

1. A.K. Main & Nakul Maini, Analog Electronics, Khanna Book Publishing House (2018).
2. A.S. Sedra & K.C.Smith, Microelectronics Circuits, Oxford University Press (1997).
3. A.P. Malvino, Electronic Principles, Tata Mcgraw Hill Publications.
4. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory.
5. William Kleitz, Digital Electronics, Prentice Hall International Inc

**Low Cost Automation**

BTMXC402	PCC 8	Low cost Automation	3-1-0	4 Credits
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**Pre-Requisites:** None

<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
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	
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												

**Course Contents:**

**Unit 1: Principles of Low Cost Automation**

**[07 Hours]**

Principles of low cost automation, need, advantages, applications and limitations of low cost automation systems, components of low cost automation systems

**Unit 2: Pneumatic Systems**

**[10 Hours]**

Pneumatic fundamentals - control elements, pneumatic air preparation, components of pneumatic systems, logic circuits, sequential circuits, cascade methods, electro-pneumatics – components, electro-pneumatic circuit design

**Unit 3: Hydraulic Systems**

**[10 Hours]**

Hydraulic fundamentals - control elements, Hydraulic oil – properties and grades, components of hydraulic systems, logic circuits, sequential circuits, meter-in and meter-out circuits, electro-hydraulics – components, electro-hydraulic circuit design

**Unit 4: PLC & SCADA**

**[07 Hours]**

Digital Electronics Basics, PLC Fundamentals, PLC Hardware & Architecture Source & sink Concepts, Introduction to PLC Programming, Basic Programming Instructions, SCADA

**Unit 5: Safety, fault-finding and maintenance and Case Study**

**[10 Hours]**

Safety, cleanliness, fault-finding instruments, Preventive maintenance

**Case study: Low cost automation for Assembly line automation**

Types and configurations for automated assembly lines, Parts delivery at workstations, Various vibratory and non vibratory part feeding devices - hopper feeders, rotary disc feeder, centrifugal and orientation, part transfer/transportation systems.

**Texts:**

1. Mujumdar.S.R, “Pneumatic System”, Tata McGraw Hill 2006
2. Mujumdar.S.R, “Oil Hydraulic Systems: Principle and Maintenance”, Tata McGraw Hill 2002
3. Andrew Parr, " Hydraulics and Pneumatics: A technician's and engineer's guide", Second edition, Butterworth-Heinemann, Oxford, 1998
4. Mikell P Groover, “Automation, Production System and Computer Integrated Manufacturing”, Prentice Hall Publications, 2007.

**References:**

1. Peter Rohner, “Industrial hydraulic control”, Wiley Edition, 1995.
2. J. R. Fawcett, "Pneumatic Circuits and Low Cost Automation", Trade & Technical Press Ltd, 1968

**Basic Human Rights**

BTHM403	HSSMC3	Basic Human Rights	3-0-0	3 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
Lecture: 3 hrs/week	Credit Course

**Pre-Requisites:** None

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

CO1	Understand the history of human rights.
CO2	Learn to respect others caste, religion, region and culture.
CO3	Be aware of their rights as Indian citizen.
CO4	Understand the importance of groups and communities in the society.
CO5	Realize the philosophical and cultural basis and historical perspectives of human rights.
CO6	Make them aware of their responsibilities towards the nation.

**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												
CO3												
CO4									3			
CO5								2		2		
CO6												1

**Course Contents:**

**Unit 1: The Basic Concepts, Fundamental Rights and Economic Program [07 Hours]**

Individual, group, civil society, state, equality, justice. Human Values, Human rights and Human Duties. Declaration of independence, Rights of citizen, Rights of working and exploited people Society, religion, culture, and their inter-relationship. Impact of social structure on human behavior.

Social Problems: Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labour.

**Unit 2: Workers and Human Rights [07 Hours]**

Migrant workers and human rights violations, human rights of mentally and physically challenged. State, Individual liberty, Freedom and democracy.

**Unit 3: NGOs and Human Rights in India [07 Hours]**

Land, Water, Forest issues.

**Unit 4: Human Rights in Indian Constitution and Law [07 Hours]**



CO5												
CO6												

**Course Contents:**

**Unit I:** Classification of mechanisms- Basic kinematic concepts and definitions Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains- Limit positions- Mechanical advantage- Transmission angle Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms.

**Unit II:** Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centres, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics.

**Unit III:** Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation.

**Unit IV:** Classification of cams and followers- Terminology and definitions Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers. Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

**Unit V:** Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes.

**Text Books:**

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. Cleghorn W.L., Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd, New Delhi

**Numerical Methods in Mechanical Engineering**

BTMPE405A	PEC 1	Numerical Methods in Engineering	3-1-0	4 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
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:** At the end of the course, students will be able to:

CO1	Describe the concept of error
CO2	Illustrate the concept of various Numerical Techniques
CO3	Evaluate the given Engineering problem using the suitable Numerical Technique
CO4	Develop the computer programming based on the Numerical Techniques

**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		1	3							
CO2	3	3		1	3							
CO3	3	3		1	3							
CO4	3	3		1	3							

**Course Contents:**

**Unit1: Error Analysis [07 Hours]**

Significant figures, round-off, precision and accuracy, approximate and true error, truncation error and Taylor series, machine epsilon, data uncertainties, error propagation, importance of errors in computer programming.

**Unit2: Roots of Equations [07 Hours]**

Motivation, Bracketing methods: Bisection methods, Open methods: Newton Raphson method, Engineering applications.

**Unit3: Numerical Solution of Algebraic Equations [07 Hours]**

Motivation, Cramer's rule, Gauss- Elimination Method, pivoting, scaling, engineering applications.

**Unit4: Numerical Integration and Differentiation [07 Hours]**

Motivation, Newton's Cotes Integration Formulas: Trapezoidal Rule, Simpson's rule, engineering applications Numerical differentiation using Finite divide Difference method

**Unit5: Curve, Fitting and Interpolation and Computer Programming [07 Hours]**

Motivation, Least Square Regression: Linear Regression, Polynomial regression.

**Interpolation:** Newton's Divide Difference interpolation, engineering applications.

**Solution to Ordinary Differentiation Equations:** Motivation, Euler's and Modified Euler's





**Course Contents:**

**Unit 1:** The concept of embedded systems design, embedded microcontroller cores, embedded memories. Examples of embedded systems,

**Unit 2:** Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing.

**Unit 3:** Sub-system interfacing, interfacing with external systems, user interfacing.

**Unit 4:** Design trade-offs due to process compatibility, thermal considerations, etc.,

**Unit 5:** Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

**Text/Reference Books**

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madiseti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming and Applications", Penram Intl, 1996.

**Signals & Systems**

BTMXE405B	PEC 1	Signals & Systems	3-1-0	4 Credits
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<b>Teaching Scheme:</b>	<b>Examination Scheme:</b>
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	
CO2	
CO3	
CO4	
CO5	
CO6	
CO7	

**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												
CO7												

**Course Contents:**

**Unit I:** Basic definitions, Classification of signals and systems. Signal operations and properties. Basic continuous time signals, signal sampling and quantization, iscretization of continuous time signals, discrete time signals. Basic system properties, Representation of digital signals. Case study of different signals form communication and biomedical field.

**Unit II:** Impulse response characterization and convolution integral for CT- LTI system, signal responses to CT-LTI system, properties of convolution, LTI system response properties from impulse response. (\*Review of Laplace transform with reference to CT signals and systems.)

**Unit III:** Impulse response characterization and convolution sum, Causal signal response to DT-LTI systems. Properties of convolution summation, Impulse response of DT-LTI system. DT-LTI system properties from Impulse response. System analysis from difference equation model

**Unit IV:** Representation of periodic functions, Fourier series, Frequency spectrum of a periodic signals, Fourier Transform, Relation between Laplace Transform and Fourier Transform and its properties. Introduction to DTFT and DFT

**Unit V:** The z-Transform, Convergence of z-Transform, Basic z-Transform, Properties of z-Transform, Inverse z-Transform and Solving difference equation using z-Transform

**Text/Reference Books:**

1. Signals and Systems by Alan V. Oppenheim, Alan S. Wilsky and Nawab, Prentice Hall.
2. Signals and Systems by K. Gopalan, Cengage Learning (India Edition).
3. Signals and Systems by Michal J. Roberts and Govind Sharma, Tata Mc-Graw Hill Publications.
4. Signals and Systems by Simon Haykin and Bary Van Veen, Wiley- India Publications.
5. Linear Systems and Signals by B.P.Lathi, Oxford University Press.
6. Signal, Systems and Transforms by Charles L. Philips, J. M. Parr and E. A. Riskin, Pearson Education.
7. Digital Signal Processing Fundamentals and Applications by Li Tan, Elsevier, Academic Press.
8. Signal and Systems by Anand Kumar, 3rd Edition, PHI

**Analog and Digital Electronics Lab**

BTMXCL406	PCC10	Analog and Digital Electronics Lab	0-0-2	1 Credit
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<b>Practical Scheme:</b>	<b>Examination Scheme:</b>
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

**List of Experiments: (Any Six Experiments)**

1. a. Design and construct a Schmitt trigger using Op-Amp for given UTP 1 and LTP values and demonstrate its working. b. Design and implement a Schmitt trigger using Op-Amp using a simulation package for two sets of UTP and LTP values and 3 demonstrate its working.
  
2. a. Design and construct a rectangular waveform generator (Op-Amp 5 relaxation oscillator) for given frequency. b. Design and implement a rectangular waveform generator (Op-Amp relaxation oscillator) using a simulation package and observe the change in frequency when all resistor values are doubled.
  
3. Design and implement a stable multivibrator circuit using 555 timers for a given frequency and duty cycle.
  
4. Design and implement Half adder, Full Adder, Half Subtractor, Full Subtractor using basic gates.
  
5. a. Given any 4-variable logic expression, simplify using Entered 16 Variable Map and realize the simplified logic expression using 8:1 multiplexer IC. b. Write the Verilog /VHDL code for an 8:1 multiplexer. Simulate 18 and verify it's working.
  
6. a) Design and implement code converter I) Binary to Gray II) Gray to Binary Code using basic gates.
  
7. Design and verify the Truth Table of 3-bit Parity Generator and 4-bit Parity Checker using basic logic gates with an even parity bit.
  
8. a. Realize a J-K Master/Slave Flip-Flop using NAND gates and verify its truth table. b. Write the Verilog/VHDL code for D Flip-Flop with positive-edge triggering. Simulate and verify it's working.

**Text Books:**

Sedra Adel S and Smith Kenneth Carless, Microelectronic Circuits, 5th Edition, Oxford University Press, 2004.

**Reference Books:**

1. A.K. Main & Nakul Maini, Analog Electronics, Khanna Book Publishing House (2018).
2. A.S. Sedra & K.C.Smith, Microelectronics Circuits, Oxford University Press (1997)
3. A.P. Malvino, Electronic Principles, Tata Mcgraw Hill Publications
4. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory
5. William Kleitz, Digital Electronics, Prentice Hall International Inc

**Automation Lab**

BTMXCL407	PCC11	Automation Lab	0-0-2	1 Credit
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<b>Practical Scheme:</b>	<b>Examination Scheme:</b>
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

**List of Experiments: (Any Eight Experiments)**

1. Study hardware and software used in PLC.
2. Implementation of logic gates in PLC.
3. Implementation of arithmetic instruction.
4. Implementation of on and off delay timers.
5. Study, understand and perform experiments on timers and counters.
6. Study and simulate analog function blocks.
7. Logic implementation for traffic control application.
8. Logic implementation for bottle filling application.
9. Direct control of double acting cylinder.
10. Indirect control of double acting cylinder.
11. Hydraulic pump/characteristic curve of variable displacement pump.
12. Single-rod cylinder/pressure intensification.