SYLLABUS OF
UNDERGRADUATE DEGREE COURSE

Mechatronics

Effective for the students admitted in year 2021-22 and onwards.

B.Tech. : Mechatronics
3rd Year - V Semester

SN	Category	Course code	Course Title	Hours			Marks			Credit
				L	T	P	IA	ETE	Total	
THEORY										
1	DC	5MX4-01	Linear Integrated Circuits	3	0	0	30	70	**100**	**3**
2		5MX4-02	Linear Control Theory	3	0	0	30	70	**100**	**3**
3		5MX4-03	Microcontroller based System Design	3	0	0	30	70	**100**	**3**
4		5MX4-04	Theory of Machines	3	0	0	30	70	**100**	**3**
5		5MX4-05	Pneumatics and Hydraulic Systems	3	0	0	30	70	**100**	**3**
6	DE		**DE-I (Any one)**	3	0	0	30	70	**100**	**3**
		5MX5-11	CAD and CAM							
		5MX5-12	Heat Transfer							
		5MX5-13	Metrology and Measurements							
		5MX5-14	Digital Signal Processing							
			Sub Total	**18**	**0**	**0**	**180**	**420**	**600**	**18**
PRACTICAL & SESSIONAL										
7	DC	5MX4-20	Pneumatics and Hydraulic Lab	0	0	2	60	40	**100**	**1**
8		5MX4-21	Theory of Machines Lab	0	0	2	60	40	**100**	**1**
9		5MX4-22	Microcontroller Lab	0	0	2	60	40	**100**	**1**
10	DE		**DE II(Any one)** **(students have to opt the same lab relevant to DE-I)**	0	0	2	60	40	**100**	**1**
		5MX5-20	CAD and CAM Lab							
		5MX5-21	Heat Transfer Lab							
		5MX5-22	Metrology Lab							
		5MX5-23	Digital Signal Processing Lab							
11	UI	5MX7-30	Industrial Training	0	0	2*	60	40	**100**	**3**
12	CCA	5MX8-00	SODECA/NCC/NSS/ ANANDAM/IPR	-	-	-	-	100	**100**	**1**
			SUB TOTAL	**0**	**0**	**10**	**300**	**300**	**600**	**8**
			TOTAL OF V SEMESTER	**17**	**0**	**10**	**480**	**720**	**1200**	**26**

L = Lecture, **T** = Tutorial, **P** = Practical, **IA**=Internal Assessment, **ETE**=End Term Exam, **Cr**=Credits

***for calculation of contact hours**

B.Tech. : Mechatronics
3rd Year - VI Semester

S.N.	Category	Course Code	Course Title	Hours			Marks			Credit
				L	T	P	IA	ETE	Total	
THEORY										
1	DC	6MX4-01	Industrial Engineering	3	0	0	30	70	**100**	**3**
2		6MX4-02	Computational Fluid Dynamics	3	0	0	30	70	**100**	**3**
3		6MX4-03	Power Electronics and Electrical Devices	3	0	0	30	70	**100**	**3**
4		6MX4-04	Machine design	3	0	0	30	70	**100**	**3**
5		6MX4-05	MEMS and Microsystems	2	0	0	30	70	**100**	**2**
6	DE		**DE-III (Any one)**	2	0	0	30	70	**100**	**2**
		6MX5-11	Industrial Automation							
		6MX5-12	Finite Element Methods							
		6MX5-13	Modelling and Simulation of Manufacturing Systems							
			Sub Total	**16**	**0**	**0**	**180**	**420**	**600**	**16**
PRACTICAL & SESSIONAL										
7	DC	6MX4-20	Machine Design Lab	0	0	3	60	40	**100**	**1.5**
8		6MX4-21	Drives, Control and Simulation Lab	0	0	2	60	40	**100**	**1**
9		6MX4-22	MATLAB Programming	0	0	3	60	40	**100**	**1.5**
10	UI	6MX7-50	Mini Project			4*	60	40	**100**	**2**
11	CCA	6MX8-00	SODECA/NCC/NSS/ ANANDAM/IPR	-	-	-	-	100	**100**	**2**
			SUB TOTAL	**0**	**0**	**12**	**240**	**260**	**500**	**8**
			TOTAL OF VI SEMESTER	**16**	**0**	**12**	**420**	**680**	**1100**	**24**

L = Lecture, **T** = Tutorial, **P** = Practical, **IA**=Internal Assessment, **ETE**=End Term Exam, **Cr**=Credits

***for calculation of contact hours**

5MX4-01: Linear Integrated Circuits

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To understand the basic concepts of operational amplifier and its various applications.
2. To understand the basics of PLL and its practical applications.
3. To know about analog multipliers.
4. To know about various analog switches and different A/D and D/A convertors.
5. To understand the concepts of switched capacitor filters, Voltage regulator and various.

Course Outcomes

Student will be able to

1. Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve engineering problems
2. Develop skills to design simple circuits using OP-AMP.
3. Gain knowledge about various multiplier circuits, modulators and demodulators.
4. Gain knowledge about PLL.
5. Learn about various techniques to develop A/D and D/A convertors.
6. Develop skills to develop simple filter circuits and various amplifiers and can solve problems related to it.

S. No	Contents	Hours
1	BASICS OF OPERATIONAL AMPLIFIERS Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, Basic information about op-amps — Ideal Operational Amplifier — General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations — JFET Operational Amplifiers — LF155 and TL082.	8
2	APPLICATIONS OF OPERATIONAL AMPLIFIERS Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.	8
3	ANALOG MULTIPLIER AND PLL Analog Multiplier using Emitter Coupled Transistor Pair — Gilbert Multiplier cell — Variable transconductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronization.	9
4	ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS Analog and Digital Data Conversions, D/A converter — specifications — weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R — 2R Ladder types — switches for D/A	8

	converters, high speed sample-and-hold circuits, A/D Converters — specifications — Flash type — Successive Approximation type — Single Slope type — Dual Slope type — A/D Converter using Voltage-to-Time Conversion — Over-sampling A/D Converters, Sigma — Delta converters.	
5	WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators — Three terminal fixed and adjustable voltage regulators — IC 723 general purpose regulator — Monolithic switching regulator, Low Drop — Out(LDO) Regulators — Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC.	9

TEXT BOOKS

1. Ramakant A. Gayakwad, “Op-amps and linear integrated circuit technology” Prentice Hall, Fourth Edition, 2000
2. Sedra A and Smith K C, “Microelectronic circuits”, Oxford University Press, Sixth Edition, 2010.

REFERENCE BOOKS

1. Neamen D A, “Electronic circuit analysis and design”, McGraw-Hill, 2001.
2. Franco S., “Design with operational amplifiers and analog integrated circuits”, New York, McGraw-Hill, Third Edition, 2002
3. Millman & Halkias Integrated Electronics: Analog and Digital circuits & system.

5MX4-02: Linear Control Theory

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To introduce students to the fundamental concepts and principles of linear control theory.
2. To provide students with a comprehensive understanding of control system analysis and design techniques.
3. To enable students to apply control theory to real-world engineering problems in the field of mechatronics.
4. To develop analytical and problem-solving skills related to linear control systems.
5. To prepare students for advanced studies and research in control systems and related areas.

Course Outcomes

Student will be able to

1. Understand the fundamental concepts of control systems, including types of control systems and their applications.
2. Analyze the behavior of linear control systems using time-domain and frequency-domain techniques.
3. Design and implement basic control systems for mechatronic applications.
4. Apply Laplace transform and transfer function methods to analyze and design control systems.
5. Apply feedback control techniques to achieve desired system performance and stability.

S. No	Contents	Hours
1	Introduction to Control Systems Introduction to control systems: Definition, types, and applications in mechatronics. Mathematical modeling of physical systems: Differential equations and transfer functions. Block diagrams and signal flow graphs. Time-domain analysis: Time response, transient and steady-state behavior. Error analysis: Steady-state error, sensitivity, and error constants.	8
2	Laplace Transform and Transfer Function Laplace transform: Definition, properties, and inverse Laplace transform. Transfer function representation of control systems. System response using transfer function: Time response and steady-state response. Stability analysis: Routh-Hurwitz criteria.	8
3	Time Domain Analysis of Control Systems Performance indices: Rise time, peak time, maximum overshoot, settling time. Steady-state errors and error constants for different types of inputs. Design specifications and transient response requirements. Introduction to controllers: P, PI, PD, and PID controllers.	9
4	Frequency Domain Analysis Frequency response of control systems. Bode plots: Magnitude and phase plots. Gain and phase margins. Nyquist stability criterion.	8
5	Control System Design Root locus technique for control system design. Design of compensators using root locus method. Introduction to state-space representation. Introduction to digital control systems.	9

TEXT BOOKS

1. J. Nagrath and M. Gopal, "Control Systems Engineering" New Age International (P) Limited, Publishers, 2nd Ed.
2. B. C. Kuo "Automatic Control Systems" John Wiley and sons, 8th Ed.

REFERENCE BOOKS

1. K. Ogata, Modern Control Engineering, Prentice Hall of India Pvt. Ltd., 5th Ed, 2010.
2. Dean C Karnopp, Donald L. Margolis and Ronald C. Rosenberg, "System dynamics Modeling, Simulation, and Control of Mechatronic Systems" John Wiley & Sons, 5th Ed, 2012.

5MX4-03: Microcontroller Based System Design

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To introduce students to the fundamental concepts of microcontrollers and their applications in various engineering fields.
2. To provide hands-on experience in programming and interfacing microcontrollers with different devices.
3. To develop the ability to design and implement microcontroller-based systems for real-world applications.
4. To familiarize students with various communication protocols used in microcontroller-based systems.
5. To enhance problem-solving and critical thinking skills in the context of embedded systems.

Course Outcomes

Student will be able to

1. Understand the architecture and working principles of microcontrollers.
2. Write and execute programs for microcontrollers using a programming language such as C/C++.
3. Interface microcontrollers with various sensors, actuators, and devices.
4. Design and implement microcontroller-based systems to solve engineering problems.
5. Demonstrate knowledge of different communication protocols commonly used in microcontroller-based systems.
6. Analyze and troubleshoot microcontroller-based systems for efficiency and reliability.

S. No	Contents	Hours
1	Introduction to Microcontrollers Introduction to embedded systems and microcontrollers, Architecture and components of microcontrollers, Microcontroller programming using C/C++, Input/output interfacing	8
2	Microcontroller Architecture and Peripherals Detailed study of microcontroller architecture, Memory organization and addressing modes, Timer/Counters and PWM (Pulse Width Modulation), Interrupts and their handling	8
3	Sensors and Actuators Introduction to various sensors (e.g., temperature, pressure, proximity), Interfacing sensors with microcontrollers, Actuators and their control (e.g., motors, solenoids)	9
4	Communication Protocols Serial communication (UART, SPI, I2C), Wireless communication (Bluetooth, Wi-Fi, Zigbee), CAN (Controller Area Network) communication	8
5	Microcontroller-based System Design Real-world applications of microcontroller-based systems, Project development and implementation, Testing, debugging, and optimization techniques	9

TEXT BOOKS

1. Muhammad Ali Mazidi, Janice G. Mazidi, and Rolin D. McKinlay. The 8051 Microcontroller and Embedded Systems: Using Assembly and C, Pearson, 2nd Ed.

2. Raj Kamal, Embedded Systems: Architecture, Programming, and Design, PHI Learning Pvt. Ltd., 2011

REFERENCE BOOKS

1. Warwick A. Smith, ARM Microcontroller Interfacing: Hardware and Software, Elektor International, 2011
2. Muhammad Ali Mazidi, Rolin D. McKinlay, and Danny Causey, PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18, Pearson Prentice Hall, 2008

5MX4-04: Theory of Machines

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart knowledge on various types of Mechanisms and visualize their applications in practical life
2. To impart knowledge of free and forced vibrations in engineering applications
3. To familiarize about concept of Governors, Gyroscope and Balancing

Course Outcomes

Student will be able to

1. CO1: Understand various mechanisms leading to kinematic analysis of machines
2. CO2: Understand concepts of balancing of reciprocating and rotating masses
3. CO3: Apply the knowledge of evaluating the frequency of systems involving various degree of freedom.
4. CO4: Analyse responses to force vibrations and understand concepts of force transmissibility and amplitude transmissibility
5. CO5: Visualize working principles of governors and gyroscopes and their engineering applications

S.No.	Contents	Hours
1.	**Introduction:** Objective, scope and outcome of the course **Force Analysis:** Rigid body dynamics in general plane motion, equations of motion-dynamic force analysis, inertia force and inertia torque, D. Alemberts principle. the principle of superposition, dynamic analysis in reciprocating engines, gas forces, equivalent masses, bearing loads, crankshaft torque, turning moment diagrams, flywheels.	8
2.	**Balancing: S**tatic and dynamic balancing, balancing of rotating masses, balancing a single cylinder engine balancing multi– cylinder engines– partial balancing in locomotive engines.	8
3.	**Free Vibration:** Basic features of vibratory systems–degrees of freedom–single degree a freedom, free vibration, equations of motion, natural frequency, types of damping, damped vibration critical speeds of simple shaft, torsional systems; natural frequency of two and three rotor systems.	8
4.	**Force Vibration:** Response to periodic forcing, harmonic forcing, forcing caused by unbalance, support motion, force transmissibility and amplitude transmissibility vibration isolation.	8
5.	**Mechanism for Control:** Governors - centrifugal governors, gravity controlled and spring controlled centrifugal governors, characteristics, effect of friction, controlling force other governor mechanisms, gyroscopes, gyroscopic forces and torques, gyroscopic stabilization, gyroscopic effects in automobiles, ships and airplanes.	8

TEXT BOOKS

1. S. S. Rattan, “Theory of Machines”, McGraw Hill, 5th Edition 2019.
2. Gordon R. Pennock, Joseph Edward Shigley and John J. Uicker JR, “Theory of Machines and Mechanisms”, Oxford University Press, SI Edition 2014.
3. G. K. Grover: Mechanical Vibrations, Nem Chand & Bros., 2009 Edition.

REFERENCE BOOKS

1. R L Norton, “Kinematics and Dynamics of Machinery”, McGraw-Hill Education, 2017
2. Thomas Bevan, “Theory of Machines”, Pearson, 3rd Edition 2009.
3. Rao J S, Dukkipati R. V., Mechanism and Machine Theory, New Age International, 2006, 2nd Ed.
4. Thomson, W.T., and Dahleh, M.D., Padmanabhan, C., “Theory of Vibrations with Applications”, Pearson Education. 2014 Edition

5MX4-05: Pneumatics and Hydraulic Systems

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide student with knowledge on the application of fluid power in process, construction and manufacturing industries
2. To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
3. To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

Course Outcomes

Student will be able to

1. Explain the fluid power and operation of different types of pumps.
2. Summarize the features and functions of hydraulic motors, actuators and flow control valves
3. Explain the different types of hydraulic circuits and systems
4. Explain the working of different pneumatic circuits and systems
5. Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.

S.No.	Contents	Hours
1.	Fluid Power Systems and Fundamentals: Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols. Basics of Hydraulics-Applications of Pascals Law- Laminar and Turbulent flow – Reynold's number – Darcy's equation – Losses in pipe, valves and fittings.	8
2.	Hydraulic System & Components: Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, construction and working of pumps – pump performance – Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders like tandem, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors.	8
3.	Design of Hydraulic Circuits: Construction of Control Components : Directional control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier – Intensifier circuit.	8
4.	Pneumatic Systems and Components: Pneumatic Components: Properties of air – Compressors – Filter, Regulator, Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design	8

	for simple applications using cascade method.	
5.	Design of Pneumatic Circuits: Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.	8

TEXT BOOKS

1. Anthony Esposito, “Fluid Power with Application”, Pearson Education 2005.
2. Majumdar S. R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGrawHill, 2001

REFERENCE BOOKS

1. Anthony Lal,” Oil Hydraulics in the service of industry”, Allied publishers, 1982.
2. Dudely, A. pease and John T. Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.
3. Majumdar S. R., “Pneumatics sytems- Principles and Maintenance”, Tata McGrawHill, 1995
4. Jagadeesha T., Thammaiah Gowda, “Fluid Power: Generation, Transmission and Control”, Wiley.
5. B. W. Anderson, “The Analysis & Design of Pneumatic Systems”, John Wiley.
6. Mc Clay Donaldson, “Control of Fluid Power Analysis and Design” Ellis Horwood Ltd.
7. K. Shanmuga Sundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy”, S. Chand& Co Book publishers, New Delhi, 2006 (Reprint 2009)

5MX5-11: CAD and CAM

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To understand the basics of CAD/CAM.
2. To gain exposure over the concepts of computer graphics.
3. To learn about the geometric issues concerned to the manufacturing and its related areas.
4. To inculcate ability to relate Computer Integrated Manufacturing engineering issues to broader engineering and social context.
5. To understand the latest advances in the manufacturing perspectives, such as automation, computer aided planning.

Course Outcomes

Student will be able to

1. Understand the importance of CAD/CAM principles in the Product development.
2. Develop NC and CNC programs related to manufacturing using codes.
3. Analyze the importance of networking in manufacturing environment.
4. Show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
5. Apply the fundamental principles of computer aided technologies to the solution of practical problems in industrial automation.

S. No	Contents	Hours
1	Product Development Cycle; Introduction to CAD/CAM, Graphics I/O Devices, Bresenham's Algorithm and DDA, Graphics software, Clipping, Hidden line/surface removal, Color models Lighting and shading , Graphics Standards, Neutral File formats, IGES, STEP	5
2	Geometric Modeling: Wireframe, Surface and Solid Parametric representation of curves & surfaces, CSG and B-Rep, World/device coordinate representations, 2D and 3D geometric transformations, Matrix representation, translation, scaling, shearing, rotation and reflection, composite transformations, concatenation.	8
3	Introduction to NC, CNC, DNC: Manual part Programming, Computer Assisted Part Programming, Examples using NC codes, Adaptive Control, Canned cycles and Subroutines, CAD / CAM approach to NC part programming, APT language, machining from 3D models.	8
4	Introduction to part families: parts classification and cooling, group technology machine cells-benefits of group technology, Process Planning, CAPP & types of CAPP, Flexible manufacturing systems (FMS), the FMS concept, transfer systems, head changing FMS, Introduction to Rapid prototyping, Knowledge Based Engineering.	9
5	CIM wheel: CIM Database, CIM-OSI Model, Networking Standards in CIM Environment, Network structure, Network architecture, TCP/IP, MAP, Virtual Reality, Augmented Reality-Artificial Intelligence and Expert system in CIM.	8

TEXT BOOKS

1. P.N. Rao, CAD/CAM: Principles and Applications 3rd Edition, Tata McGraw Hill, India, 2010.
2. Ibrahim Zeid and R. Sivasubramaniam, 2nd Edition, Tata McGraw Hill, India, 2009

REFERENCE BOOKS

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 2007
2. James A. Rehg, Henry W. Kraebber, Computer Integrated Manufacturing, Pearson Education. 2007
3. Donald Hearn and M.Pauline Baker "Computer Graphics" with OpenGL Prentice Hall, International, 2010

5MX5-12: Heat Transfer

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. Understand the concepts and different modes of heat transfer.
2. Analyze the different systems using the concepts of conduction, convection and radiation.
3. Understand the basic concepts of design of heat exchangers.

Course Outcomes

Student will be able to

1. Understand different modes of heat transfer and apply related heat transfer laws.
2. Calculate the heat flow rate in different engineering applications and its implications on temperature.
3. Design fins and heat exchangers for industrial applications.

Examination note: Please note that data hand book will not be provided to the students in examinations so provide the suitable data in question paper.

S. No.	Contents	Hours
1	Objective, scope and outcome of the course.	1
2	**Introduction:** Heat transfer processes, conduction and radiation. Fourier's law of heat conduction, thermal conductivity, thermal conductivity of solids, liquids and gases, effect of temperature on thermal conductivity. Newton's law of cooling, definition of overall heat transfer coefficient. General parameters influence the value of heat transfer coefficient. **Conduction:** General 3-Dimensoinal conduction equation in Cartesian, cylindrical and spherical coordinates; different kinds of boundary conditions; nature of differential equations; one dimensional heat conduction with and without heat generation; electrical analogy; heat conduction through composite walls; critical thickness of insulation	6
3	**Heat transfer from extended surfaces:** Governing differential equation of fin, fin efficiency and effectiveness for different boundary conditions. Unsteady state heat conduction for slab, cylinder and sphere, Heisler chart.	6
4	**Convective Heat Transfer:** Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation: Buckingham pi Theorem and Rayleigh's method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations – Integral Method as approximate method. **Forced convection:** External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders. Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for horizontal plate and tube flow. **Free Convection:** Development of Hydrodynamic and thermal boundary layer along a vertical plate – Use of empirical relations for Vertical plates and pipes. **Heat transfer with change of phase:** Nature of vaporization phenomena; different regimes of	10

	boiling heat transfer; correlations for saturated liquid vaporization; condensation on flat plates; correlation of experimental results, drop wise condensation.	
5	**Heat exchangers:** Types of heat exchangers, arithmetic and logarithmic mean temperature differences, heat transfer coefficient for parallel, counter and cross flow type heat exchanger; effectiveness of heat exchanger, N.T.U. method, fouling factor, constructional and manufacturing aspects of heat exchangers.	9
6	**Thermal Radiation:** Plank distribution law, Kirchhoff's law; radiation properties, diffuse radiations; Lambert's law. Radiation intensity, heat exchange between two black bodies heat exchanger between gray bodies. Shape factor; electrical analogy; reradiating surfaces heat transfer in presence of reradiating surfaces.	9
	Total	41

TEXT BOOKS

1. Holman J. P, Heat Transfer, Tata McGraw Hill, New Delhi, (SIE) 10th Ed.
2. Nag P. K., Heat and Mass Transfer, Tata McGraw Hill, (SIE) 3rd Ed.

REFERENCE BOOKS

1. Cengel Y.A., Heat and Mass transfer, Tata McGraw Hill, (SIE) 5th Ed.
2. Ozisik M. Necati, Heat Transfer - A Basic Approach, McGraw Hill, New York, 1985.
3. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, New York, 2013, 7th Ed., Wiley Student Editiom.

5MX5-13: Metrology and Measurements

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide knowledge on various Metrological equipments available to measure the dimension of the components.
   To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.
2. To explain the different instruments for linear and angular measurements, surface finish etc.,
3. To know about the sensors used in sensing different dimensions
4. To provide knowledge about advanced metrology, CMM, computerized inspection etc.

Course Outcomes

Student will be able to

1. Describe the concepts of measurements to apply in various metrological instruments.
2. Outline the principles of linear and angular measurement tools used for industrial applications
3. Explain the procedure for conducting computer aided inspection
4. Demonstrate the working of different comparators
5. Demonstrate the sensors used in mechanical and electro-mechanical equipments.

S. No	Contents	Hours
1	**Basics of Metrology:** Introduction to Metrology; Need, Elements, Work piece, Instruments, Persons, Environment and their effect on Precision and Accuracy, Errors in Measurements, Types and Control, Types of standards, calibration, classification and performance characteristics of a instrumentation system, Specification and testing of dynamic response, Strain Measurement, electric strain gauges types, selection and installation, strain gauge circuits, temperature compensation and calibration, load cells, Mechanical and Optical Strain Gauges	6
2	**Sensors:** Various Mechanical, Electro-Mechanical and Photoelectrical Sensors for sensing of displacement, velocity, acceleration, torque, force, temperature from low to high range, flow, level of fluid , pressure, angular speed, voltage, frequency and current. **Transducers**, classification of transducers and their applications, piezoelectric transducers	8
3	**Basic Concepts and Comparators**: Basic concept, Legal metrology, Precision, Accuracy, Types of errors, standards of measurement, traceability, interchangeability and selective assembly, gauge blocks, limit gauges, tailors principle of gauge design. Comparators: Mechanical, Electronic, optical and Pneumatic Automatic gauging	8
4	**Linear, Angular and Form Measurement:** Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications. profile projectors toolmakers microscope. **Measurement of surface finish**: Terminology, roughness, waviness, analysis of surface finish, stylus probe instrument.	8
5	Strain gauges, pressure measurement, flow measurement, temperature measurement, Force and	6

	torque measurement, displacement and acceleration measurement,	
6	**Advances in Metrology**: Coordinate measuring machine (CMM): Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications., Applications of Image Processing in measurement –computer aided inspection.	6

TEXT BOOKS

1. T. G. Beckwith, N.L. Buck and R.D. Marangoni, Mechanical Measurements, Narosa Publishing House, 6th Ed.
2. Kumar, D. S. - Mechanical Measurement and Control, Metropolitan Book Co Pvt. Ltd., New Delhi, 2015
3. I. C. Gupta, Engineering Metrology, Dhanpat rai Publications, 2005.

REFERENCE BOOKS

1. J.P. Holman, Experimental Methods for Engineers, Tata McGraw-Hill, 2004.
2. Williams Bolton, Instrumentation and control, Elsevier Ltd., 2004.
3. E. O. Doeblin, Measurement Systems: Application and Design, Tata McGraw- Hill, 2004.

5MX5-14: Digital Signal Processing

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To describe signals mathematically and understand how to perform mathematical operations on signals.
2. It will provide knowledge of Digital filter.
3. To discuss word length issues ,multi rate signal processing and application.
4. To describe signals mathematically and understand how to perform mathematical operations on signals.
5. It will provide knowledge of Digital filter.
6. To discuss word length issues ,multi rate signal processing and application.
7. To describe signals mathematically and understand how to perform mathematical operations on signals.
8. It will provide knowledge of Digital filter.
9. To discuss word length issues ,multi rate signal processing and application.

Course Outcomes

Student will be able to

1. Illustrate digital signals, systems and their significance.
2. Analyse the digital signals using various digital transforms DFT, FFT etc.
3. Design and develop the basic digital system.
4. Interpret the finite word length effects on functioning of digital filters.

S. No	Contents	Hours
1	INTRODUCTION Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.	7
2	DISCRETE TIME SYSTEM ANALYSIS Z-transform and its properties, inverse z-transforms; difference equation — Solution by ztransform, application to discrete systems — Stability analysis, frequency response — Convolution — Discrete Time Fourier transform , magnitude and phase representation.	8
3	DISCRETE FOURIER TRANSFORM & COMPUTATION Discrete Fourier Transform- properties, magnitude and phase representation –Computation of DFT using FFT algorithm — DIT &DIF using radix 2 FFT — Butterfly structure.	8
4	DESIGN OF DIGITAL FILTERS FIR & IIR filter realization — Parallel & cascade forms. FIR design: Windowing Techniques — Need and choice of windows — Linear phase characteristics. Analog filter design — Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation Warping, pre warping.	8
5	DIGITAL SIGNAL PROCESSORS Introduction — Architecture — Features — Addressing Formats — Functional modes —	9

	Introduction to Commercial DS Processors.	

TEXT BOOKS

1. Oppenheim A V and Sehafer R W, “Discrete Time Signal Processing”, Prentice Hall (1989).
2. Proakis J G and Manolakis D G, “Digital Signal Processing”, Pearson Education India.

REFERENCE BOOKS

1. Oppenheim A V, Willsky A S and Young I T, “Signal & Systems”, Prentice Hall, (1983).
2. Ifeachor and Jervis, “Digital Signal Processing”, Pearson Education India.
3. DeFatta D J, Lucas J G and Hodgkiss W S, “Digital Signal Processing”, J Wiley and Sons, Singapore, 1988
4. Sanjit K Mitra “Digital Signal Processing” TMH Course Outcomes:

5MX4-20: Pneumatics and Hydraulic Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To impart knowledge on various types of Pneumatics and Hydraulic devices and visualize their applications in practical life.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Design and test various hydraulic circuits
2. Design and test various pneumatic circuits
3. Modeling and analysis of basic electrical, hydraulic, and pneumatic systems
4. Simulation of basic hydraulic, pneumatic and electrical circuits.

S. No	Contents
1	Design and testing of hydraulic circuits such as (i) Pressure control (ii) Flow control (iii) Direction control (iv) Design of circuit with programmed logic sequence, using an optional PLC in hydraulic Electro hydraulic Trainer.
2	Design and testing of pneumatic circuits such as (i) Pressure control (ii) Flow control (iii) Direction control (iv) Circuits with logic controls (v) Circuits with timers (vi) Circuits with multiple cylinder sequences with Pneumatic Electro pneumatic Trainer.
3	Modeling and analysis of basic electrical, hydraulic, and pneumatic systems using MATLAB/LABVIEW software
4	Simulation of basic hydraulic, pneumatic and electrical circuits using Automation studio software

5MX4-21: Theory of Machines Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To impart knowledge on various types of Mechanisms and visualize their applications in practical life.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. CO1: Students will be able to understand the mechanism and kinematic analysis of machines
2. CO2: Students will be able to perform balancing of rotating masses.
3. CO3: Students will be able to understand various brakes, dynamometers and clutches used in engineering applications
4. CO4: Students will be able to draw controlling force curves for various governors

S. No	Contents
1	To study inversions of four bar chain: coupling Rod, beam Engine
2	To study inversion of double slider chain, Oldham coupling, Scotch Yoke and elliptical trammel.
3	To determine natural frequency of a spring mass system.
4	Performing the experiment to find out damping co-efficient in case of free damped torsional vibration
5	To conduct experiment of trifler suspension.
6	Study of various types of dynamometers, brakes and clutches.
7	To plot force versus radius and lift versus speed curves for governors on Universal Governor apparatus
8	To experimentally verify the relation for gyroscopic couple
9	To perform balancing of rotating masses by graphical and analytical methods

5MX4-22: Microcontroller Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To impart knowledge on various types of microcontrollers and their applications in mechatronics.
2. To Design and implement simple mechatronic systems and their Troubleshoot and debugging.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Understand the basics of microcontrollers and their applications in mechatronics.
2. Program microcontrollers using C/C++ programming language.
3. Interface and control various sensors and actuators with microcontrollers.
4. Design and implement simple mechatronic systems using microcontrollers.
5. Troubleshoot and debug microcontroller-based mechatronic systems.

S. No	Contents
1	Introduction to Microcontrollers • Familiarization with microcontroller boards and development tools. • Writing and uploading a simple "Hello World" program.
2	LED Blinking • Interface an LED with the microcontroller. • Write a program to make the LED blink at a specific rate.
3	Push Button Input • Interface a push-button switch with the microcontroller. • Write a program to detect the button press and control the LED accordingly.
4	PWM (Pulse Width Modulation) • Generate PWM signals using the microcontroller. • Control the intensity of an LED or a motor using PWM.
5	Analog-to-Digital Conversion • Interface an analog sensor (e.g., potentiometer) with the microcontroller. • Write a program to read the sensor value using the ADC and display it.
6	Serial Communication • Establish serial communication between the microcontroller and a computer. • Write a program to send and receive data via the serial port.
7	Ultrasonic Distance Measurement

	• Interface an ultrasonic sensor with the microcontroller. • Write a program to measure distance using the sensor and display the result.
8	Motor Control • Interface a DC motor with the microcontroller. • Write a program to control the motor's direction and speed.
9	LCD Display • Interface an LCD display with the microcontroller. • Write a program to display messages on the LCD.
10	Mechatronics System Integration • Design and implement a simple mechatronic system using various sensors, actuators, and the microcontroller. • Test and optimize the performance of the mechatronic system.

5MX5-20: CAD and CAM Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

2. To understand and handle design problems in a systematic manner
3. To apply CAD/CAM concepts in real life applications.
4. To understand and analyze the various aspects in of manufacturing design.
5. To inculcate the ability to relate Computer Integrated Manufacturing engineering issues to broader engineering and social context.
6. To develop the concepts for NC and CNC programs related to manufacturing using codes.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Lean about different softwares and packages of CAD/ CAM.
2. Prepare the 2D and 3D drawing of machine components and their assemblies.
3. Prepare manual part programming for CNC machines using a standard G-codes and M- codes.
4. Identify and analyze the various aspects in of manufacturing design.

S. No	Contents
1	Exercises in Modeling and Analysis of various types of Mechanical Components and Assemblies feature using CAD softwares. At least 10 components and assemblies should be modeled and analyzed by the students using sotwares in the laboratory.
2	Drafting: Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances.
3	Representation of dimensioning and tolerances.
4	Part Modeling: Generation of various 3D Models through Protrusion, revolve, sweep. Creation of various features. Feature based and Boolean based modeling and Assembly Modeling.
5	Sheet Metal Operations.
6	Study of various post processors used in NC and CNC Machines.
7	Part-Programming on the above CNC machines and execution of part programs for Machining given profiles (At least 10 different jobs for turning, drilling, milling and threading operations)
8	Prepare manual Part programming for CNC machines using a standard G-codes and M- codes, simulation of Tool Path.
9	Computer Assisted Part Programming using APT language
10	Exposure to component modelling and CL data generation using CAD/CAM Software like Unigraphics, Pro/E, Smart CAM, etc.

Minor Project: Students will be given different 2D/3D shapes to be generated by software or graphics programming in C++/MATLAB using surface and solid modeling schemes. Students can also be given projects based on geometric modeling in Rapid Prototyping.

TEXT BOOKS

1. CAD/CAM: Principles and Applications 3rd Edition, Tata McGraw Hill, India, 2010.
2. Ibrahim Zeid and R. Sivasubramaniam, 2nd Edition, Tata McGraw Hill, India, 2009

REFERENCE BOOKS

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 2007
2. James A. Rehg, Henry W. Kraebber, Computer Integrated Manufacturing, Pearson Education. 2007
3. Donald Hearn and M.Pauline Baker "Computer Graphics" with OpenGL Prentice Hall, International, 2010

5MX5-21: Heat Transfer Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. Understand the various forms of heat transfer and their applications in real life problems.
2. Analyze different methods to calculate the heat transfer coefficient in various heat transfer problems.
3. Analyze the theoretical knowledge and apply it in conducting experiments in the forms of heat transfer.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Perform steady state conduction experiments to estimate thermal conductivity of different materials for plane, cylindrical and spherical geometries.
2. Perform the transient heat conduction experiment and obtain variation of temperature along the length of the pin fin.
3. Estimate heat transfer coefficients in forced convection, free convection and determine effectiveness of heat exchangers
4. Perform radiation experiments:determine surface emissivity of a test plane and stefan-Boltzmann's constant and compare with theritical values
5. Estimate heat transfer coefficients in condensation, boiling and effectiveness of heat pipe

Sr.No.	NAME OF EXPERIMENT (Perform any twelve)
1	To Determine Thermal Conductivity of Insulating Powder.
2	To Determine Thermal Conductivity of a Metal Rod.
3	To Determine the Heat Transfer Rate and Temperature Distribution for a Pin Fin.
4	To Determine the Emissivity of the Test Plate Surface.
5	To Determine Stefan Boltzmann Constant of Radiation Heat Transfer.
6	To Determine the Surface Heat Transfer Coefficient for Heated Vertical Cylinder in Natural Convection.
7	To Determine the Heat Transfer Coefficient in Drop Wise and Film Wise condensation.
8	To Evaluate the critical heat flux value by studying different zones of boiling
9	To determine the LMTD and Effectiveness of Concentric Tube type Heat Exchanger in Parallel and Counter Flow Modes.
10	To Determine the convective heat transfer coefficient in forced convection
11	To Determine Thermal Conductivity of a Liquid
12	To Determine the thermal conductivity of a lagged pipe apparatus
13	To Demonstrate the effectiveness of a heat pipe in the cooling of complex systems
14	To Study and Compare LMTD and Effectiveness of Shell &Tube /Helical Coil / Cross Flow Heat Exchangers

5MX5-22: Metrology Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. General lab practices are included in the curriculum in order to provide hands-on experience with various measuring instruments to utilize in industries.
2. To provide students with the necessary skills for calibration and testing of different gauges and instruments.
3. To provide students with the necessary skills to collect data, perform analysis and interpret results to draw valid conclusions through standard test procedures using various metrology instruments.
4. To know about line standards, end standards, and various types of comparators.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Demonstrate and use different length measuring instruments like Slip guage, bevel protractor and sine bar.
2. Evaluate the surface quality of a given specimen which is important in all kind of manufacturing.
3. Analyze and interpret the results to draw valid conclusions through standard test procedures using various metrology instruments.
4. To work on Coordinate measuring machine (CMM).

S. No	Contents
1	Taper Angle Measurement Using Sine Bar and Slip Gauge.
2	Measurement of Angle Using Universal Bevel Protractor.
3	Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
4	Measurement of alignment using Autocollimator.
5	Measurement of displacement using POT, LVDT & Capacitive transducer.
6	Strain Measurement using strain gauge.
7	Position and velocity measurement using encoders.
8	Calibration of a Pressure Guage with the help of a dead weight Guage Tester
9	Analog to Digital Converters.
10	Study and practical demonstration on Coordinate measuring machine (CMM)

5MX5-23: Digital Signal Processing Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. General lab practices are included in the curriculum in order to provide hands-on experience with various measuring instruments to utilize in industries.
2. To provide students with the necessary skills for calibration and testing of different gauges and instruments.
3. To provide students with the necessary skills to collect data, perform analysis and interpret results to draw valid conclusions through standard test procedures using various metrology instruments.
4. To know about line standards, end standards, and various types of comparators.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Demonstrate and use different length measuring instruments like Slip guage, bevel protractor and sine bar.
2. Evaluate the surface quality of a given specimen which is important in all kind of manufacturing.
3. Analyze and interpret the results to draw valid conclusions through standard test procedures using various metrology instruments.
4. To work on Coordinate measuring machine (CMM).

S. No	Contents (Conduct six from each group)
1	PART A - LIST OF EXPERIMENTS USING MATLAB (i) Introduction to MATLAB (ii) To find DFT / IDFT of given DT signal. (iii) Program to obtain Linear Convolution of two finite length sequences. (iv) Program for Computing auto correlation. (v) To find frequency response of a given system(transfer function/ difference equation). (vi) Implementation of FFT of given sequence. (vii) Determination of Power Spectrum of a given signal. (viii) Implementation of LP FIR filter for a given sequence. (ix) Implementation of HP FIR filter for a given sequence. (x) Implementation of LP IIR filter for a given sequence. (xi) Implementation of HP IIR filter for a given sequence. (xii) Implementation of I/D sampling rate converters.
2	LIST OF EXPERIMENTS USING DSP PROCESSOR (i) Architecture and Instruction Set of DSPCHIP- TMS320C5515 (ii) Computation of N- Point DFT of a Given Sequence. (iii) Implementation of FFT of Given Sequence .

	(iv)	Power Spectrum.
	(v)	Implementation of LP FIR Filter for Given Sequence & Implementation of HP FIR Filter for Given Sequence.
	(vi)	Implementation of LP IIR Filter for Given Sequence & Implementation of HP IIR Filter for Given Sequence.
	(vii)	Generation of Sinusoidal Signal Through Filtering.
	(viii)	Generation of DTMF Signals.
	(ix)	Implementation of Decimation Process.
	(x)	Implementation of Interpolation Process.
	(xi)	Impulse Response of First Order and Second Order Systems.
	(xii)	Audio Applications.
	(xiii)	Noise removal: Add noise above 3kHz and then remove ; Interference Suppression using 400 Hz Tone.

6MX4-01: Industrial Engineering

(Common for ME and MX)

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To analyze different planning activities needed during the operations stage of a manufacturing or a service industry.
2. To apply productivity techniques for achieving continuous improvement.

Course Outcomes

Student will be able to –

1. Analyze the way price of a product affects the demand for a product for consequent actions and predict demand for a product by making use of different demand forecasting techniques.
2. Explain Break even analysis to determine safe production levels and costing of industrial products.
3. Apply productivity techniques for continuous improvement in different functionalities of an industry.
4. Analyze the existing operations that happen in factories for establishing time standards for different activities.
5. Demonstrate the knowledge of selection of location for the new plant & optimizing the layout within the plant for smooth production.

S. No	Contents	Hours
1	**Plant Location, Plant Layout -** Plant Location: Major factors influencing the location of an industry and choice of site, Plant Layout: Principles of plant layout, use of travel charts, Flow Pattern. Different Types of Layouts Viz. Product, Process and Combination Layouts, Introduction to Layouts Based on GT, JIT and Cellular Manufacturing Systems, Development of Plant Layout. **Material Handling and Plant Maintenance**: Types of Material Handling Equipment, Relationship of Material Handling with Plant Layouts, Operation and Maintenance of Material Handling Equipment. Plant Maintenance: Maintenance policies; preventive, break down and corrective action.	8
2	**Production Planning and Control –** Types of production, Function of production planning and control, Sales Forecasting Techniques, Product Design, Process Planning, Machine Loading, Routing and Scheduling, Dispatching, Controlling, Progress Reporting, Corrective Action. Gantt's Charts. Introduction to CPM and PERT	6
3	**Materials Management and Inventory Control:** Field and scope of material management, Material Requirement Planning and programme, Inventory Control: Classification of Costs, Direct and Indirect Cost, Labour, Material and Over-Head, Prime Cost, Factory Cost, Fixed Cost, Variable Cost, Increment Cost, Allocation of Over-Head Costs, Break even Analysis, Types of Inventories, Determining Economic Order Quantity (EOQ), Quantity Discounts, Lead Time and Re-order Level, ABC, VED, FSN Models, Re-order Cycle Systems, Procedure for Purchase and Storage.	7
4	**Work Study and Motion Study -** Use and Applications, Techniques, Human Factors in the Application of Work Study, Method Study Objectives, Basic Procedure, Various Charting Techniques, Use of Photographic Techniques, SIMO Charts, Principles of Motion Economy,	7

	Work Measurement Techniques, Time Study, Work Sampling, Predetermined Motion Time Standards (PMTS), Analytical Estimation.	
5	**Personnel Management:** Basic Introduction to Acts related to Industries: Labour Legislation: Indian Factory Act, Payment of Wages Acts, Workman's Compensation Act, Trade Union Act, Industrial Dispute Act, Employees State Insurance Act, Minimum Wages Act. Industrial Relations Management: Union Relations, Trade Union Movement and Collective Bargaining, Employee's Participation in Management. Wage Payment System: Job evaluation, Merit Rating Methods of Wage Payment, Time Wages, Piece Wages System and Incentive Schemes.	7

TEXT BOOKS

1. Industrial Engineering and Management, Ravi Shankar, Galgotia, 2nd Ed.
2. Khanna, O.P. - Industrial Engineering and Management, Dhanpat Rai Publishers, New delhi, 2020

REFERENCE BOOKS

1. Maynard's Industrial Engineering Handbook, 5th Edition, Kjell B. Zandin, he McGraw-Hill Companies, Inc
2. Dalela, S. and Mansuor Ali - Industrial Engineering and Management systems, Standard Distributors and Publishers, New Delhi, 2010, 6th Ed.
3. Motion and Time Study: Design and Measurement of Work, 7th Edition, John Wiley, New York.
4. ILO - Introduction to Work Study, International Labor Office , Geneva.
5. Jain, K.C. and Agarwal, L. N. – Production Planning Control & Industrial Management, Khanna Publishers, New Delhi.

6MX4-02: Computational Fluid Dynamics

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide knowledge of basic equations of fluid dynamics.
2. To share knowledge of basic distribution techniques.
3. To impart knowledge of integration method, numerical solution of incompressible fluids and brief introduction to compressible flows.

Course Outcomes

Student will be able to –

1. CO-1: To be able to formulate the basic equations for fluid dynamics.
2. CO-2: To understand clearly the finite difference method and applications of numerical schemes to analyse the fluid dynamics in real engineering field.
3. CO-3: To select appropriate integration method to solve ordinary differential equations. And, also finite volume method and its applications in fluid dynamics field.
4. CO-4: To understand and select the pressure correction techniques and introduction to upwind schemes.

Sr. No.	Contents	Hours
1.	**Basic equations of Fluid Dynamics**: General form of a conservation law, Equation of mass conservation, Conservation law of momentum, Conservation equation of energy. The dynamic levels of approximation. Mathematical nature of PDEs and flow equations.	8
2.	**Basic Discretization techniques**: Finite Difference Method (FDM), Analysis and Application of Numerical Schemes: Consistency, Stability, Convergence, Fourier or von Neumann stability analysis, Modified equation, Application of FDM to wave, Heat, Laplace and Burgers equations.	9
3.	**Integration methods for systems of ODEs**: Linear multi-step methods; Predictor-corrector schemes; ADI methods; The Runge-Kutta schemes. Vorticity-stream function formulation. Solution of Navier-Stokes equations using MAC algorithm. The Finite Volume Method (FVM) and conservative discretization.	9
4.	**Numerical solution of the incompressible Navier-Stokes equations**: Primitive variable formulation; Pressure correction techniques like SIMPLE, SIMPLER and SIMPLEC;	8
5.	**Brief introduction to compressible flows and numerical schemes**: Quick idea of Euler equations, homogenity and flux jacobian. Introduction to upwind schemes.	7
	Total	41

TEXT BOOKS

1. J. C. Tannehill, D. A. Anderson, and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, CRC Press, 2012.
2. J. D. Anderson Jr., Computational Fluid Dynamics, McGraw-Hill International Edition, 2017.

REFERENCE BOOKS

1. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2017.
2. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2010.
3. C. A. J. Fletcher, Computational Techniques for Fluid Dynamics, Vol. 1 and 2, Springer, 1998.

6MX4-03: Power Electronics and Electrical Devices

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics, power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
2. To explain the techniques for design and analysis of single phase diode rectifier circuits.
3. To explain different power transistors, their steady state and switching characteristics and limitations.
4. To explain different types of Thyristors, their gate characteristics and gate control requirements.
5. To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers.

Course Outcomes

Student will be able to –

1. To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics, power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
2. To explain the techniques for design and analysis of single phase diode rectifier circuits.
3. To explain different power transistors, their steady state and switching characteristics and limitations.
4. To explain different types of Thyristors, their gate characteristics and gate control requirements.
5. To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers.

Sr. No.	Contents	Hours
1.	Introduction: Objective, scope and outcome of the course.	1
2.	Power Semiconductor Devices: Introduction, Scope and Application, Classification of Power Converters, Construction and characteristics of Thyristors, MOSFET, IGBT, IGCT and GTO, Comparison of Controllable switches.	6
3.	Phase Controlled (AC to DC) Converters (Rectifiers): Principle of phase control, Full-wave controlled Converters. Single phase full wave converters, Single phase two pulse converters with discontinuous load and its performance, three phase thyristor converters: half wave, full and semi converters. Dual Converters. Effect of source impedance on performance of converter.	8
4.	DC to DC Converters (Choppers): Introduction, Classification, Principle and Operation, Control strategies, Chopper configurations, Thyristor chopper circuits, Jones chopper, Morgan chopper, AC (Multiphase) chopper, Switched mode power supply: step down (buck), Step up (boost) and step down/step up	7

	(buck/boost) converters and Cuk converter.	
5.	DC to AC Converters (INVERTERS) Introduction, Classification, single phase half and full bridge VSI,three phase VSI 120 and 180 degree conduction mode. Performance Parameters of Inverter, Voltage control of single phase and three phase Inverter, Series inverter, Parallel inverter, Current source inverter.	7
6.	AC Voltage Controllers: Introduction, Principal of On-Off control and Phase Control, Single phase Bidirectional Controllers with R and R-L Loads, Three phase full wave controllers	8
7.	Cycloconverters: Single Phase and Three phase Cycloconverter and Matrix Converter Application of Power Electronics: D.C. Motor Speed control, A.C. Drives: variable frequency drives. AC Voltage Regulators.	6
	Total	43

TEXT BOOKS

1. Ned Mohan, Tore M. Undeland, 'Power electronics: converters, applications, and design', John Wiley & Sons.,3 rd edition.
2. P. S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi, 5th edition.
3. M.D. Singh, K B Khanchandani, 'Power Electronics', second edition, TATA McGraw Hill.

REFERENCE BOOKS

1. Muhammad H. Rashid, "Power Electronics - circuits, devices and applications", Prentice Hall of India, 2nd edition.
2. Vedam Subramanyam, Power Electronics – Devices, Converters and Applications", Revised 2nd edition, New Age Publications.
3. Dubey, Joshi & Doradla, Thyristorised controller, New age Publication, 2012, 2n ed.
4. B. K. Bose, 'Modern Power Electronics & AC Drives', Prentice Hall India, 1st ed.

6MX4-04: Machine Design

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyse commonly used machine components.
2. To impart knowledge and enable students to design common mechanical components.

Course Outcomes

Student will be able to –

1. CO1: Identify considerations for design and selection of materials, factor of safety and standard sizes as per relevant codes/standards for machine components.
2. CO2: Analyse and design mechanical components subjected to fluctuating loads.
3. CO3 Understand mode of failure in shafts, keys and couplings and design them for the given specifications.
4. CO4: Design various gears such as spur, bevel, helical and worm for given power and velocity ratio.
5. CO5: Design sliding contact bearing and select a suitable rolling contact bearing from the manufacturer's catalogue

Examination Note: Students can practice using the data handbook in class, and data handbook will be given in the exam.

S.No.	Contents	Hours
1.	**Introduction:** Scope and outcome of the course, steps in design, requirements of a designer **Design Fundamentals:** Design process, computer aided design, optimum design, mechanical properties of materials, types of loads, stresses - static, varying, thermal, impact and residual; factors of safety, theories of failure, stress concentration factors.	10
2.	**Design for fatigue loading:** Endurance limit, endurance limit modifying factors, Soderberg Goodman's criterion, design for finite life.	6
3.	**Design of Shafts, Keys and Couplings:** Design of solid and hollow shafts based on strength and torsional rigidity, type of power transmission keys, design of sunk keys, type of couplings, design of rigid and flexible couplings.	8
4.	**Design of gear teeth:** Lewis and Buckingham equations, wear and dynamic load considerations, design of spur, helical, bevel and worm gears	8
5.	**Design of sliding bearings:** Methods of lubrication, hydrodynamic, hydrostatic, boundary lubrication, design of hydrodynamic bearings for minimum friction and maximum power transmission, thermal equilibrium of hydrodynamic bearings. **Rolling contact bearings:** Selection of rolling element bearings for different loads and load cycles from manufacturer's catalogue.	8

TEXT BOOKS

1. V. B. Bhandari, Design of Machine Elements, McGraw Hill, 5th edition, 2020.

2. R.C. Bahl and V. K. Goel, Mechanical Machine Design, Standard Publishers Distributors, 2010 edition
3. P. C. Sharma and D. K. Aggarwal, Machine Design, S. K. Kataria and Sons (New Delhi), 13th ed., 2017.

REFERENCE BOOKS

1. Richard G. Budynas, J. Keith Nisbett, et al.: Shigley's Mechanical Engineering Design, McGraw Hill Education (India), 11th edition, 2020.
2. U. C. Jindal: Machine Design, Pearson Education India, 1st edition 2010

6MX4-05: MEMS and Microsystems

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To introduce the basic concepts of micro systems and advantages of miniaturization.
2. To study the various materials and their properties used for micromachining techniques.
3. To teach the fundamentals of micromachining and micro fabrication techniques.
4. To impart knowledge of the basic concept of electromechanical effects, thermal effects Micro fluidics and integrated fluidic systems.
5. To teach the fundamentals of pressure sensors and accelerometer sensors through design and modeling
6. To give exposure to different MEMS devices.

Course Outcomes

Student will be able to –

1. Gain thorough knowledge of materials used for micromachining techniques.
2. Understand the process of Bulk Micro Machining techniques.
3. Acquire the knowledge of Electromechanical effects, Thermal effects, Micro fluidics, Devices such as pumps, valves, mixers, Integrated fluidic systems and BioMEMS.
4. Analyze and develop models for different types of Pressure Sensors and accelerometers.
5. Acquire expertise in the design of sensors for any practical applications

S.No.	Contents	Hours
1.	Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Micro fabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.	5
2.	Working Principles of Microsystems: Introduction, Micro sensors, Micro actuation, MEMS with Micro actuators, Micro accelerometers, Microfluidics. Engineering Science for Microsystems Design and Fabrication: Introduction, Molecular Theory of Matter and Inter-molecular Forces, Plasma Physics, Electrochemistry.	6
3.	Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermo mechanics, Fracture Mechanics, Thin Film Mechanics, and Overview on Finite Element Stress Analysis.	5
4.	Scaling Laws in Miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Fluid Mechanics, Scaling in Heat Transfer.	6
5.	Overview of Micro manufacturing: Introduction, Bulk Micro manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro manufacturing.	5

TEXT BOOKS

1. Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, Wiley.
2. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, Micro and Smart Systems, Wiley India, First Edition, 2010..

REFERENCE BOOKS

1. Hans H. Gatzen,Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Microelectromechanical Systems (MEMS), Cengage Learning.
3. Gregory TA Kovacs, Micro machined Transducers Source Book, WCB McGraw Hill, Singapore, 1998.
4. Sorab. K.Ghandhi, VLSI Fabrication Principles, Wiley Inter Science Publication, New York, 1994.

6MX5-11: Industrial Automation

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
2. How to Maintain Industrial Automation systems.

Course Outcomes

Student will be able to -

1. Explain automation components and systems application
2. Identify suitable industrial automation hardware for given application
3. Measure industrial parameters like temperature, pressure, force, displacement, speed, flow, level, humidity and pH.
4. Integrate SCADA with PLC Systems

S. No	Contents	Hours
1	Introduction: Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: modbus & profibus. Role of computers in measurement and control.	4
2	Automation components: Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.	6
3	Programmable logic controllers: Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.	7
4	Distributed Control System: Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.	7
5	Overview of Industrial automation using robots: Basic construction and configuration of robot, Pick and place robot, Welding robot. Internet of things for plant automation and overview of Industry 4.0	6

TEXT BOOKS

1. Singh S.K.; “Industrial Instrumentation and Control”; TMH; 3rd Edition; ISB 13- 978-9351340102;
2. Bolton W.; “Programmable Logic Controllers” ,Newnes publications,4th Edition,2003

REFERENCE BOOKS

1. Johnson C.D.; “Process Control Instrumentation Technology”, PHI; 8th edition; 2014
2. Parr Newnem; “Industrial control handbook”, Industry Press, 3rd Edition, 1999
3. Dunning, Delmar; “Programmable logic controller”; Thomson/Delmar Learning, 3rd Edition, 2005

6MX5-12: Finite Element Method

(Common for ME and MX)

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart basics of finite element analysis.
2. Available material models for structural materials/joints.
3. Modeling of engineering system.
4. Implementation of material model in finite element method and applications

Course Outcomes

Student will be able to -

1. To adopt finite element method to solve problems in solid mechanics.
2. To formulate and solve problems in one-dimensional structures including trusses/beams/frames/link.
3. To formulate FE characteristic equations for two-dimensional elements and analyze plain stress, plain strain, axisymmetric and plate bending problems.

Sr. No.	Contents	Hour
1.	**Introduction to finite element methods**: Historical background, basic concept of the finite element method, comparison with finite difference method. Finite elements for one dimensional, two dimensional, three-dimensional and interpolation elements.	4
2.	**One-dimensional problems**: 1-D linear and 1-D quadratic elements - Finite element modeling, Coordinates and shape functions. Assembly of global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.	5
3.	**Analysis of Trusses**: Derivation of stiffness matrix for plane truss, Displacement of stress calculations. Analysis of beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection.	6
4.	**Finite element modelling**: Two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Estimation of load vector, Stresses Finite element modeling of axi-symmetric solids subjected to axi-symmetric loading with triangular elements. Two dimensional four noded isoparametric elements and numerical integration.	6
5.	**Dynamic Analysis**: Formulation of finite element model, element - Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss and beam. Finite element – formulation to 3 D problems in stress analysis. Convergence requirements, Mesh refinements, Effect of geometry of an element on finite element method.	6
	Total	28

TEXT BOOKS

1. Cook Witt Robert D., Malkus, Plesha, Concepts and Applications of Finite Elements Analysis, Wiley student edition, 4th ed, 2007.
2. Reddy J. N., Introduction to the Finite Element Method, Mc Graw Hill , 3rd ed., 2017.

REFERENCE BOOKS

1. Dixit U. S., Finite Element Methods For Engineers, Cengage learning, 1st ed., 2009
2. Bhavikatti SS, Finite Element Analysis, New Age International, 3rd Ed., 2015

6MX5-13: Modelling and Simulation of Manufacturing Systems

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart knowledge in the field of modern methods for simulation and modelling of production systems for industrial needs.
2. To focus on technological processes and manufacturing systems and applies the principles of discrete simulation for their modelling using software tool
3. To familiarize with discrete event simulation for modelling & simulation of manufacturing systems

Course Outcomes

Student will be able to -

1. Understand the basic concepts and applications of discrete event simulation
2. Analyse the simulation input data
3. Verify and validate simulation models using statistical techniques
4. Analyse and interpret the simulation output results
5. Build credible simulation models for real-time applications

Sr. No.	Contents	Hours
1.	**Introduction**: Introduction to manufacturing systems, introduction to simulation, applications, system and system environment, types of simulation, simulation procedure,e of simulation.	3
2.	**Probability distributions**: Review of basic probability and statistics, probability distributions, random number generators, testing of random numbers.	3
3.	**Analysis of Simulation input data**: Data collection, statistical analysis of numerical data, tests for independence and identically distributed data, distribution fitting, selecting a distribution in the absence of data, modelling discrete probabilities, demonstration of input modelling using Arena/others simulation package.	7
4.	**Model Building of Discrete systems**: Modelling Paradigms – Modelling of Structural elements and Operational elements – Modelling issues – Model Verification and Validation.Applications of Simulation in Manufacturing – Manufacturing Modelling Techniques – Modelling Material Handling system – Model building exercises using Arena – Case study.	7
5.	**Simulation output analysis**: Design of Simulation Experiments: Determination of warm up period, Run length, Number of replications – Statistical analysis of simulation output – Terminating and Non-Terminating Simulations – Comparing alternative system designs – Variance reduction Techniques – Simulation Optimization.	8
	Total	28

TEXT BOOKS

1. Law A. W. and Kelton D. W. – 'Simulation Modeling and Analysis' – McGraw Hill – 2010 – 5th Edition
2. Kelton D. W., Sadowski R. P. and Sasowski D. A. – 'Simulation with ARENA' – McGraw Hill – 2009

REFERENCE BOOKS

1. Banks J., Carson J. S., Nelson B. L. and Nicol D. M. – 'Discrete Event System Simulation' – Pearson Education – 2001 – 3rd Edition
2. Viswanathan N. and Narahari Y. – 'Performance Modeling of Automated Manufacturing Systems' – Prentice Hall – 1998

6MX4-20: Machine Design Lab

Credit: 1.5Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+3P

Course Objectives

1. To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyse commonly used machine components.
2. To impart knowledge and enable students to design common mechanical components

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Know the phenomenon of fatigue and design the components subjected to fluctuating loads.
2. Design various gears for the given power and velocity ratios.
3. Understand mode of failure in shafts, keys and couplings and design them for the given specifications.
4. Design sliding contact bearings and select a suitable rolling element bearing from the manufacturer's catalogue

Students can practice using the data handbook in class, and data handbook will be given in the exam.

S.No.	Sessional Work	Hours
	Problems on:	
1.	Design for static loading and stress concentration	4
2.	Design for fluctuating loads	6
3.	Design of spur, bevel, helical and worm gears	4
4.	Design of shafts, keys and couplings	6
5.	Design of sliding contact bearings and selection of rolling element bearings	4

6MX4-21: Drives, Control and Simulation Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. Understand the principles of various drives and control systems used in mechatronics applications.
2. Analyze and simulate different control strategies for mechatronic systems.
3. Design and implement control algorithms for mechatronic devices.
4. Develop skills in using simulation tools for the analysis and design of mechatronic systems.
5. Troubleshoot and analyze the performance of mechatronic systems.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Understand the principles of various drives and control systems used in mechatronics applications.
2. Analyze and simulate different control strategies for mechatronic systems.
3. Design and implement control algorithms for mechatronic devices.
4. Develop skills in using simulation tools for the analysis and design of mechatronic systems.
5. Troubleshoot and analyze the performance of mechatronic systems.

S.No.	Practical
1.	DC Motor Speed Control Objective: To study and implement speed control of a DC motor using various techniques (voltage control, current control, PWM control) and compare their performance.
2.	PID Controller Design for a Servo Motor Objective: To design a PID controller for a servo motor and analyze its response to different reference inputs and disturbances.
3.	Stepper Motor Control Objective: To study and implement open-loop and closed-loop control of a stepper motor and compare their performance in terms of accuracy and speed.
4.	AC Motor Control Objective: To analyze and implement speed control of an AC motor using vector control techniques.
5.	Design and Simulation of a Mechatronic System Objective: To design and simulate a mechatronic system involving multiple actuators and sensors using simulation software (e.g., MATLAB/Simulink).
6.	Fuzzy Logic Control Objective: To design and implement a fuzzy logic controller for a mechatronic system and evaluate its performance in comparison to conventional control techniques.
7.	Model Predictive Control (MPC) Objective: To study and implement Model Predictive Control for a mechatronic system and compare

	its performance with other control strategies.
8.	Haptic Feedback Control Objective: To design and implement haptic feedback control for a virtual environment using force/torque sensors and actuators.
9.	Robotic Arm Control Objective: To control a robotic arm using inverse kinematics and develop a trajectory planning algorithm for its end-effector.
10.	Sensor Interfacing and Data Acquisition Objective: To interface different sensors (e.g., proximity sensors, encoders) with a microcontroller and acquire data for control applications.
11.	Integration of Control Systems in Mechatronic Devices Objective: To integrate and control different subsystems of a mechatronic device and optimize its overall performance.
12.	Fault Diagnosis and Troubleshooting Objective: To identify and diagnose faults in mechatronic systems and develop strategies for fault-tolerant control.

6MX4-22: MATLAB Programming

(Common for ME and MX)

Credit: 1.5Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+3P

Course Objectives

1. To Impart the Knowledge to the students with MATLAB software.
2. To provide a working introduction to the MATLAB technical computing environment.
3. To introduce students the use of a high-level programming language, MATLAB.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. Understand the basics of MATLAB
2. Understand solving linear and polynomial equations using MATLAB

S. No	Contents
1	Study of Introduction to MATLAB
2	Study of basic matrix operations
3	Script Files and Function Files
4	To solve linear equation, Gaussian Elimination
5	Determination of Eigen values and Eigen vectors of a Square matrix.
6	Polynomial Curve Fitting, Least Square Curve Fitting
7	Numerical Integration (Quadrature), Double Integration
8	A first-order linear ODE, A second-order linear ODE
9	Synthesis of Four bar chain mechanism
10	Determination of roots of a polynomial.
11	Basics of 2-D and 3-D plots