ME8791	**MECHATRONICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVE:
- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

UNIT I   INTRODUCTION   9
Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors

UNIT II   MICROPROCESSOR AND MICROCONTROLLER   9
Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram,.

UNIT III   PROGRAMMABLE PERIPHERAL INTERFACE   9
Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT IV   PROGRAMMABLE LOGIC CONTROLLER   9
Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT V   ACTUATORS AND MECHATRONIC SYSTEM DESIGN   9
Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

TOTAL : 45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
- CO1   Discuss the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems and sensor technology.
- CO2   Discuss the architecture of Microprocessor and Microcontroller, Pin Diagram, Addressing Modes of Microprocessor and Microcontroller.
- CO3   Discuss Programmable Peripheral Interface, Architecture of 8255 PPI, and various device interfacing
- CO4   Explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.
- CO5   Discuss various Actuators and Mechatronics system using the knowledge and skills acquired through the course and also from the given case studies

TEXT BOOKS:
1. Bolton, "Mechatronics", Printice Hall, 2008
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Prentice Hall, 2008.

REFERENCES:
1. Bradley D.A, Dawson D, Buru N.C and Loader A.J, "Mechatronics", Chapman and Hall, 1993.
2. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2013
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", PWS publishing company, 2007.
4. Krishna Kant, "Microprocessors & Microcontrollers", Prentice Hall of India, 2007.
5. Michael B.Histand and Davis G.Alciatore, "Introduction to Mechatronics and Measurement systems", McGraw Hill International edition, 2007.

ME8595	THERMAL ENGINEERING – II	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To apply the thermodynamic concepts for Nozzles, Boilers, Turbines, and Refrigeration & Air Conditioning Systems.
- To understand the concept of utilising residual heat in thermal systems.

UNIT I   STEAM NOZZLE   9
Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow.

UNIT II   BOILERS   9
Types and comparison. Mountings and Accessories. Fuels - Solid, Liquid and Gas. Performance calculations, Boiler trial.

UNIT III   STEAM TURBINES   9
Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing.

UNIT IV   COGENERATION AND RESIDUAL HEAT RECOVERY   9
Cogeneration Principles, Cycle Analysis, Applications, Source and utilisation of residual heat. Heat pipes, Heat pumps, Recuperative and Regenerative heat exchangers. Economic Aspects.

UNIT V   REFRIGERATION AND AIR – CONDITIONING   9
Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, Working principle of air cycle, vapour absorption system, and Thermoelectric refrigeration. Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling load calculations. Cooling towers – concept and types.

TOTAL:45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1   Solve problems in Steam Nozzle
CO2   Explain the functioning and features of different types of Boilers and auxiliaries and calculate performance parameters.
CO3   Explain the flow in steam turbines, draw velocity diagrams for steam turbines and solve problems.
CO4   Summarize the concept of Cogeneration, Working features of Heat pumps and Heat exchangers
CO5   Solve problems using refrigerant table / charts and psychrometric charts

TEXT BOOKS:
1. Kothandaraman, C.P., Domkundwar .S and Domkundwar A.V.,"A course in Thermal Engineering", Dhanpat Rai & Sons, , 2016.
2. Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata Mc Graw Hill Publications, 2010.

REFERENCES:
1. Arora .C.P., "Refrigeration and Air Conditioning", Tata Mc Graw Hill, 2008
2. Ballaney. P.L ." Thermal Engineering", Khanna publishers, 24th Edition 2012
3. Charles H Butler : Cogeneration" McGraw Hill, 1984.
4. Donald Q. Kern, " Process Heat Transfer", Tata Mc Graw Hill, 2001.
5. Sydney Reiter "Industrial and Commercial Heat Recovery Systems" Van Nostrand Reinhols, 1985.

ME8692	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

UNIT I   INTRODUCTION   9
Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II   ONE-DIMENSIONAL PROBLEMS   9
One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

UNIT III   TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS   9
Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT IV   TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS   9
Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT V   ISOPARAMETRIC FORMULATION   9
Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

TOTAL : 45 PERIODS

OUTCOMES

CO1   Summarize the basics of finite element formulation.
CO2   Apply finite element formulations to solve one dimensional Problems.
CO3   Apply finite element formulations to solve two dimensional Problems.
CO4   Apply finite element method to solve heat transfer and fluid mechanics problems.
CO5   Apply finite element method to solve problems on dynamic analysis.

TEXT BOOKS:
1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

REFERENCES:
1. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013)*
2. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 1990
3. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002
4. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, 2004
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.

ME8781	**MECHATRONICS LABORATORY**	**L**	**T**	**P**	**C**
		0	0	4	2

OBJECTIVES:
- To know the method of programming the microprocessor and also the design, modeling & analysis of basic electrical, hydraulic & pneumatic Systems which enable the students to understand the concept of mechatronics.

LIST OF EXPERIMENTS:
1. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.
2. Stepper motor interface.
3. Traffic light interface.
4. Speed control of DC motor.
5. Study of various types of transducers.
6. Study of hydraulic, pneumatic and electro-pneumatic circuits.
7. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software.
8. Study of PLC and its applications.
9. Study of image processing technique.

TOTAL: 60 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1   Demonstrate the functioning of mechatronics system with various pneumatic, hydraulic and electrical systems.
CO2   Demonstrate the functioning of control systems with the help of PLC and microcontrollers.

Sl. No.	NAME OF THE EQUIPMENT	Qty.
1	Basic Pneumatic Trainer Kit with manual and electrical controls/ PLC Control each	1 No.
2	Basic Hydraulic Trainer Kit	1 No
3	Hydraulics and Pneumatics Systems Simulation Software	10 No
4	8051 - Microcontroller kit with stepper motor and drive circuit sets	2 No
5	Image processing system with hardware & software	1 No.

MS8711   **COMPUTER AIDED ENGINEERING LABORATORY**   **L T P C**
0 0 4 2

OBJECTIVE:
- To expose the students in the usage of software for modeling and analysis of machine components.

LIST OF EXPERIMENTS:
1. Solid modeling of engineering components of a typical assembly and extraction of production drawings of the above components and assembly.
2. Determination of stresses and factor of safety in critical machine components by FEM and experimental validation of the results by strain measurement.
3. Dynamic analysis of chassis frame of an automobile.
4. Thermal analysis of IC engine components using FEA software.
5. Crash analysis of an automobile using FEA software.
6. Kinematic and dynamic analysis of mechanisms using mechanism analysis software.
7. Thermal Analysis of electronic equipments.
8. Analysis of flow through pipes using CFD software.
9. Simulation of stamping process using metal forming software.
10. Tolerance stack up using simulation software.

TOTAL: 60 PERIODS

OUTCOMES:
- Exposed to use CAD software for creating wire frame and solid models of machine parts
- Ability to conduct kinematic and dynamic simulations of mechanisms
- Knowledge in using softwares for Crash/Impact, flow analysis.
- Usage of FEA softwares in mechanical and thermal load analysis

MS8712   **THERMAL ENGINEERING LABORATORY – II**   **L T P C**
                                                                        0 0 4 2

OBJECTIVES
- To study the heat transfer phenomena predict the relevant coefficient using implementation
- To study the performance of refrigeration cycle / components

LIST OF EXPERIMENTS:
HEAT TRANSFER LAB: **30**
1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Determination of Thermal conductivity of composite wall.
6. Determination of Thermal conductivity of insulating powder.
7. Heat transfer from pin-fin apparatus (natural & forced convection modes)
8. Determination of Stefan – Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Effectiveness of Parallel / counter flow heat exchanger.

REFRIGERATION AND AIR CONDITIONING LAB   **15**
1. Determination of COP of a refrigeration system
2. Experiments on Psychrometric processes
3. Performance test on a reciprocating air compressor
4. Performance test in a HC Refrigeration System
5. Performance test in a fluidized Bed Cooling Tower

OUTCOME
- Ability to demonstrate the fundamentals of heat

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Guarded plate apparatus	1 No.
2	Lagged pipe apparatus	1 No.
3	Natural convection-vertical cylinder apparatus	1 No.
4	Forced convection inside tube apparatus	1 No.
5	Composite wall apparatus	1 No.
6	Thermal conductivity of insulating powder apparatus	1 No.
7	Pin-fin apparatus	1 No.
8	Stefan-Boltzmann apparatus	1 No.
9	Emissivity measurement apparatus	1 No.
10	Parallel/counter flow heat exchanger apparatus	1 No.
11	Single/two stage reciprocating air compressor	1 No.
12	Refrigeration test rig	1 No.
13	Air-conditioning test rig	1 No.

MS8713   **INDUSTRIAL TRAINING V**   **L T P C**
(MANAGERIAL SKILLS, CREATIVITY, SOFT SKILLS, HRM)   **0 0 0 2**

Managerial skills, soft skills and HRM, Generation of creative and innovative ideas, SWOT analysis Executive Skills-Group Discussions-Communication Skills-Project Report preparation methods-Focus on customer needs-Visual Management-Scheduling systems-Maintenance Management-Vendor Developments-Model Preparations-Production, Planning & Controls-Storage & Inventory Management-Supply Chain Management-Lean Methods-Wastage Identifications - Equipment Up Time-Kaizen & Lean Practices, human Resource Management Skills-Innovation & Adaptation Skills-Creative Skills- Patent Right knowledge-Competitive Skills- Interview focusing skills- Product Development Skills- Reverse Engineering Skills- Concurrent Engineering Skills-Prototyping Skills-Costing Skills- Analyzing Skills- Marketability Analysis Skills.

MS8801   **DESIGN FOR MANUFACTURE AND ASSEMBLY**   **L T P C**
                                                       3 2 0 4

OBJECTIVES:
- Apply the principle of geomatic tolerance in assembly.
- Use of datum system for assembly
- Use of systematic assembly procedure for manufacturing assembly.

UNIT I   **DFM APPROACH, SELECTION AND SUBSTITUTION OF MATERIALS**
                IN INDUSTRY   **9+6**
DFM approach, DFM guidelines, standardisation, group technology, value engineering, comparison of materials on cost basis, design for assembly, DFA index, Poka – Yoke principle; concept; design creativity.

UNIT II   **TOLERANCE ANALYSIS**   **9+6**
Process capability, process capability metrics, C_p, C_{pk} , cost aspects, feature tolerances, geometric tolerances, surface finish, review of relationship between attainable tolerance grades and different machining process, cumulative effect of tolerances, sure fit law, normal law and truncated normal law. SELECTIVE ASSEMBLY: Interchangeable and selective assembly, deciding the number of groups, Model-I: group tolerances of mating parts equal; Model-II: total and group tolerances of shaft, control of axial play-introducing secondary machining operations, laminated shims, examples.

UNIT III   **DATUM SYSTEMS**   **9+6**
Degrees of freedom, grouped datum systems-different types, two and three mutually perpendicular grouped datum planes, grouped datum system with spigot and recess, pin and hole, grouped datum system with spigot and recess pair and tongue-slot pair, computation of translational and rotational accuracy, geometric analysis and applications.

UNIT IV   **TRUE POSITION TOLERANCING THEORY**   **9+6**
Comparison between co-ordinate and convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, examples.

FORM DESIGN OF CASTINGS AND WELDMENTS:
Redesign of castings based on parting line considerations, minimising core requirements, redesigning cast members using weldments, use of welding symbols – design considerations for plastic component manufacturing.