Shri Rawatpura Sarkar University, Raipur

Examination Scheme & Syllabus

for

M.Tech.(Machine Design)

Semester-II

(Effective from the session: 2022-23)

Board of Studies

Dr. Ajay Kr. Gupta Dr. Shashank Soni Mr. Kamal Kumar Pradhan

SHRI RAWATPURA SARKAR UNIVERSITY, RAIPUR, CHHATTISGARH
FACULTY OF ENGINEERING

Two Years M.Tech. Programmme
Scheme of Teaching and Examination
M.Tech. Second Semester Machine Design
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the session: 2022-23)

S.N	Course Code	Course Title	Hours per week			Credit	Examination Scheme			Sem End Exam Duration (Hrs)
			L	T	P		Continuous Evaluation	Sem End Exam	Total	
1.	MENDE201T	Advanced Machine Tool Design	3	1	-	4	30	70	100	3
2.	MENDE201P	Advanced Machine Tool Design Lab	-	-	4	2	15	35	50	-
3.	MENDE202T	Advanced Computational Methodology	3	1	-	4	30	70	100	3
4.	MENDE203T	Elective-II	3	1	-	4	30	70	100	3
5.	MENDE204T	Optimization Techniques	3	1	-	4	30	70	100	3
6.	MENDE205T	CAD/CAM Application	3	1	-	4	30	70	100	3
7.	MENDE206P	Computer Integrated Manufacturing Lab	-	-	4	2	15	35	50	-
						24			600	

L – LECTURE T- TUTORIAL P- PRACTICAL

ELECTIVE-II

I	Experimental Method	MENDE204A
III	Automation and Control Engineering	MENDE204B

Board of Studies

Dr. Ajay Kr. Gupta Dr. Shashank Soni Mr. Kamal Kumar Pradhan

<table>
<tr><td>Course Title</td><td colspan="5">ADVANCED MACHINE TOOL DESIGN</td></tr>
<tr><td>Course Code</td><td colspan="5">MENDE201T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Manufacturing science, Machine Design.</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students:
To familiarize with constructional & design features of machine tool structures like bed, columns, sideways, guide ways etc.
To give exposure of types of drives and drive elements and their selection criteria.
To develop skills in designing feed gear boxes, bearings, power screws, clutches etc.
To acquaint with the use of standards & hand books to retrieve relevant data for design/selection.
To appraise the students about safety and safety standards.
To acquaint with the recommended procedure of carrying out acceptance tests & their significance.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT – I
Elements of Machine Tools
Types and capabilities of various machine tools. General purpose and special purpose machine tools. Design of machine tool structures. Design of bed & columns: Materials of construction, Profiles, Static and dynamic stiffness. Designing for strength and rigidity. Methods of enhancing rigidity.
Design of simple machine tool columns like pillar drill column etc. on the basis of strength and rigidity. Design of machine tool bed cross-section like lathe bed.
Machine tool guideways: Materials of construction, Classification of guideways, Types of slideways, Clearance adjustment and wear compensation techniques, Fundamentals of
UNIT – II
Design of Speed and Feed Boxes
Stepped and Stepless speed outputs, selection of spindle speed ranges, construction of structural, speed, gearing & deviation diagrams, layout of speeds on arithmetic and geometric progression, kinematic advantages of geometric progression series and selection of values of common ratio. Stepless drives: Mechanical stepless drives, single disc, double disc and cone disc transmissions, speed regulation by epicyclic gear train, positive infinitely variable drives (PIV drives), Kopp’s and Svetozarav’s drives. Feed boxes: Quadrant change gear mechanism, speed boxes with gear cone and sliding key, Norton gear drive, Meander gear drives, gear boxes with clutched drive, Schopke drive and Ruppert drive. Design of gear</td></tr>
</table>

	UNIT – III **Design of Belt Drives and Power Screws** Design of belts and pulleys: Materials of construction for belts. Types of belts- specifications & selection. Design of flat belt & v- belt pulleys. Design of power screws: Materials of construction. Power screw profiles and selection, design of machine tool power screws based on strength, buckling and stiffness, power requirements and efficiency, mounting of power screws elementary treatment of ball recirculating power screws. **UNIT – IV** **Design of Machine Tool Bearings** Bearing materials & their characteristics. Types of bearings- selection & application. Design of ball & roller bearings: Bearing designation (ISI, SAE, and SKF). Calculation of equivalent load, cubic mean load, static & dynamic load bearing capacities. Selection of ball & roller bearing from handbook. Mounting & maintenance of bearings. Design of journal bearings: Terminology. Theory of lubrication, bearing characteristic No., Sommerfeld No., calculations involving bearing dimensions, clearance, coefficient of friction, heat generated, and heat dissipated and power lost in friction. Mounting & maintenance of bearings. **UNIT – V** **Safety of Machine Tools & Acceptance Tests** Safety concepts, various safety devices incorporated in machine tools to safeguard safety of man, tools and equipment. Introduction to safety standards. Acceptance tests on machine tool: Significance, performance and geometrical tests on lathe, milling, drilling and shaping machines.
Course Outcomes	**At the end of this course students will be able to:** • Use codes and hand books to retrieve relevant data for design and selection. • Design machine tool structures & drive elements. • Design feed gear boxes, bearings and power screws. • Get exposure to requirements like maintaining of expected accuracy levels, parametric optimization, managing wear and tear problems etc.
Text Books	1. Sen and Bhattacharya “Principles of machine tools” New Central Book Agency. 2. N.K.Mehta “Machine tool design and Numerical Control” Tata MGH 3. G R Nagpal “Machine tool Engineering” Khanna Publishers. 4. PSG Design Data book: PSG College of engineering and technology, Coimbatore.
Reference Books	1. S.K. Basu and D.K.Pal “Design of Machine tool” Oxford and IBH publishing Co. 2. H.C.Town. “The design and construction of machine tools” 3. Machine tool design hand book: Central Machine Tool Research Institute, Bangalore. Tata MGH.

SHRI RAWATPURA SARKAR UNIVERSITY, RAIPUR, CHHATTISGARH
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Course Title	**ADVANCED COMPUTATIONAL METHODOLOGY**				
Course Code	**MSCCP102T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**ENGINEERING MATHEMATICS –I, II& III**				
Course objectives	**This course will enable students to:** • To represent the problems mathematically. • To optimize the solutions. • To analyze the result numerically and linguistically by fuzzy theory. • EmphasizethemeaningandpurposeofthesetechniquesandtheiruseinsolvingEngineering Problems.				
Course Contents	**UNIT – I** **Graph Theory And Its Application** Basic Terminology. Simple graph. Multi graph, Types of graph .Path .Cycles. Eulerian and Hamiltonian graph. Shortest path problem Representation of graph. Trees and their properties. Spanning Tree. Binary Tree. Tree traversal. **UNIT - II** **Fuzzy Set And Its Applications** Fuzzy sets-Basic definitions, α-level sets. Convex fuzzy sets. Basic operations on fuzzy sets. Types of fuzzy sets. Cartesian products, Algebraic products. Bounded sum and difference, t-norms andt-conorms.The Extension Principle- The Zadeh's extension principle. Image and inverse image of fuzzy sets. Fuzzy numbers. Elements of fuzzy arithmetic. **UNIT – III** **Cryptography And Its Application** Introduction to the Concepts of Security: The need for security, Security Approaches, Principles of Security, Types of Attacks. Cryptographic Techniques: Plain Text and Cipher Text, Substitution Techniques, Transposition Techniques Encryption and Decryption, Symmetric and Asymmetric Key Cryptography, Steganography, Key Range and Key Size, Possible Types of Attacks. DES, RSA, Digital Signature.				

	UNIT - IV **Statistical Analysis** Expectation and variance of random variable. Sampling Distribution. Testing a Hypothesis. Level of significance. Confidence limits. Test of significance for large sample. Central limit theorem. Test of significance for means of two large samples. Sampling Variables-small samples. Student t-distribution, Chi-square test. **UNIT - V** **Optimization Techniques** Dynamic Programming-Deterministic and Probabilistic Dynamic programming. Inventory- Basic characteristics of an inventory system. The Economic order quantity. Deterministic models. Network analysis (PERT/ CPM).
Course outcomes	**After the completion of course:** 1. This is the foundation of research and development in the computational domain of engineering and technology. 2. As the prerequisite, this will be traced the thought and ideas to design the behavioral tools over the engineering range. 3. This is a transformation from theory to application through measuring theory of natural problems and its applications.
Text Books	1. CalculusofVariationswithApplications, Gupta,A.S.PrenticeHallofIndia(P)Ltd.,New Delhi, 6th print,2006 2. Introduction to Partial Differential Equations, Sankar Rao, .K Prentice Hall ofIndia(P) Ltd., New Delhi, 5th print,2004 3. AdvancedEngineeringMathematics, Jain.R.K,Iyengar.S.R.K.Narosapublications2nd Edition,2006 4. NumericalMethodsinScienceandEngineering,Grewal,B.S-KannaPublications,New Delhi. 5. NumericalMethods,Kandasamy.P,Thilagavathy.KandGunavathy,SChandand Co., Ltd., New Delhi, 5th Edition,2007 6. TheoryandproblemsofComplexVariableswithanIntroductiontoConformal MappingandItsapplications,Schaum'soutlineseries,Spiegel,M.R-McGrawHillBookCo.,1987.

Reference Books	1. Multi - Objective Optimization Using Evolutionary Algorithms, K. Deb(2003)John Wiley 2. Applied Statistics & Probability for Engineers: Montgomery, Douglas C. &Runger, George C. (2007), 3/e,Wiley India. 3. Parallel distributed processing Vol.1 (1986) Rumelhart, D.E and McClelland,J.L.,, M I T Press, 1986. 4. Fuzzy logic implementation and applications (1996), Patyra, M.J. and Mlynek Wiley,

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<table>
<tr><td>Course Title</td><td colspan="5">OPTIMIZATION TECHNIQUES</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPE204T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Design Engineering, Design of Elements and Basic Knowledge of optimization</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students:
Acquire knowledge and develop basic understanding of the concepts of optimization and mathematical modelling.
Acquire knowledge for basic modelling techniques to formulate the real life practical problems into a mathematical model.
Use different direct and gradient based optimisation method to solve single and multivariable un-constrained or constrained nonlinear function for minimization or maximization.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT-I
Introduction to optimization techniques
Basic Concepts, Constrained & unconstrained optimization problems. Functions of one variable, multivariable optimization with no constraints, Kubn tucker conditions, equality & in equality constraints. Applications of linear programming general design applications of optimization conventional Vs optimum design process, optimum design Problem formulation process.

UNIT-II
Non-Linear Programming
Basic Concepts of Non Linear Programming, unimodal function, elemination methods, search techniques exhaustive & dichotomous search, golden section method. Interpolation methods-Quadratic & cubic. Unconstrained minimization methods, direct search method – random search method-random search method, patterned search method-rosam brocks method, descent methods – steepest descent method

UNIT-III
Non linear Programming
constrained optimization techniques Direct method-cutting plane method, gradient project method, indirect method –penalty finds method (Interior & exterior)</td></tr>
</table>

	UNIT-IV **Geometrical & integer programming** Introduction unconstrained minimization & constrained minimization problems. Polynomial unconstrained minimization problem Integer linear & non-linear programming. **UNIT-V** **Stochastic Program & other topics in optimization** Stochastic linear & non-linear programming Introduction to optimum design with MAT LAB
Course Outcomes	**At the end of this course students will be able to:** • Use non-traditional optimization methods such as Genetic Algorithms, Simulated Annealing, Global Optimization. • Application of software for optimization and develop the computer programs for different optimization algorithms. • Get aware to Goal Programming, Advanced Optimization Techniques and Dynamic Programming
Text Books	1. S. S. Rao, Optimization: Theory and Applications 2. Kalyanmoy Deb, Optimization for Engineering Design
Reference Books	1. Mohan C Joshi & K. M. Moudgalya Optimization Theory & Practice 2. Introduction to optimum design –J.S.Arora, Mcgraw Hill Pub. 3. Practical Methods of Optimization –R.Flether, Wiley

Course Title	**CAD/CAM APPLICATION**				
Course Code	**MENPE205T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	Operation research and Industrial Management				
Course Objectives	**This course will enable students:** • To familiarize with the concepts, principles and knowledge of analytical problem solving at operational levels. • To acquaint with functions of operation management and its interrelation with other business functions. • To study key areas of production management and decision making. • To acquaint with importance of planning and control in production activities.				
Course Contents	**UNIT – I** **CAD/CAM contents and tools** History of CAD/CAM Development, Definition of CAD/CAM tools, Industrial look at CAD/CAM Hardware **UNIT – II** **CAD/CAM Software Introduction** Graphics Standards, Basic Definition, Software modules, Application of software in CAD/CAM. Wire Frame models; Wire entities, Curve representation, and parametric represenation of Analytical curves, parametric representation of synthetic curves. Curves manipulations, Design & Engineering applications. **UNIT – III** **Surface Modeling and Representation** Introduction, Surface model, Surface representation, Parametric representation of Analytic and synthetic surface Manipulations. Solid Models, Solid Representations, Fundamentals of Solid Modeling, Half spaces, Boundary Representations, Constructive solid geometry, Sweep Representation, Analytic solid modeling **UNIT – IV** **Geometric Transformations** Introduction to Geometric Transformations, Mechanical Assembly, Mass Property calculations, finite Element Modeling and Analysis. **UNIT – V**				

	NC, CNC &DNC Fundamentals of NC, CNC & DNC, Basics of NC Programming, NC Programming languages, Generation of Tool Path, Verification of tool path
Course Outcomes	**At the end of this course students will be able to:** • Identify and analyse operation flow, primary and supporting activities to achieve quality and targets. • Get exposure to latest trends in design operations management.
Text Books	1. Computer Aided Design and Manufacturing –M.P.Groover and E.W Zimmers, Prentice Hall, India 2. CAD/CAM Theory & Practice –Ibrahim Zeid –Tata Mcgraw Hill Pub.
Reference Books	1. CAD/CAM/CIM –P. Radhakrishnan and S. Subramnaiyam, New Age International 2. Mathematical Elements of Computer Graphics –David. F. Rogers and J. Alan Adams, McGraw Hill.

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<table>
<tr><td>Course Title</td><td colspan="5">ADVANCED MACHINE TOOL DESIGN-LAB</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPE201P</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>-</td><td>-</td><td>4</td><td>2</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Workshop and Manufacturing process.</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students:
Technical knowledge and computing skills necessary to design, analyze and create novel products and solutions.
suitable tools for machining processes including turning, facing, thread cutting and tapping.
Practice on machine tools and their operations.
gain the knowledge of design of structures, guide ways, spindles of machine tools</td></tr>
<tr><td>Course Contents</td><td colspan="5">LIST OF EXPERIMENTS
Step Turning and Taper Turning on Lathe
Thread Cutting and Knurling on Lathe
Machining Flat Surface using Shaper Machine
Square bar Manufacturing of using Milling Machine
Making Internal Splines using Slotting Machine
Drilling, Tapping & Grinding
Grinding of Single Point Cutting Tool
Planning Machine
Lathe Tool and Drill Tool Dynamometers</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">At the end of this course students will be able to:
Calculate the values of various forces involved in the machining operations
Design various single and multipoint cutting tools.
Analyze heat generation in machining & coolant operation
Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish
Analyze economics of machining operations</td></tr>
</table>

Text Books	1. Mehta N. K., "Machine Tool Design", Tata McGraw Hill 2. Pal D. K. and Basu S. K., "Design of Machine Tools", 4th Revised Edition, Oxford-IBH. 3. Bhattacharya A., Sen G. C., "Principles of Machine Tools", New Central Book Agency, Calcutta.
Reference Books	1. Acherkan N. S., "Machine Tool", Vol. I to Vol. II, MIR publications 2. Kundra T, Rao P.M., Tiwari N. K., "Numerical Control and Computer Aided Manufacturing", Tata McGraw Hill 3. Martin S. J., "NC Machine Tools", ELBS publication

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Course Title	**COMPUTER INTEGRATED MANUFACTURING - LAB**				
Course Code	**MENPE206P**				
Course Credits	**L**	**T**	**P**	**TC**	
	-	**-**	**4**	**2**	
Prerequisites	Basic Knowledge of computer, workshop and industrial Management				
Course Objectives	**This course will enable students:** • To introduce the concepts of computer aided engineering for design & manufacture. • To develop skills in preparing machining sequence and estimate manufacturing time. • To appraise the significance and control of tolerance in design &manufacturing. • To impart knowledge on computer graphics, which are used in diverse areas of engineering.				
Course Contents	**LIST OF EXPERIMENTS** 1- Introduction to Computer Integrated Manufacturing (CIM) Lab. 2- Introduction to OPEN CIM Software. 3 - Operating Scorbot ER-9. 4 - Operating AS/RS. 5(a) – Making the tutorial CIM setup in OPEN CIM Software. 5(b) - Making UET AMS Lab CIM setup in OPEN CIM Software. 6- Operating the UET AMS lab CIM setup practically. 7- Introduction to CNC and Part Programming. 8- Operating CNC mill. 9- Introduction to CNC Simulator Pro 10(a) - Construction of a stairs model in CNC Simulator Pro. 10(b) - Making Channels in a work piece. 11 - Making holes in a rectangular plate using G and M codes in CNC Simulator Pro. 12- Operating CNC Lathe in CNC Simulator Pro. 13- Operating Denford CNC.				
Course Outcomes	**At the end of this course students will be able to:** • Illustrate software configuration of graphic packages. • Demonstrate use of Computer graphics in design. • Get oriented with CNC and related software tools. • Solve physical and engineering problems with emphasis on Structural and Thermal Engineering applications.				

Text Books	1. P.N. Rao "CAD / CAM" Tata- McGraw-Hill. 2. William M Neumann and Robert F.Sproul "Principles of Computer Graphics" Mc Graw Hill Book Co. Singapore. 3. Barr, Krimger and Lazaer "CAD Principles and Applications"
Reference Books	1. Ibarahim Zeid "Mastering CAD – CAM" Tata- McGraw-Hill. 2. Donald Hearn and M. Pauline Baker "Computer Graphics" Prentice Hall, Inc.

ELECTIVE-II

Course Title	**EXPERIMENTAL METHOD**				
Course Code	**MENPE203A**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	Mechanical Measurement and metrology, Applied Physics and Mechanics				
Course Objectives	**This course will enable students:** • Familiarity with different types of measurement systems/devices for engineering measurements • Capability to handle different types of measurement signals and utilize this capability to obtain reliable measurement results • Ability and practice in engineering report writing, including assessment and manipulation of data, and drawing conclusions from that data				
Course Contents	**UNIT – I** **Theory and Experimentation in Engineering** Problem solving approaches, Types of engineering experiments, computer simulation and physical experimentation; Generalized measuring system, types of inputs, analog and digital signals, standards, calibration and uncertainty, **UNIT – II** **Measurement System** Performance characteristics, static performance characteristics-static calibration-linearity, static sensitivity, repeatability, hysteresis-threshold- resolution, readability and span; **UNIT – III** **Analysis of Experimental Data** Causes and types of experimental error, un-certainty analysis, statistical analysis of data, probability distributions and curve fitting; Dynamic performance characteristics; Input types; Instrument types- zero order instrument, first order instrument, second order instrument; **UNIT – IV** **Experiment Plans** Model building; Measurement Methods and Applications : Measurement of force and torque; Measurement of strain and stress; Measurement of pressure; Flow measurement and flow visualization; measurement of temperature; optical methods of measurements; **UNIT – V** **Data Acquisition and Processing** Types and configurations of DAS, signal conditioning, A/D, D/A conversion;				

	Design, Planning, Execution and Analysis of experimental projects.
Course Outcomes	**At the end of this course students will be able to:** • Apply analytical and experimental methods to make measurements and to find and correct defects in measurement systems. • Use a variety of equipment and techniques to measure force, flow, pressure, temperature, speed, strain. • Setting the instruments for zero error adjustment • To understand principle, working of various measuring instruments.
Text Books	1. Beckwith, Buck, and Marangoni, Mechanical Measurements, Narosa Publishing House, 1995. 2. Doeblin, Measurement Systems - Application and Design, McGraw-Hill, 1990. 3. Doeblin, Engineering Experimentation, McGraw-Hill, 1995.
Reference Books	1. Holman, Experimental Methods for Engineers, 6e, McGraw-Hill, 1994. 2. M. I. Eremets “High Pressure Experimental Methods” Oxford University Press, 1996

ELECTIVE-II

Course Title	**AUTOMATION AND CONTROL ENGINEERING**				
Course Code	**MENPE203B**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	Applied physics and Instrumentation and control				
Course Objectives	**This course will enable students:** • To acquaint with basic concepts of industrial automation involving pneumatic and hydraulic controls. • To familiarize with the elements of electro-pneumatic interface with control systems. • To learn about the application of microprocessors and microcontrollers.				
Course Contents	**UNIT – I** **Automation** Definition; Automation in production systems; Automation principles and strategies; Basic elements of an automated system; Advanced automation functions; Levels of automation; Types of automation; Benefits and Impact of Automation in Manufacturing and Process Industries. Architecture of Industrial Automation Systems. **UNIT – II** **Pneumatic control systems** Overview of different types of valves and Actuators in Pneumatics, their applications and their ISO symbols. Design of Pneumatic circuits using Cascade method and Shift register method (up to 3 cylinders). Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves with and without grouping. Design of Pneumatic circuits using PLC Control (ladder programming only and up to 3 cylinders) with applications of Timers and Counters and concept of Flag and latching. **UNIT – III** **Hydraulic control systems** Overview of different types of valves, Actuators and Accumulators used in Oil hydraulic circuits, their applications and their ISO symbols. Basic hydraulic circuits involving linear and rotary actuators (No sequential circuits). Fundamental concepts of digital and servo hydraulic controls. Comparison between proportional, digital and servo hydraulic control systems. **UNIT – IV** **Sensors and Transducers** Fundamentals of displacement, position and Proximity Sensors; Velocity and				

	Motion Sensors; Force and Fluid Pressure Sensors; Liquid level and Flow sensors; Temperature and light Sensors; Control of stepper motors. **UNIT – V** **Fundamentals of Control System** Control system concepts, classification of control systems, mathematical representation of system equations, response characteristics of components and systems through classical solution. Analog computer and Laplace transformation, Frequency response analysis, polar plots, Testing of System's stability using Routh's criteria, Bode plots, Nyquist plot and Root locus method of analysis.
Course Outcomes	**At the end of this course students will be able to:** • Apply automation techniques to manufacturing set-ups. • Design and develop pneumatic and hydraulic control circuits of medium complexity. • Illustrate the use of PLC in control systems. • Model the system and check the stability of a mechanical system.
Text Books	1. Mikell P. Groover "Automation, Production Systems, and Computer-integrated Manufacturing" (3rd Edition), PHI Learning Private Limited, New Delhi. 2. U.A.Bakshi, V.U.Bakshi, "Principles Of Control Systems" Technical Publications Pune . 3. Peter Croser, Frank Ebel "Pneumatics Basic Level" Festo Didactic GmbH & Co. Germany 4. G. Prede, D. Scholz "Electropneumatics Basic Leve"
Reference Books	1. S.Ilango and V. Soundararajan "Introduction to Hydraulics and Pneumatics" PHI Learning Pvt. Ltd. New Delhi. 2. P.N. Paraskevopoulos "Modern Control Engineering" CRC Press.