VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech Mechatronics (MTR)
(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech MECHATRONICS (MTR)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20 MTR 11	Applied Mathematics	03	--	02	03	40	60	100	4
2	PCC	20 MTR 12	Fluid Power Automation	03	--	02	03	40	60	100	4
3	PCC	20 MTR 13	Advanced Control Systems	03	--	02	03	40	60	100	4
4	PCC	20 MTR 14	Mechatronics System Design	03	--	02	03	40	60	100	4
5	PCC	20 MTR 15	Sensors And Signal Conditioning	03	--	02	03	40	60	100	4
6	PCC	20 MTR L16	Fluid Power Automation Laboratory	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	01	--	02	03	40	60	100	2
			TOTAL	**17**	**04**	**12**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20 MTR 21	Automotive Electronics	03	--	02	03	40	60	100	4
2	PCC	20 MTR 22	Micro and Smart Systems	03	--	02	03	40	60	100	4
3	PCC	20 MTR 23	Safety and Security of Mechatronics System	03	--	02	03	40	60	100	4
4	PEC	20 MTR 24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20 MTR 25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20 MTR L26	Advanced Control System Laboratory	--	04	--	03	40	60	100	2
7	PCC	20 MTR 27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20XXX24X	**Course title**	**Course Code under 20XXX25X**	**Course title**
20 MTR 241	Industrial Automation	20 MTR 251	Programmable Logic Controllers (PLCS)
20 MTR 242	Finite Element Method	20 MTR 252	Reliability and Failure Analysis
20 MTR 243	Smart Materials and Structures	20 MTR 253	Vibration Analysis

Note:
1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the programme shall be mandatory.
The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25.
2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20 MTR 31	Artificial Intelligence And Neural Networks	03	--	02	03	40	60	100	4
2	PEC	20 MTR32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20 MTR33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20 MTR 34	Project Work phase -1	--	02	--	--	100	--	100	2
5	PCC	20 MTR 35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20 MTR I36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		**Professional elective 4**	
Course Code under	**Course title**	**Course Code under**	**Course title**
20 MTR 321	Digital Image Processing And Machine Vision	20 MTR 331	Robotics Engineering
20 MTR 322	Embedded Systems With Advanced Microcontrollers	20 MTR 332	Micromachining
20 MTR 323	Simulation Modelling And Analysis	20 MTR 333	Product Design
20 MTR 324		20 MTR 334	

Note:

1. Project Work Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	20MTR41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Work Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

APPLIED MATHEMATICS

(Effective from the academic year 2020-21)

SEMESTER-I

Subject Code	20MTR11	CIE Marks	40
Number of Contact Hours/Week	03-00-02	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model. Roots of Equations: Bracketing Methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed-point iteration.

MODULE 2

Roots of polynomial-Polynomials in Engineering and Science, Muller's method, Numerical Differentiation and Numerical Integration: Newton – Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae.

MODULE 3

System of Linear Algebraic Equations and Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods.

MODULE 4

Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method

MODULE 5

Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering. Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets

Course outcomes:

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

- Model some simple mathematical models of physical Applications.
- Find the roots of polynomials in Science and Engineering problems.
- Differentiate and integrate a function for a given set of tabulated data, for Engineering Applications.
- Understand Eigen values and Eigen Vectors to maintain relationships

between two variables while solving problems

- Apply various mathematical methods involving arithmetic, algebra, to solve problems.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

- S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
- Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata Mcgraw Hill, th 4 Ed, 2002.
- M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.

Reference Books:

- PeFind the roots of polynomials in Science and Engineering problems.
- Differentiate and integrate a function for a given set of tabulated data, for Engineering Applications.

FLUID POWER AUTOMATION

(Effective from the academic year 2020-21)

SEMESTER-I

Subject Code	20MTR12	CIE Marks	40
Number of Contact Hours/Week	03-00-02	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Fluid Power Generating/Utilizing Elements: Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification-drive characteristics-Linear actuator- Types, mounting details, cushioning-power packs-construction, reservoir capacity, heat dissipation, accumulators-standard circuit symbols, circuit (flow) analysis.

Control and regulation elements: Direction flow and pressure control valves-method of actuation, types, sizing of ports-pressure and temperature compensation, overlapped and under lapped spool valves-operating characteristics-electro hydraulic systems, electro hydraulic servo valves-different types characteristics and performance

MODULE 2

Comparison of Hydraulics and Pneumatics: need for Automation, Hydraulic and Pneumatic comparison-ISO symbols for fluid power elements, Hydraulic, pneumatics- Selection criteria and examples related to selection criteria.

Advanced Hydraulics: Types of proportional control devices-pressure relief, flow control, directional control, Hydraulic symbols, Spool configurations, electrical operation, Basic electrical circuit and operation, solenoid design, comparison between conventional and proportional valves.

MODULE 3

Method of control : Comparison between analogue and digital control, Proportional attributes, Ramp, Gain, dead band, Dither, Pulse width modulation, Amplifier cards, Principles of operation, Design and application, Analogue and digital, Closed loop, Internal and external feedback devices, Operation and application of closed loop system, Integrated electronics option frequency Response, Principles of operation, Bode diagrams and their use in manufacturer's data, PID control, Practical exercises, Commissioning and set up procedures, open loop circuits, closed loop circuits, Interface to the control.

MODULE 4

Electrical Control of Fluid power: Electrical control of Hydraulics and Pneumatics, use of relays, Timers, counters, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits, Electronic circuits for various open loop control and closed loop (Servo) control of Hydraulics and **Pneumatics. Circuit Design:** Typical industrial hydraulic circuit design methodology- Ladder diagram- cascade, method-truth table-

karnaugh map method-sequencing circuits- combinational and logic circuits

MODULE 5

Application of Propositional and Servo Valves : Velocity control, Position control and Directional control and applications example: paper industry, process industry, printing sawmill, wood working, extrusion press, power metallurgical press, continuous casting, Food and packaging, Injection moulding, Solar energy and automobile

Course outcomes:

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

- Analyse and identify the functional requirements of a fluid power.
- Identify the various applications of fluid power.
- Differentiate between fluid power and transport systems.
- Apply concept of fluid power for the industrial applications of fluid power
- Analyze and design hydraulic and pneumatic circuits

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Pnematic System, S.R.Majumdar,TMH, 1995
(2) Fluid Power Systems and Control, Antony Esposito, Prentice Hall,1998
(3) Hydraulic and Pneumatics control, R.Srinivasan, Vijay Nicole Imprints Private Ltd.
(4) Hydraulic and Pneumatics, Andrew Parr, Butterworth-Heinemann

Reference Books

(1) (1) Hydraulic control systems, Herbert R Merritt, John Wiely& Sons, Newyork,1967.
(2) (2) Basic fluid power, Dudbey A Peace, Prentice hall Inc,1967.
(3) (3) Fluid power logic circuit design, Peter Rohner,Macmillan press Ltd, London,1979.
(4) (4) Fluid Power logic circuit design, Peter Rohner, Mcmelan prem,1994.

ADVANCED CONTROL SYSTEMS

(Effective from the academic year 2020-21)

SEMESTER-I

Subject Code	20MTR13	CIE Marks	40
Number of Contact Hours/Week	03-00-02	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Mathematical models of Physical systems, Performance specification, Root locus analysis and design, **frequency domain analysis and design Sampled data control systems –** Introduction to control systems , Sampling process; Sample and Hold circuit; Types of signals ; Mathematical operation on discrete time signals; Z-transform; Properties of Z-transforms; Inverse Z-transform; Solving the differential equations using Z-transform; and its Applications.

MODULE 2

State space analysis- concepts of states; State space formulation; State model of linear system; State diagram and signal flow graph; State-space representation using physical variables-Electrical systems and mechanical translational system; State-space model of Mechanical translational systems and Rotational system.

MODULE 3

Stability, Controllability and Observability- Linear discrete-time systems(LDS); Transfer function of LDS systems; Stability analysis of sampled data control systems using Jury's stability test, Bilinear transformation and Root locus technique; Similarity transformation; Eigen values and Eigen vectors; Canonical form of state model; Controllability test and Observability test using Gilbert's method of testing, Kalman test and Duality property.

MODULE 4

Nonlinear systems- Introduction to Nonlinear systems; common physical non linearity's; Describing function; Derivation of describing function of dead-zone and saturation nonlinearity; Derivation of describing function of saturation nonlinearity; Derivation of describing function of dead-zone nonlinearity; Derivation of describing function of relay with dead-zone and hysteresis.

MODULE 5

Derivation of describing function of Backlash nonlinearity; Describing function analysis of nonlinear systems using polar plot and Nichols plot ; Phase plane and phase trajectories; Singular points; Stability analysis of nonlinear systems using phase trajectories ; Construction of phase trajectories by- analytical method, Isocline method, delta method; Jump response; Liapunov's stability criterion; Popov's stability criterion.

Course outcomes:

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

- Analyse various control systems.
- Acquire knowledge of transfer function of systems using signal flow graph and block diagram reduction.
- Analyse stability of systems.
- Apply time domain analysis of control systems.
- Analyse frequency domain of control systems

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) "Control Systems Engineering", J. Nagarath and M. Gopal, New Age International (P)Limited,
(2) Publishers, Fourth edition – 2005
(3) "Fundamentals of Signals & Systems", Michael Roberts, 2nd ed, Tata M cGraw-Hill,2010.

Reference Books

(1) "Modern Control Engineering ", K. Ogata, Pearson Education Asia/ PHI, 4th Edition,2002.
(2) "Feedback and Control System", Joseph J Distefano III et al., Schaum's Outlines,TMH, 2nd Edition 2007.
(3) "Discrete Time Control Systems", Ogata K., Addison Wesley Longman, 2nd Edition,2000.

MECHATRONICS SYSTEM DESIGN

(Effective from the academic year 2020-21)

SEMESTER-I

Subject Code	20MTR14	CIE Marks	40
Number of Contact Hours/Week	03-00-02	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Introduction to Mechatronic System Design: Key elements – Mechatronics Design process –Design Parameters – Traditional and Mechatronics designs – Advanced approaches in Mechatronics - Industrial design and ergonomics, safety.

MODULE 2

Modelling of Mechatronics system: Need for modelling – systems overview – representation of systems (block diagram, signal flow graphs, transfer function and state space) -Modelling technique (analytical and identification techniques) – direct method- analogue approach – bond graph approach – modelling of electrical, mechanical, thermal, fluid and hybrid systems – system identification methods overview – Least square method.

MODULE 3

Generalized Mechatronics Design Process: Recognition of the Need, Conceptual Design and Functional Specification, First principle Modular Mathematical modelling, Sensor and Actuator Selection, Drivers for Actuators, Control System Design, Design Optimization, Prototyping, Hardware in-the-loop Simulation, Deployment/Life Cycle, Deployment of Embedded Software, Life Cycle Optimization.

MODULE 4

Design optimization: Optimization – problem formulation - constraints – over view of linear and nonlinear programming techniques – other optimization techniques- optimal design of mechatronics system with case studies.

MODULE 5

Fault Finding: Fault– Detection Techniques, Watch Dog Timer, Parity and Error Coding Checks, Common Hardware Faults, Microprocessor Systems, Emulation and Simulation, PLC Systems.

Course outcomes:

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

- Acquire knowledge of basic system modelling.
- Apply modelling technique for the building mechatronics system design
- Describe fault finding techniques
- Apply design optimization for mechatronics systems developments.
- Design and implement control systems for mechatronic machines.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) "Mechatronic Modeling and Simulation Using Bond Graphs", Shuvra Das., CRC Press, 2009
(2) "Mechatronics – Electronic control systems in Mechanical & Electrical Engineering", W. Bolton, Pearson Education Ltd., 2003.
(3) "Mechatronics System Design", Shetty and Kolk, CENGAGE Learning, India, second edition, 2011.
(4) "Bond Graph in Modeling, Simulation and Fault Identification" Amalendu Mukherjee, Ranjit Karmakar, Arun kumar samantaray, I.K International Pvt Ltd, Jan 2006.
(5) Mechatronics - W. Bolton, Pearson Edition
(6) "Mechatronics System Design", Devadas Shetty, Richard A.Kolkm, PWS Publishing Company.

Reference Books

(1) Mechatronics -Mahalik, TMH.
(2) Mechatronics - HMT, TMH.
(3) Understanding Electro-Mechanical Engineering: An Introduction to Mechatronics -Kamm, PHI.

SENSORS AND SIGNAL CONDITIONING

(Effective from the academic year 2020-21)

SEMESTER-I

Subject Code	20MTR15	CIE Marks	40
Number of Contact Hours/Week	03-00-02	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Introduction to Measurement System: General Concepts and Terminology, Sensors Classification, General Input-Output Configuration, Static Characteristics of Measurement Systems, Dynamics Characteristics of Measurement Systems, Input Characteristics: Impendence, Primary Sensors, Problems.

Resistive Sensors: Potentiometers, Strain Gages, Resistive Temperature Detectors (RTDs), Thermistors, Magneto resistors, Light Dependent Resistors (LDRs), Resistive Hygrometers.

MODULE 2

Signal conditioning For Resistive Sensors: Measurement of Resistance, Voltage Dividers, Wheatstone bridge, Balance Measurements, Instrumentation Amplifiers, and Interference.

Reactive Variation and Electromagnetic Sensors: Capacitive Sensors, Inductive Sensors, Electromagnetic Sensors.

MODULE 3

Signal conditioning For Reactive Variation Sensors: Problems and Alternatives, AC Bridges, Carrier Amplifiers, variable Oscillators, Resolver– to Digital and Digital-to-Resolvers Converters.

Self-Generating Sensors: Thermoelectric Sensors: Thermocouples, Piezoelectric Sensors, Photovoltaic Sensors, Electrochemical Sensors.

MODULE 4

Signal Conditioning for Self-Generating Sensors: Chopper and Low- Drift Amplifiers, Electrometer Amplifiers, Charge Amplifiers, Noise in Amplifiers.

Digital sensors: Position Encoders, Variable Frequency Sensors.

MODULE 5

Other transduction Methods: Sensors based on Semiconductors Junctions, Sensors based on MOSFET Transistors, Charge-Coupled Sensors, Ultrasonic based Sensors, Fiber-Optic Sensors.

Telemetry and Data Acquisition: Data-Acquisition System Structure, Telemetry Systems, Amplitude Telemetry, Frequency Telemetry.

Course outcomes:

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

- Illustrate the measuring systems and their characteristics
- Interpret the type of sensors for particular applications
- Understanding of thermocouples, piezoelectric and pyro-electric transducers and their applications.
- Demonstrate various signal conditioning for sensors
- Explain the transducers and telemetry and data acquisition

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) "Mechatronics", Bolton W., Thomson Press, 2003.
(2) "Mechatronics", Bradley D.A., and Dawson, Burd and Loader, Thomson Press
(3) "Measurement system, Application and Design", Ernest O. Doeblin, Tata Mc Graw Hill Publishing
(4) Company Ltd., Fiftieth Edition, 2004

Reference Books

(1) "Sensor and Actuators", Patranabis D., Prentice Hal l of India (Pvt) Ltd.,2005.
(2) "Transducer Engineering", Renganathan S., Allied Pu blishers (P) Ltd., 2003

FLUID POWER AUTOMATION LABORATORY

Course Code	20MTRL16	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl. NO Experiments

(1) Study of Hydraulic Pump and to draw characteristic curve of variable displacement pump.
(2) Single rod cylinder with Pressure In-intensification (Use 4/2 DCV). Exercises on Meter- in Meter-out Circuit.
(3) Application Involving 4/3 Direction Control Valve: Open Centre & Closed Center
(4) Application Involving 4/3 Direction Control Valve Using motor.
(5) Speed Control of Single Acting Cylinder. Slow speed Extension and Rapid Retraction by using pneumatic components.
(6) Position Dependent Control of a Pneumatic Double Acting Cylinder with Mechanical Limit Switches.
(7) Logical Control with Shuttle and Twin-Pressure Valves of pneumatic components.
(8) Sequential Control of Two Double Acting Cylinders without Overlapping Signals.

Course outcomes:

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

- Ability to design and implement pneumatic components system for simple applications.
- Capability to control various types of Control Valve, Pneumatic Double Acting Cylinder
- Demonstrate various valves of pneumatic components with logic control
- Design and develop fluid power circuits to various applications.
- Interpret the specifications of the fluid power system components for various applications.

Text Book

(1) Anthony Esposito, *"Fluid Power with Applications"*, Prentice Hall international, 7th edition, 2014.

Reference Books

(1) Jagadeesha T., *"Fluid Power Control"*, NPTEL Web course.
(2) FESTO, *"Fundamentals of Pneumatics"*, Vol I, II, III.
(3) Majumdar .S.R., *"Oil Hydraulics"*, Tata McGraw Hill, 2002.
(4) Werner Deppert , *"Kurt Stoll, Pneumatic Application"*, Vogel verlag ,1986

RESEARCH METHODOLOGY AND IPR

Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. ■

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. ■

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. ■

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. ■

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of

Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. ■

Course outcomes:

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

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.

(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,3rd Edition, 2011.

(3) Study Material (For the topic Intellectual Property under module 5),

Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books

(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.

(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

AUTOMOTIVE ELECTRONICS

(Effective from the academic year 2020-21)

SEMESTER-II

Subject Code	20MTR21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Automotive fundamentals overview – four stroke cycle, engine control, ignition system, spark plug, spark pulse generation, ignition timing, drive train, transmission, brakes, steering system, starting system.

Actuators – fuel metering actuators, fuel injector, ignition actuator

Exhaust After – Treatment System –AIR, catalytic converter, exhaust gas recirculation n (EGR), Evaporative emission systems

MODULE 2

Air/ fuel system – fuel handling, air intake system, air/ fuel management

Sensors: Oxygen (02/EGO) sensors, throttle position sensor (TPS), engine crankshaft angular position (CKP)sensor, magnetic reluctance position sensor, engine speed sensor, ignition timing sensor, hall effect position sensor, shield field sensor, optical crankshaft position sensor, manifold absolute pressure(MAP) sensor-strain gauge and capacitor capsule, Engine coolant temperature(ECT) sensor, intake air temperature (AIT) sensor, knock sensor, airflow rate sensor, throttle angle sensor.

MODULE 3

Electronic Engine Control – engine parameters, variables, engine performance terms, electronic fuel control system, electronic ignition control, idle speed control, EGR control.

Vehicle motion control – cruise control, chassis, power brakes, antilock brake system (ABS), electronic steering control, power steering, traction control, electronically controlled suspension.

MODULE 4

Communication-serial data, communication systems, protection, body and chassis electrical systems, remote keyless entry, GPS

Automotive Instrumentation– sampling, measurement & signal conversion of various parameters. Radar warning system, low tire pressure warning system, radio navigation, advance driver information system

MODULE 5

Integrated body- climate control systems, electronic HVAC system, Safety systems- SIR, interior safety, lighting, entertainment systems.

Automotive diagnostics – Timing light, engine analyzer, on-board diagnostic off- board diagnostics, expert systems.

Course outcomes:

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

- Obtain an overview of automotive components, subsystems, design cycles, communication protocols and safety systems employed in today's automotive industry.
- Differentiate electronic and mechanical components used in automobile systems
- Apply concept of integration of system components
- Analyse and measure signal conversion parameters
- Obtain an overview of automotive diagnostics

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) "Automobile Electrical and Electronic Systems" Tom Denton, Routledge,5 edition,2017.

Reference Books

(1) understanding automotive electronics, Willian b. Ribbens, SAMS/Elsevier publishing 6th edition,2002

(2) Automotive electrics automotive electronics systems and components, Robert Bosch Gmbh, john wiley & sons ltd., 5th sedition, 2007

MICRO AND SMART SYSTEMS

(Effective from the academic year 2020-21)

SEMESTER-II

Subject Code	20MTR22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Glimpses of Microsystems: scaling effects, Smart materials and systems: an overview Micro sensor: Micro actuators Microsystems examples, structural health monitoring and vibration control

MODULE 2

Microfabrication processes:Structure of silicon and other materials Silicon wafer processing; Thin-film deposition Lithography, wet etching and dry etching Bulk micromachining and Surface micromachining Wafer-bonding; LIGA and other moulding techniques Soft lithography and polymer processing Thick-film processing; Low temperature co-fired ceramic processing Smart material processing.

MODULE 3

Mechanics of Solids Stresses and deformation: bars and beams Micro device suspensions: lumped modelling Residual stress and stress gradients Poisson effect; Anticlastic curvature; examples of micromechanical structures Vibrations of bars and beams Gyroscopic effect Frequency response; damping; quality factor Basic 10Hrs. micro-flows for damping calculation

MODULE 4

Types of numerical methods for solving partial differential equations, Weak form; shape functions, Iso parametric formulation and numerical integration, Implementation of the finite element method, FEM for piezoelectric

MODULE 5

Electronics and packaging: Semiconductor devices: basics, Signal conditioning for microsystems devices, Integration of Microsystems and microelectronics, Packaging of Microsystems: why and how, Flip-chip, ball grid, etc.; reliability, Case studies

Course outcomes:

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

- Describe micro systems, micro sensors and type of micro fabrication processes
- Distinguish electronic and mechanical components used in automobile systems
- Apply concept of mechanics of solids
- Analyse partial differentiation for micro systems
- Describe electronic packaging of micro electronics

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Microsystem Design, S.D. Senturia, Kluwer Academic Publishers, 2001

(2) MEMS & Microsystems Design and Manufacture, Tai-Ran Hsu, McGraw Hill, 2002.

(3) Smart Material Systems and MEMS: Design and Development Methodologies, V.K.Varadan, K.J. Vinoy, and S. Gopalakrishnan, Wiley, 2006.

Reference Books

(1) Micromachined Transducers Sourcebook, G.T.A. Kovacs, WCB McGraw-Hill, 1998.

(2) Microsensors: principles and applications, J.W. Gardner, John Wiley & Sons, 1994.

(3) Principles of Microfabrication, M. Madou, CRC Press, 1998.

SAFETY AND SECURITY OF MECHATRONICS SYSTEM

(Effective from the academic year 2020-21)

SEMESTER-II

Subject Code	20MTR23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Types of Automobile. Limiting dimensions as per central motor vehicle Rules. Engine classification, construction, Materials of engine components. Prototype testing as per Central Motor Vehicle Rules **Fuel System-**fuel tank, Fuel filter, Types of fuel system. **Carburettor-** simple and modern, fuel injection system. Emission standards as per CMV Rules

MODULE 2

Electrical System – Storage battery operations and Maintenance. Ignition system - coil and Magneto Ignition system. Starting system, Lighting system, Horn system- wind shield. Wiper Motors, Fans, Heaters, Trafficator. Automobile air conditioning, Central Motor Vehicle Rules regarding Lighting, windshields, wipers.

MODULE 3

Transmission system – clutches-operation and fault finding of clutches, Fluid Flywheel, Gear-Box types, steering systems, chassis springs, suspension.
Differential Dead and Live axles, Rims, Tyre etc. Brakes-Types, Construction and fault finding, CMV Rules- Brakes, Steering & Tyre.

MODULE 4

Lubrication systems- Types, components, Lubricating oil, Cooling system – Details of components, study of systems, Types.
Miscellaneous- Special gadgets and accessories for fire fighting vehicles. Automobile accidents. CMV Rules regarding safety devices for drivers, passengers

MODULE 5

Safety features like airbags, antilock braking systems (ABS), anti-skid systems, belt tensioners or the electronic stability program (ESP interlocked interaction of mechanics, electronics and information technology. deployment in the safety-relevant environment and fault tolerance. Fault tolerant Mechatronics. Operability and reliability

Course outcomes:

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

- Describe different safety aspects of Mechatronics system
- List the integrating components of Mechatronics system
- Apply fault tolerance and interdependency of various elements
- Describe the operation ability and reliability of systems
- Enumerate the characteristics of fuel system and Carburettor in a typical automobile.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Automobile Engineering, B. S. Narang, Khanna Publishers; Fifth edition ,1995

(2) Automobile Engineering, Dr. Kirpal Singh, Standard Publishes-Distributors-Delhi; 13th edition ,2012.

Reference Books

(1) Automobile chassis and body Construction, Operation and Maintenance, William H Crouse, McGraw-Hill automotive technology series,1971.

(2) Automobile Machines, William H Crouse, McGraw-Hill HED, 10th edition,2017.

INDUSTRIAL AUTOMATION

(Effective from the academic year 2020-21)

SEMESTER-II

Subject Code	20MTR241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Automation in Production & Manufacturing Systems: Automation in Production system, Principles &Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Components of Manufacturing Systems, Classification of Manufacturing Systems, Manufacturing Cells, GT, Cellular Manufacturing, FMS, Flow lines & Transfer Mechanisms.

MODULE 2

Automated Assembly & Material handling Systems: Introduction to Material Handling, Overview of Material Handling Equipment, Considerations in Material Handling System Design, The 10 Principles of Material Handling, Material Transport Systems, Automated Guided Vehicle Systems, Monorails and other Rail Guided Vehicles, Conveyor Systems, Analysis of Material Transport Systems, Storage Systems, Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated Storage Systems, Engineering Analysis of Storage Systems., Overview of Automatic Identification Methods.

MODULE 3

Quality& Shop Floor Control Systems: Traditional & Modern Quality Control Methods, SPC Tools, Inspection Principle & Practices, Inspection Technologies, Computer Aided Quality Control Steering, Contact & Non-Contact Inspection Methods, Co-Ordinate Measuring Machine, Factory Data Collection Systems, Automatic Identification Systems.

MODULE 4

Control Technologies in Automation: Industrial Control Systems, Process Industries Verses Discrete Manufacturing Industries, Continuous Verses Discrete Control, Computer Process & its forms. Sensors, Actuators & other Control System Components.

MODULE 5

Computer Based Industrial Control: Introduction & Automatic Process Control, Computer Aided Process, Planning; Retrieval types, Generative type, Material Requirement Planning, Fundamental Concepts of MRP, Capacity Planning.

Course outcomes:

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

- Describe different production systems and their importance
- List the automated manufacturing systems
- Distinguish elements of automated system
- Apply control system for automation
- Describe computer aided process planning

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education, 2nd Edition,2002.

(2) Computer Based Industrial Control, Krishna Kant, EEE-PHI, 2nd s editions,2010.

Reference Books

(1) Performance Modelling of Automated Manufacturing Systems, Viswanandham, PHI,1994

(2) CAD/CAM by Zeid, Tata McGraw Hill. 2000

(3) Principles of CIM,Vajpayee, PHI, 1998

FINITE ELEMENT METHOD

(Effective from the academic year 2020-21)

SEMESTER-II

Subject Code	20MTR242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Introduction to finite element method: basic steps in finite element method to solve mechanical engineering problems (solid, fluid and heat transfer). Functional approach and Galerkin approach. Displacement approach: admissible functions.

Convergence criteria: conforming and nonconforming elements, C0, C1 and Cn continuity elements. Basic equations, element characteristic equations, assembly procedure, boundary and constraint conditions.

MODULE 2

Solid Mechanics: One-dimensional finite element formulations and analysis – bars- uniform, varying and stepped cross section. Basic (Linear) and higher order elements formulations for axial, torsional and temperature loads with problems.

Beams- basic (linear) element formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions, numericals.

Trusses, Plane frames and Space frame – basic (Linear) elements formulations for different boundary conditions -axial, bending, torsional, and temperature loads, numericals.

MODULE 3

Two-dimensional finite element formulations for solid mechanics problems: triangular membrane (tria 3, tria 6, tria 10) element, four noded quadrilateral quad membrane 4, quad 8) element formulations for in-plane loading with simple problems. Triangular and quadrilateral axi-symmetric basic and higher order elements formulation for axi-symmetric loading with simple numericals.

Three-dimensional finite element formulations for solid mechanics problems: finite element formulation of tetrahedral element (tet 4, tet 10), hexahedral element (hexa 8, hexa 20), for different loading conditions. Serendipity and Lagrange family elements

MODULE 4

Finite element formulations for structural mechanics problems: Basics of plates and shell theories: classical thin plate theory, shear deformation theory and thick plate theory. Finite element formulations for triangular and quadrilateral plate elements. Finite element formulation of flat, curved, cylindrical and conical shell elements.

MODULE 5

Dynamic analysis: finite element formulation for point/lumped mass and distributed masses system, finite element formulation of one-dimensional dynamic analysis: bar, truss, frame and beam element.
Finite element formulation of two-dimensional dynamic analysis: triangular membrane and axi-symmetric element, 10Hrs. quadrilateral membrane and axi -symmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame.

Course outcomes:
At the end of the course the student will be able to:

- Understand the concepts of Variation methods and weighted residual methods.
- Identify the application and characteristics of FEA elements such as bars, beams, plane and isoperimetric elements, and 3D element.
- Develop element characteristic equations and generate global stiffness equations.
- Apply suitable boundary conditions to a global structural equation, and reduce it to a solvable form.
- Identify how the finite element method expands beyond the structural domain, for problems involving dynamics and heat transfer.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Introduction to Finite Elements in Engineering, T. R. Chandrupatla and A. D. Belegundu, Prentice Hall, 3rd Ed, 2002.
(2) Finite Elements Analysis– Procedures in Engineering, Lakshminarayana H. V., Universities Press, 2004.

Reference Books

(1) Finite Elements Method in Engineering, Rao S. S, 4th Edition, Elsevier, 2006
(2) Textbook of Finite Element Analysis, P. Seshu, PHI, 2004.
(3) Introduction to Finite Element Method, J.N.Reddy, McGraw -Hill, 2006.
(4) Finite Element Modelling for Stress Analysis, Cook R. D., Wiley,1995.

SMART MATERIALS AND STRUCTURES

(Effective from the academic year 2020-21)

SEMESTER-II

Subject Code	20MTR243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Smart Structures: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inch worm Linear Motor.

Beam Modelling: Beam Modelling with induced strain Rate effects, Inch worm Linear Motor Beam Modelling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezoelectrical Applications.

MODULE 2

Shape memory Alloy: Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications of SMA and Problems.

ER and MR Fluids: Mechanisms and properties, Fluid Composition and behaviour, The Bingham Plastic and Related Models, Pre-Yield Response. Post-Yield flow applications in Clutches, Dampers and Others.

MODULE 3

Vibration Absorbers: series and Parallel Damped Vibrations (Overview), Active Vibration Absorbers, Fiber Optics, Physical Phenomena, Characteristics, Sensors, Fiber Optics in Crack Detection, applications.

Control of Structures: Modelling, Control Strategies and Limitations, Active Structures in Practice.

MODULE 4

MEMS–Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.

MODULE 5

Devices: Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions) , Polymers in MEMS, Optical MEMS Applications.

Course outcomes:

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

- Understand the behaviour and applicability of various smart materials
- Design simple models for smart structures &materials.
- Perform simulations of smart structures & materials application Conduct experiments to verify the predictions
- Ability to analyse vibration absorbers and control of structures
- Exposure to MEMS

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Smart Material sand Structures- M.V. Gandhiand B. So Thompson, Chapmanand Hall, London; NewYork,1992.

(2) Smart Structures and Materials- B. Culshaw, Artech House, Boston,1996.

(3) Smart Structures: Analysis and Design-A.V.Srinivasan, Cambridge University Press, Cambridge, NewYork,2001.

Reference Books

(1) Piezoelectric Sensories : Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002

(2) Hand book of Giant Magneto strictive Materials-G.Engdahl, Academic Press, San Diego,Calif.;London,2000

PROGRAMMABLE LOGIC CONTROLLERS (PLCS)

(Effective from the academic year 2020-21)

SEMESTER-II

Subject Code	20MTR251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Technical Definition Of PLC, What Are Its Advantages, Characteristic Functions, Of A PLC, Chronological Evolution Of PLC, Types Of PLC, Unitary PLC, Modular Small PLC, Medium PLC, Large PLC Block Diagram Of PLC: Input / Output (I/O) Section Processor Section, Power Supply, Memory. Central Processing Unit: Processor Software Executive Software, Multitasking, Languages, Ladder Language. Input and Output Contact Program Symbols, Numbering System of Inputs and Outputs, Program Form.

MODULE 2

Introduction to Logic: Equivalent Ladder Diagram of AND Gate, Equivalent Ladder Diagram of OR Gate, Equivalent Ladder Diagram of NOT Gate, Equivalent Ladder Diagram of XOR Gate, Equivalent Ladder Diagram of NAND Gate, Equivalent Ladder Diagram of NOR Gate, Equivalent Ladder Diagram to Demonstrate De Morgan Theorem, Ladder Design. Timer and Its Classification: Characteristics of PLC Timer, Functions in Timer, Resetting Retentive and Non-Retentive, Classification of PLC Timer, Or Delay and Off Delay Timers Timer-On Delay, Timer Off Delay, Retentive and Non-Retentive Timers, Format of a Timer Instruction.

MODULE 3

PLC Counter: Operation Of PLC Counter, Counter Parameters, Counter Instructions Overview Count Up (CTU) Count Down (CTD).Introduction to Comparison Instructions, Discussions On Comparison Instructions, " EQUAL." or "EQU" Instruction, "NOT EQUAL" or "NEQ" Instruction, "LESS THAN" or "LES" Instruction, "LESS THAN OR EQUAL" or "LEQ" Instruction, GREATER THAN" or "GRT" Instruction, "GREATER THAN OR EQUAL TO" or "GRQ" Instruction , "MASKED COMPARISON FOREQUAL" or "MEQ" Instruction, "LIMIT TEST" or "LIM" Instruction. Addressing Data Files: Format of Logical Address. Addressing Format for Micrologic System.

MODULE 4

Data Movement Instructions, Logical Instructions, Mathematical Instructions. Special Mathematical Instructions, Data Handling Instructions, Program Flow Control Instructions, Proportional Integral Derivative (PID) Instruction. Introduction to Classification of I/O, I/O System Overview, Practical I/O System and Its Mapping Addressing Local and Expansion I/O, Input-Output Systems, Direct f/O, Parallel I/O Systems Serial I/O Systems. Sinking and Sourcing, Discrete Input Module, Rectifier with Filter, Threshold Detection, Isolation, Logic Section Specifications of Discrete Input Module

and Output Modules. Specifications of Analog Input Module, Types of Analog, Input Module Special Input Modules, Analog Output Module, I/O Modules in Hazardous Locations Power Supply Requirements, Power Supply Configuration, Filter.

MODULE 5

INDUSTRIAL COMMUNICATION AND NETWORKING Introduction: Evolution of Industrial Control Process, Types of Communication Interface Types of Networking Channels, Parallel Communication Interface, IEEE- 488 Bus, Devices Useable with IEEE - 488, Handshaking Process, Interface Management Lines, Serial Communication Interface. Communication Mode, Synchronization And Timing In Communication, Synchronous And Asynchronous Transmissions Compared, Different Recommended Standards Compared Software Protocol, Industrial Network, Network Topology, Media Access Methods, Open System Interconnection (OSI) Network Model, Network Components, Advantage Of Standardized Industrial Network, Industrial Network, Controller Area Network (CAN), AS-I Interface, FOUNDATION FIELDBUS: Physical Layer (Layer 1), Communication Stack (Layers 2 and 7), User Layer (Layer 8)Introduction to Utility Of Automation, General Structure Of An Automated Process, Examples of Some Simple Automated Systems, Selection Of PLC, Introduction to various PLCs available in Siemens /Bosch. Exercise in industrial automation.

Course outcomes:

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

- Identify the characteristics of different PLC
- Differentiate the elements of PLC
- Describe the various form of instructions
- Apply the logic to build ladder diagram
- Describe various communication and networking interfaces

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) 'PLC and Industrial Applications", Madhuchhandan Gupts and Samarjit Sen Gupta, Pernram International Pub. (India) Pvt. Ltd., 2011.

Reference Books

(1) www.equinoxac.co.uk
(2) Basic PLC Course (Programmable Logic Controller)' Mohd Shafiek Yaacob, Pearson,2006.

RELIABILITY AND FAILURE ANALYSIS

(Effective from the academic year 2020-21)

SEMESTER-II

Subject Code	20MTR252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Reliability definition : introduction, definition, failure data, mean failure rate, mean time to failure, mean time between failure, graphical plots, four important points, mttf in terms of failure density, generalization, reliability in terms of hazard rate and failure density, int integral form, mean time to failure in integral form, reliability in other situations.

MODULE 2

Hazard models: constant hazard, linearly increasing hazard, the Weibull model, on density function and distribution function, distribution function and reliability analysis, some important distributions, choice of distribution, expected value, standard deviation and variance, theorems concerning expectation and variance

MODULE 3

Conditional probabilities and multiplication rule, independent events, venn diagrams- sample space, probability calculation by venn diagrams, system reliability, series configuration, parallel and mixed configuration, application to specific hazard models, anr-out-of-n structure, method of solving complex system, system not reducible to mixed configurations, mean time to failure of systems, logic diagrams, markov models, markov graphs, system subjected to probability laws.

MODULE 4

Reliability improvement, improvement of components, redundancy, element redundancy, unit redundancy, stand by redundancy, optimization, reliability-cost trade-off, fault tree analysis and other techniques, fault free construction, calculation of reliability from fault tree, tie-set and cut-set, use of Boolean algebra, basic operations, truth tables, demorgan's theorem, application to reliability analysis, probability calculations.

MODULE 5

Maintainability, availability(qualitative aspects) system down time, availability, reliability and maintainability trade-off, instantaneous repair rate, mean time to repair, reliability and availability functions, reliability allocation and applications, reliability allocation for a series system, applications, marine power plant, computer system, nuclear power plants, general complex systems, failure modes and effect analysis.

Course outcomes:

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

- Analyze failure data, hazard models solve related numerical problems
- Apply reliability improvement methods to engineering systems
- Explain quality, reliability, quality control and statistical quality control
- Explain maintainability and availability concepts to improve the system effectiveness
- Illustrate the differences between reliability, maintainability and availability along with case studies.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) An introduction to reliability and maintainability, Charles E Ebeling, TMH,2000.
(2) Reliability Engineering, Balaguruswamy, Tata Mcgraw Hill, Fourth edition, 2003

Reference Books

(1) The Assurance Sciences, Halpern, Seimund, Prentice hall International, New Jersey, USA,1978.
(2) Hand book of Reliability Engineering and Management, Kraus, John W Ireson. W.G and Cooms.C.F, McGraw Hill Book Company Inc,USA.

VIBRATION ANALYSIS

(Effective from the academic year 2020-21)

SEMESTER-II

Subject Code	20MTR253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Review of Mechanical Vibrations: Basic concepts; free vibration of single degree of freedom systems with and without damping, forced vibration of single DoF- system. Force and motion isolation. Two DoF-systems: natural frequency.

Transient Vibration of Single Degree-of Freedom System: impulse excitation, arbitrary excitation, Laplace transform formulation, pulse excitation and rise time, shock response spectrum, shock isolation, finite difference numerical computation.

MODULE 2

Vibration Control: introduction, vibration isolation theory, vibration isolation theory for harmonic excitation, practical aspects of vibration analysis, shock isolation, dynamic vibration absorbers, vibration dampers.

Vibration measurement and applications: introduction, transducers, vibration pickups, frequency measuring instruments, vibration exciters, signal analysis.

MODULE 3

Modal Analysis and Condition Monitoring: dynamic testing of machines and structures, experimental modal analysis, machine condition monitoring and diagnosis.

Nonlinear vibrations: introduction, source of nonlinearity, qualitative analysis of nonlinear systems. Phase plane, conservative systems, stability of equilibrium, method of isoclines, perturbation method, method of iteration, self-excited oscillations

MODULE 4

Random Vibrations: random phenomenon, time averaging and expected value, frequency response function, probability distribution, correlation, power spectrum and power spectral density, Fourier transforms, FTs and response.

MODULE 5

Continuous System: vibrating string, longitudinal vibration of rods, torsional vibration of rods, suspension bridge as continuous system, Euler equation for beams, vibration of membrane.

Course outcomes:

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

- Describe basics of vibration analysis, vibration control and measurement techniques
- Understood the concept of Degree of Freedom in vibrating system.

- Apply monitoring of machine condition and fault diagnosis techniques to solve the problems
- Analyse nonlinear vibration and random vibrations and their causes.
- Have an introduction about continues systems

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Theory of vibration with application, - William T. Thomson. Marie Dillon dahleh, Chandramouli Padmanaban, Pearson Education ,5th edition,2008.
(2) Fundamentals of mechanical vibration. -S. Graham Kelly. McGraw Hill, 2nd edition.
(3) Mechanical Vibrations, -S.S Rao, Pearson Education, 4th edition,2003.

Reference Books

(1) Mechanical Vibrations- S. Graham Kelly, Schaum's Outlines, tata McGraw Hill, 2007

ADVANCED CONTROL SYSTEM LABORATORY

Course Code	20MTRL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl.NO	Experiments
1	Mathematical models of physical systems in the design and analysis of control systems.
2	To Study the effect of P, PI, PID controllers using MATLAB.
3	To analyses the stability of linear systems using Bode, Root locus, Nyquist plots.
4	To calculate an impulse response of a system described by difference equation y[n]+0.7y[n-1]–0.45y[n-2]-0.6y[n-3]=0.8x[n]-0.44x[n-1]+0.36x[n-2]+0.02 x[n-3]
5	Question based on response of LTI systems to different inputs. ALTI system is defined by the difference equation y[n]=x[n]+x[n+1]+x[n+2]. (a)determine the impulse response of the system and sketch it. (b)determine the output y[n]of the system when the input is x[n]=u[n]. (c)Determine the output of the system when the input is a complex exponential (E.g.[n]=2*exp(j0.26n)).
6	Comparison of DFT and DCT (in terms of energy compactness) Generate the sequence x[n]=(n-64) for=0,127. (a) Let X[k]=DFT{x[n]}. For various values of 1, set to zero "high frequency coefficients "X[64-1]= ....X[64]= ..... X[64+L]=0andtaketheinverseDFT.Plot the results. (b) Let XDCT[k]=DCT(X[n]).For the same values of L, set to zero "high frequency coefficient "XDCT[127-L]= ....XDCT[127].Take the inverse DCT for each case and compare the reconstruction with the previous case. Use Laasonen Model and Crank Nicolson Model draw the characteristic curves for various boundary conditions.

Course outcomes:

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

- Design of linear Control Systems
- Analyse the various controllers effect using MATLAB.
- Define (specifications) the adequate control systems.

TECHNICAL SEMINAR

Course Code	20MTR27	CIE Marks	100
Number of contact Hours/week	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the

Marks distribution for CIE of the course 20MTR27 **seminar:**

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

ARTIFICIAL INTELLIGENCE AND NEURAL NETWORKS

(Effective from the academic year 2020-21)

SEMESTER-III

Subject Code	20MTR31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
Credits - 04			

MODULE 1

Introduction, history, structure and function of single neuron, neural network architectures, neural learning, use of neural networks. Supervised learning, single layer networks, perceptions, linear separability, perceptions training algorithm, guarantees of success, modifications.

MODULE 2

Multiclass networks-I, multilevel discrimination, preliminaries, back propagation, setting parameter values, theoretical results

MODULE 3

Accelerating learning process, application, mandaline, adaptive multilayer networks. Prediction networks, radial basis functions. Polynomial networks, regularization, unsupervised learning, winner take all networks

MODULE 4

Learning vector quantizing, counter propagation networks, adaptive resonance theorem, topologically organized networks, distance-based learning, neo-cognition

MODULE 5

Associative models, hop field networks, brain state networks, BoItzmann machines, hetero associations. Optimization using hop filed networks, simulated annealing, random search, evolutionary computation.

Course outcomes:

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

- Describe concept and need of network
- Choose the required type of networks for various purposes
- Differentiate the propagations of network
- understanding of the history of artificial intelligence (AI) and its foundations.
- Apply concept of artificial intelligence for practical situations

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Elements of Artificial Neural Networks, KishanMehrotra, C. K.Mohan, SanjayRanka, Penram, 1997.

Reference Books

(1) Artificial Neural Networks, R.Schalkoff, MGH, 1997.
(2) Artificial Intelligence and Neural Networks, Dr K Uma Rao.
(3) Artificial Intelligence and Neural Networks" by F A car Savaci.
(4) Applied Artificial Intelligence: A compact introduction to neural networks and deep learning" Wolfgang Beer.

DIGITAL IMAGE PROCESSING AND MACHINE VISION

(Effective from the academic year 2020-21)

SEMESTER-III

Subject Code	20MTR321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	Exam Marks	60
Total Number of Contact Hours	40	Exam Hours	03
Credits - 03			

MODULE 1

Overview of Applications of Vision and Image Processing, Digital Image Formats, Colour Models, Data Types, Operators., Manipulating Matrices, File I/O, The Image Processing Toolbox

MODULE 2

Thresholding, Histogram Equalization, Linear Filtering (convolution) , Noise Reduction, Nonlinear Filtering, Gradients, Edge Magnitude and Direction , Finite Difference Filters , Laplacian of Gaussian Filter, Canny Edge Detector, Colour Transformations, Colour Histogram Equalization Colour Median Filtering., Colour Gradient and Edge Detection

MODULE 3

Thresholding as a form of Segmentation, Basic Global Thresholding, Optimal Global Thresholding, Techniques to improve global thresholding, Region Labelling, Boundary Tracing, Boundary-based measures of accuracy, Region-based measures of accuracy, Measuring Reproducibility.

MODULE 4

Boundary Descriptors, Region and Shape Descriptors, Texture Description, SIFT Features and Bags of Words Supervised and Unsupervised Clustering, Nearest Neighbour Classifiers, Bayesian Classification, Training and Testing Methodologies.

MODULE 5

Introduction, definition, human visual system. Active vision system, increasing of machine vision. Machine vision components, hardware's and algorithms, image function and characteristics, image formation & image sensing frequency space analysis, Fourier transform, convolution algorithms, image gaussion, image enhancement, image analysis and segmentation data reduction, feature extraction, edge detection, image recognition and decisions, machine learning, Image processing Applications of machine vision.

Course outcomes:

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

- Describe the typical steps for solution of image processing/vision problems: pre- processing, segmentation, description, and recognition
- understand the need for image transforms different types of image transforms and their properties.
- learn different techniques employed for the enhancement of images.
- Possess knowledge and understanding of basic and some advanced methods for each step in the process

- Choose appropriate methods and implement solutions to small-scale image processing and vision problems.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Sonka M. Hlavac V. and Doyle R., Image Processing, Analysis, and Machine Vision, PWS Publishing, 1999.
(2) Bose T., Digital Signal and Image Processing, Wiley, 2004.
(3) Forsth D. A. and Ponce J., Computer Vision: A Modern Approach, Prentice Hall, 2003.

Reference Books

(1) Gonzales R.C. and Woods P., Digital Image Processing, Addison-Wesley, 2002.
(2) Duda R. O., Hart P. E., and Stork D. G., Pattern Classification, Wiley Inter science, 2001.
(3) Serra J., Image Analysis and mathematical Morphology, Academic Press, 1982.

EMBEDDED SYSTEMS WITH ADVANCED MICROCONTROLLERS

(Effective from the academic year 2020-21)

SEMESTER-III

Subject Code	20MTR322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	Exam Marks	60
Total Number of Contact Hours	40	Exam Hours	03
Credits - 03			

MODULE 1

INTRODUCTION TO EMBEDDED SYSTEMS AND ARM 9 CORE

Definitions – Brief overview of micro-controllers - DSPs, -Typical classifications – Memory Devices and application scenarios of embedded systems. Introduction about ARM 9 Processor-DSP Processor-Sharc Processor - Internal Architecture – Modes of Operations – instruction set – Pipelining – AMBA – Applications and futures.

MODULE 2

PROGRAMMING OF ARM PROCESSOR

Programming of C – ARM Compiler - introduction to l inker – librarian – image conversion utility and supporting libraries

MODULE 3

INTRODUCTION TO FPGA

FPGA & CPLD Architectures - FPGA Programming Technologies- FPGA Logic Cell Structures- FPGA Programmable Interconnect and I/O Ports - FPGA Implementation of Combinational Circuits - FPGA Sequential Circuits - Timing Issues in FPGA Synchronous Circuits.

MODULE 4

PROGRAMMING OF FPGA

Introduction to Verilog HDL and FPGA Design flow with using Verilog HDL - FPGA Arithmetic Circuits - FPGAs in DSP Applications - Design of SDRAM & Halftone Pixel Converter - Programming FPGAs. Introduction to DSP processor - TMS320C54x and TMS320C6x architecture.

MODULE 5

APPLICATIONS OF ARM 9 AND FPGA CONTROLLERS

Specific examples of time-critical and safety-critical embedded systems - applications in automation- automotive – aerospace - medical and manufacturing

Course outcomes:

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

- Understand concept of embedded systems.
- Describe the FPGA & CPLD architectures and programming techniques.
- Apply the knowledge for the effective use of advanced controllers and its programming in real time product development
- Demonstrate programming skills of FPGA
- Demonstrate programming of ARM Processor

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Embedded microprocessor Systems – Real World Design, Ball S.R., Prentice Hall, 2006.

(2) Advanced FPGA Design, Wiley Inter-Science, Steve Kilts, Wiley-IEEE Press, 2007.

Reference Books

(1) "Real Time systems", C.M. Krishna, Kang G. Shin, Mc Graw Hill, 2009

(2) "Embedded System Design". Frank Vahid and Tony Givagis , Wiley, 2001

(3) "An Introduction to the Design of S mall – Scale Embedded Systems", Tim Wilmshurst, Palgrave Macmillan, 2011.

(4) "Computers as Components – Principles of Embedded Computing System Design", Wayne Wolf, Morgan Kaufmann Publisher s 2009.

SIMULATION MODELLING AND ANALYSIS

(Effective from the academic year 2020-21)

SEMESTER-III

Subject Code	20MTR323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	Exam Marks	60
Total Number of Contact Hours	40	Exam Hours	03
Credits - 03			

MODULE 1

Introduction: Principle of Computer Modelling and Simulation Monte Carlo simulation. Nature of Computer - modelling and simulation. Limitations of simulation, areas of applications. System and Environment: Components of a system – disc rete and continuous systems, Models of a system–a variety of modelling approaches.

MODULE 2

Discrete Event Simulation: Concepts in discrete event simulation, manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem. Statistical Models in simulation: Discrete distributions, continuous distributions, Numericals.

MODULE 3

Random Number Generation: Techniques for generating random numbers– Mid square method–the mod product method–Constant multiplier technique– Additive Congruential method–Tests for random numbers–The Kolmogorov–Smimov test, Chi-square test

MODULE 4

Random Variate Generation: Inversion transforms technique– Exponential distribution. Uniform distribution, weibul distribution, continuous distribution, generating, approximate normal variates Erlang distribution. Empirical Discrete Distribution: Discrete uniform–distribution, Poisson distribution geometric distribution–acceptance. Rejection technique for Poisson distribution, gamma distribution.

MODULE 5

Design and Evaluation of Simulation Experiments: Variance reduction techniques– antithetic variables, variables– verification and validation of simulation models, simulation software and packages

Course outcomes:

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

- Describe concept of simulation
- Differentiate discrete and random variable simulation
- Apply the concept of simulation to practical application
- Describe evaluation of simulation experiments

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Discrete Event System Simulation– Jerry Banks &John Scar son II, Prentice Hall Inc.,1984.
(2) Systems Simulation–GordanG., PrenticeHall India Ltd. ,1991.

Reference Books

(1) System Simulation with Digital Computer–NusingDeo, Prentice Hall of India,1979.
(2) Computer Simulation and Modeling–Francis Neelam kovil, John Wiley&Sons,1987.

ROBOTICS ENGINEERING

(Effective from the academic year 2020-21)

SEMESTER-III

Subject Code	20MTR331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	Exam Marks	60
Total Number of Contact Hours	40	Exam Hours	03
Credits - 03			

MODULE 1

Definition need and scope of Industrial robots – Ro bot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics –Robot trajectories – Control of robot manipulators – Robot dynamics Methods for orientation and location of objects.

MODULE 2

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

MODULE 3

Transducers and Sensors – Tactile sensor –Proximity and range sensors – Sensing joint forces – Robotic vision system –Image Representation - Image Grabbing – Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

MODULE 4

Methods of Robot Programming – Characteristics of t ask level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

MODULE 5

Internet of Things – Introduction, Definition & Characteristics of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Cloud Computing, Big Data, Industrial IoT.

Course outcomes:

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

- Describe configuration and kinematics of robot
- Differentiate controlling and sensing elements of robots
- Analyse kinematics of robot
- Describe various methods of Robot Programming and their significances
- Understand the existing IoT and its applications in industry's

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Industrial Robotics Technology, Programming and Applications, Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., Mc Graw- Hill, Int., 1986.

(2) Robotics Control, Sensing, Vision and Intelligence, K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., McGraw Hill, 1987.

(3) Robotics for Engineers, Koren,Y., McGraw-Hill, 1987

Reference Books

(1) Robotics Technology and Flexible Automat ion, Deb, S.R Tata Mc Graw-Hill, 1994

(2) Expert Systems and Robotics, Jordanides,T. and Torby,B.J., Springer Verlag, New York, May 1991.

(3) Robo tics Engineering An Integrated Approach, Klafter,R.D., Chmielewski, T.A. and Negin,M., Prentice-Hall of India Pvt. Ltd., 1984.

MICROMACHINING

(Effective from the academic year 2020-21)

SEMESTER-III

Subject Code	20MTR332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	Exam Marks	60
Total Number of Contact Hours	40	Exam Hours	03
Credits - 03			

MODULE 1

Introduction to Micromachining: Historical background, classification, Need and applications of Micromachining in engineering industries Introduction, scaling laws and difference between macro and micro machining. Mechanical type advanced micro machining processes, Abrasive jet micro machining (AJJM), ultra-sonic micro machining (USSM), and Abrasive water jet micromachining.

MODULE 2

Traditional Micromachining Processes: Diamond Turning, Micro- milling, Micro grinding. Mechanical Advanced Micromachining and Nano-finishing Processes: Abrasive Jet Micromachining, Ultrasonic Micromachining, Abrasive Water Jet Machining, Abrasive Flow nano finishing.

MODULE 3

Finishing Processes: Abrasive flow finishing (AFF) Chemo mechanical polishing (CMP), Magnetic Abrasive finishing (MAF), Magneto rheological finishing (MRF), and Abrasive flow finishing (AFF) Magnetic float polishing (MFP).

MODULE 4

Electric discharge Micromaching (EDMM) Wire EDM, EDDG, ELID, Laser Beam Micromachining (LBMM), Electron Beam Micromachining (EBMM), Electrochemical Micromaching (ECMM), Electrochemical Micro Deburring, and Photochemical Micromachining.

MODULE 5

Theory of Micromachining – Chip Formation – Size Effect in Micromachining – Micro turning, Micro milling, Micro drilling – Micro machining Tool Design – Precision Grinding – Partial Ductile Mode Grinding – Ultraprecision Grinding – Binder less Wheel – Free Form Optics.

Course outcomes:

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

- Model the material removal and tool wear rate in various micro machining processes
- Explain various existing traditional Micromachining Processes and their significance
- Analyse the processes and evaluate the role of each process parameter during micro machining of various advanced materials.
- Explain various finishing processes

- Design the requirements to achieve best quality of machined surface while micro machining of various industrial engineering materials

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Micro-Cutting: Fundamentals and Applications, Cheng, Huo, Wiley Publication.

Reference Books

(1) Introduction to Micromachining. V. K. Jain, 2nd Edition, Narosa Publishing House.
(2) Precision Manufacturing by David Dornfeld and Dae-Eun Lee, Springer US.

PRODUCT DESIGN

(Effective from the academic year 2020-21)

SEMESTER-III

Subject Code	20MTR333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	Exam Marks	60
Total Number of Contact Hours	40	Exam Hours	03
Credits - 03			

MODULE 1

DEVELOPMENT PROCESSES AND ORGANIZATION: Characteristics of successful product development, Design and development of product, Duration and cost of product development, the challenges of product development, A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organization, the AMF organization.

MODULE 2

PRODUCT PLANNING, IDENTIFYING CUSTOMER NEEDS AND PRODUCT SPECIFICATION: The product planning process, identifying opportunities, Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and process. Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into hierarchy, establish the relative importance of the needs and reflection the results and the process. What are specifications, when are specifications establishing specifications, setting the final specifications.

MODULE 3

CONCEPT GENERATION, SELECTION AND TESTING:

The activities of concept generation clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process. Overview of concept selection methodology, concept screening, and concept scoring, Definition and the purpose of concept test, choose a survey population, choose a survey format, communication the concept, measure customer response, interpret the result, reflect on the results and the process.

MODULE 4

PRODUCT ARCHITECTURE

What is product Architecture, implications of the Architecture, Establishing the Architecture, Variety and supply chain considerations, platform planning, and related system level design issues. INDUSTRIAL DESIGN: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design

MODULE 5

PRODUCT DEVELOPMENT: Elements of economic analysis, base case financial mode, sensitive analysis, project trade- offs, influence of qualitative factors on project success, qualitative analysis.

MANAGING PROJECTS: Understanding and representing task, baseline

project planning, accelerating projects, project execution, post-mortem project evaluation.

Course outcomes:

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

- Use the Product Design and Development Process, as a means to manage the development of an idea from concept through to production
- Understand the types of industries and need for development
- Explain various stages of product design development
- Apply the concept of product architecture.
- Analyse the economics and qualitative factors on project execution

Question paper pattern:

- The question paper will have ten questions.
- There will be 2questions from each module.
- Each question will have questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Product Design and Development, Karl Ulrich, Steven Eppinger, Anita Goyal, McGraw Hill Education; 4th edition ,2009.

Reference Books

(1) Product Design, OTTO, Pearson Education India; 1st edition ,2003.

PROJECT WORK PHASE – 1

Course Code	20MTR34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:
At the end of the course the student will be able to:

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation
CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

MINI PROJECT

Course Code	20MTR35	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

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

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

INTERNSHIP / PROFESSIONAL PRACTICE

Course Code	20MTRI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson. ■

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

PROJECT WORK PHASE -2

Course Code	20MTR41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism. ■

Course outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■