COEP Technological University Pune

(A Unitary Public University of Govt. of Maharashtra)

DEPARTMENT OF MANUFACTURING ENGINEERING AND INDUSTRIAL MANAGEMENT

NEP CURRICULUM STRUCTURE

M.Tech. (Mechatronics)

(Effective From AY 2025-2026)

COEP Technological University Pune
(A Unitary Public University of Govt. of Maharashtra)

NEP 2020 Compliant

Curriculum Structure

M. Tech. (Mechatronics)

(Effective from: A.Y. 2025-26)

Curriculum Structure for M. Tech. Mechatronics (OPTION II)
NEP Effective from 2025-26
Semester I

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1.	PSMC	MCH-25001	Applied Statistics	3	1	-	1	4	30	20	50	-	-
2.	PSBC	MCH-25002 MCH-25003	Principles of Design of Machine Elements * Principles of Electronics#	2	-	2	1	3	30	20	50	50	50
3.	PCC	MCH-25004	Power Electronics and Drives	3	1		1	4	30	20	50		
4.	PCC	MCH-25005	Mechatronics System Design	3	-	-	1	3	30	20	50		
5.	PCC	MCH-25006	Advanced Sensor Systems and Instrumentation	3	-	-	1	3	30	20	50		
6.	PCC	MCH-25007	Mechatronics System Design Laboratory	-	-	2	-	1				50	50
7.	PCC	MCH-25008	System Modelling and Simulation Laboratory	-	-	2	-	1				50	50
8	PEC-1	%	Programme specific Elective course	3	-	-	1	3	30	20	50	-	-
9.	RM	SET-25001	Research Methodology and IPR	3	-	-	1	3	30	20	50	-	-
				20	2	6		25					
Total Credits				25									

Legends: L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits,
ISE: In-Semester-Evaluation, ESE: End-Semester-Evaluation, MSE: Mid-Semester Evaluation, TA: Teacher's Assessment, CIE: Continuous-Internal-Evaluation

*- Course for students admitted to M. Tech Mechatronics with UG (E&Tc/ Electrical/ Computer/Instru.)

- Course for students admitted to M. Tech Mechatronics with UG (Mechanical, Production)

Departmental Elective Course – I (One course to be chosen from the following).

Sr. No.	Course Code%	Course Name
1	MCH(PE)-25001	Control Systems and Control Engineering
2	MCH(PE)-25002	Product Design and Development
3	MCH(PE)-25003	Optimization techniques
4	MCH(PE)-25004	Digital Signal Processing and Machine Vision

Semester II

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1.	OE	<tbd>	Open elective	3	-	-	1	3	30	20	50	-	-
2.	PCC	MCH-25009	Robotics	3	-	2	1	4	30	20	50	50	50
3.	PCC	MCH-25010	Embedded System Design	3	-	-	1	3	30	20	50	50	50
4.	PCC	MCH-25011	Fluid Power Automation	3	-	-	1	3	30	20	50	50	50
5.	PEC-2	#	Programme specific Elective course	3	-	-	1	3	30	20	50	-	-
6.	PEC-3	@	Programme specific Elective course	3	-	-	1	3	30	20	50	-	-
7.	PCC	MCH-25012	Embedded System Design Laboratory	-	-	2	-	1				50	50
8.	PCC	MCH-25013	Fluid Power Automation Laboratory	-	-	2	-	1				50	50
9.	AEC	SET-25002	Technical Communication Skills	1	-	2	1	2	50	50	-	100	-
10	LLC	<tbd>	Liberal Learning Course	-	-	2	2	1	-	-	-	100	-
Total Credits				24									

- Exit option to qualify for **PG Diploma in Mechatronics**:
  - Eight weeks domain specific industrial internship in the month of June-July after successfully completing first year of the program.

Interdisciplinary Open Course (for other specializations)

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	OEC	OEC-25031	Reliability Engineering	3	--	--	3

Departmental Elective Course –II (One course to be chosen from the following)

Sr. No.	Course Code#	Course Name
1	MCH(PE)-25005	Micro Electro-Mechanical Systems
2	MCH(PE)-25006	Autotronics and Vehicle Intelligence
3	MCH(PE)-25007	Nanotechnology
4	MCH(PE)-25008	Industrial Instrumentation and Control

Departmental Elective Course –III (One course to be chosen from the following)

Sr. No.	Course Code@	Course Name
1	MCH(PE)-25009	Computer Integrated Manufacturing
2	MCH(PE)-25010	Fuzzy logic and neural networks
3	MCH(PE)-25011	Advanced Control System
4	MCH(PE)-25012	Entrepreneurship essentials

Semester-III

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	SLC	<tbd>	Massive Open Online Course –I	3	-	-	1	3	-	-	100	-	-
2	SLC	<tbd>	Massive Open Online Course –II	3	-	-	1	3	-	-	100	-	-
3	OJT	MCH-26001	Internship	-	-	-	-	3	-	-	100	-	-
4	Project	MCH-26002	Dissertation Phase – I	-	-	22	12	11	-	-	-	70	30
Total Credits				20									

Semester-IV

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	Project	MCH-26003	Dissertation Phase – II	-	-	22	12	11	-	-	-	70	30
Total Credits				11									

Internship after semester-II during summer vacation and evaluation will be done in the start of semester-III.

MOOC Courses:

The MOOC Course must be from NPTEL for a minimum of 12 weeks.

Generally, the selected course should be in line with specializations or project needs.

SEMISTER I

Course: Applied Statistics

Course Code	MCH-25001	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-1-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	4	**ESE**	50

Corse Objectives:

1. To study basic probability theory, sampling distributions, and standard probability distributions.
2. To analyze statistical inference methods using confidence intervals and hypothesis testing.
3. To apply statistical tests such as t, χ^2, and F tests for data analysis and decision-making.
4. To study ANOVA and Design of Experiments techniques for experimental analysis.
5. To apply statistical quality control tools and perform statistical analysis using R.

Syllabus:

Contents	Lecture
• Probability Theory and Sampling Distributions. Basic probability theory along with examples. • Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance. • Inferences on Means and Standard Deviations **,** Inferences on a Population or Process Mean, Confidence Intervals, Hypothesis Tests, Choice of a Confidence Interval or a Test, Sample Size, Inferences on a Population or Process Standard Deviation Confidence Intervals, Inferences on Two Populations or Processes Using Independent Pairs of Correlated Data Values, Inferences on Two Populations or Processes Using Data from Independent Samples, Comparing Standard Deviations from Several Populations, estimating the difference between two means and ratio of two variances. Some sampling tests like χ2, t, F. • Statistical Hypotheses: General Concepts , Testing a Statistical Hypothesis , The Use of *P*-Values for Decision Making in Testing Hypotheses, Single Sample: Tests Concerning a Single Mean , Two Samples: Tests on Two Means , Choice of Sample Size for Testing Means, One Sample: Test on a Single Proportion, Two Samples: Tests on Two Proportions One- and Two-Sample Tests Concerning Variances, Goodness-of-Fit Test • ANOVA: One – way, Two – way with/without interactions, Latin Squares ANOVA technique, • Principles of Design Of Experiments, some standard designs such as CRD, RBD, LSD. • Statistical Quality Control, Introduction, nature of control limits, purpose of	4 Hrs./ Week

Contents	Lecture
control charts, control charts for variables, control charts for attributes. • Statistical analysis with R, Statistical models in R, Formulae, Generic functions, Packages, Linear models, Analysis of variance, Updating generalized linear models, families, Nonlinear least squares and maximum likelihood models.	

Course outcomes:

At the end of course students will be able to

- Understand basic concepts of probability and statistics and apply as per the characteristics in data analysis
- Apply the concept of Hypothesis testing to carry out Regression analysis and ANOVA and planning Design of Experiments
- Apply statistical quality control tools for various applications

Suggested learning resources:

1. Ronald E, Walpole, Sharon L. Myers, Keying Ye, Probability and Statistics for Engineers and Scientists (9th Edition), Pearson Prentice Hall, 2012
2. Douglas C. Montgomery, "Design and Analysis of Experiments" (7th Edition), Wiley Student Edition, 2009.
3. S. P. Gupta, "Statistical Methods", S. Chand & Sons, 37th revised edition, 2008
4. William W. Hines, Douglas C. Montgomery, David M. Goldsman, "Probability and Statistics for Engineering", (4th Edition), Willey Student edition, 2006.
5. Douglas C. Montgomery , George C. Runger , Applied Statistics and Probability for Engineers,3rd Edition, John Wiley and Sons, Inc.,2003.

Course: Program Specific Bridge Course (PSBC) (* For ETC/ Electrical/ Comp/Instru UG Students)
Principles of Design of Machine Elements

Course Code	MCH-25002	**Scheme of Evaluation**	CE & ESE
Teaching Plan	2-0-2-1 = 2	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To study the concepts of stress, strain, elastic behavior, bending, torsion, and thermal effects in structural members.
2. To analyze shear force, bending moment, stresses, deflections, and combined loading conditions in machine elements.
3. To apply design principles, material selection, and factors of safety in the design of shafts, springs, fasteners, gears, clutches, brakes, and bearings.
4. To study the fundamentals of mechanical vibrations, including free undamped vibrations and natural frequency determination.
5. To analyze rolling contact bearings, lubrication methods, load life relationships, and selection using manufacturer data.

Syllabus:

Contents	Lecture
• Simple stresses and strains: Concept of stress and strain linear, lateral, shear and volumetric), Hook's law. Elastic constants and their relationship. Generalized Hook's law. Axial force diagram, stresses, strains and deformation in determinate and indeterminate homogeneous and composite bars under concentrated loads, self-weight. Thermal stresses, deflections Bimetal strips, thermal forces, Thermal effects used in sensors and actuators. • Shear force and bending moment diagrams: Concept and definition of shear force and bending moment in beams due to concentrated load, UDL, uniformly varying loads and couples in determinate beams. Relation between SF, BM and intensity of loading, construction of SF, and BM diagrams for cantilevers, and simple beams. • Stresses due to bending and torsion: Theory of simple bending, concept and assumptions, Derivation of Flexure formula. Bending stress distribution diagram. Moment of resistance and section modulus calculations. Theory of torsion, torsional stresses and torsional deflections. • Loads and stress in machine elements: Types of loads, static, shock, impact and fluctuating loads, types of stresses, tensile, compressive, direct and torsional shear, bending stresses. Combined effect of direct, bending and torsional stresses. Design concepts, material and process selection design process, factor of safety & design codes, materials. Design of shafts and different types of levers based on torsional and lateral rigidity, combined loadings. Design of keys, keyways and splines. Standard threads, stresses in threads, preloaded fasteners in tension, joint stiffness	2 Hrs./ Week & Th. 2 Hrs./ Week Lab

Contents	Lecture
factor, power screws. • Design of springs: Spring configurations, materials, design of helical compression, extension and torsion springs. Design of composite springs in parallel, series, concentric, Belleville Spring, washers. Design of leaf springs. • Spur Gears: Law of Gearing, Effect of Pressure angle and Centre Distance, Path of Contact, Arc of Contact, Contact Ratio, Interference and Undercutting, Minimum number of teeth to avoid interference, Design of Spur Gears, Selection of Type of Gears, Force Analysis, Gear tooth Failures, Selection of Materials, Beam Strength, Wear Strength, Effective Load Calculation, Dynamic Load, Gear Design for Maximum Power Transmitting Capacity. Force Analysis, of helical gears, bevel gears and Worm Gears. • Introduction to Mechanical Vibrations: Importance of the Study of Vibrations, Elements of a Vibratory System, Examples of Vibratory Motion, Terms used in Vibratory Motion, Degrees of freedom and Examples of Degrees of freedom, Types of Vibrations, Free Vibrations of linear and torsional systems • Free Undamped Vibrations: Methods to determine the Equation of Motion, Vibration Analysis Procedure, Determination of Natural Frequency of Free Transverse Vibrations:- Derivation and Examples, Determination of Natural Frequency of Free Torsional Vibrations: - Equivalent Stiffness of Spring Combinations. • Friction Clutches, Brakes and Dynamometer: Pivot collar friction, types of friction clutches, design consideration for plate, cone & centrifugal clutches. Types like band brake, shoe brake, band & block brake, Disc Brakes, absorption & transmission type dynamometers. Design consideration of various brakes. • Rolling Contact Bearings: Types, Static and Dynamic load Capacity, Stribeck's Equation, Concept of equivalent load, Load life Relationship, Selection of bearing from Manufacturer's Catalogue, Design for variable loads and Speeds, Bearings with Probability of Survival other than 90%, Lubrication and Mounting of bearing. Recirculating ball screw bearings.	

Course outcomes:

- Design simple machine parts and components.
- Understand basic procedure for the selection of machine components
- Design various joints, gears brakes, dynamometer etc.

Suggested learning resources:

1. Ramamrutham S.: Strength of Materials, Dhanpat Rai & Sons, 1991.

2. V. B. Bhandari, “Design of Machine Elements”, Tata McGraw Hill Publishing Company Ltd., 2nd Edition, 2007
3. Beer and Johnston: Strength of Materials- CSB Publisher.
4. Rao, J.S. & Dukkipati, R.V.: Mechanism & Machine Theory, New Age International Pvt.Ltd. Publishers.
5. Ramamurthy, V.: Mechanics of Machines, Narosa Publishing House.
6. Manufacturing Technology, P.N. Rao, Tata McGraw-Hill Publishing Limited, II Edition, 2002.
7. S. S. Rattan, “Theory of Machines”, Tata McGraw Hill Publishing Company Ltd., 2nd Edition, 2007

Course: Program Specific Bridge Course (* For Mechanical/Prod. UG Students)
Principles of Electronics

Course Code	MCH-25003	**Scheme of Evaluation**	CE & ESE
Teaching Plan	2-0-2-1 = 2	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To study the role, scope, and applications of Mechatronics and its interdisciplinary design elements.
2. To study analog and digital electronic components, circuits, and power electronic devices used in mechatronic systems.
3. To analyze transducers, signal conditioning circuits, noise issues, grounding, shielding, and data acquisition systems.
4. To study control system components, classifications, transfer functions, and time–frequency response analysis tools.

Syllabus:

Contents	lecture
• Role of various Engineering disciplines in Mechatronics, Mechatronics Design elements, Scope and Applications of Mechatronics, Analog electronic components and devices, Oscillators as signal generators, Power supplies and voltage regulators, Power Electronics- Devices, Industrial electronic circuits, Digital Electronics- Arithmetic circuits, Multiplexers/Demultiplexers, Registers, Counters, Memories, Few examples of transducers, Signal conditioning Circuits using Operational amplifiers, Noise Problems, Grounding and shielding, Data acquisition systems,-Single channel and multichannel, Data loggers, Control Systems Components, Classification of Control Systems, Transfer functions, Time and Frequency response Analysis tools.	2 Hrs./ Week & **Th**. 2 Hrs./ Week **Lab**

Course outcomes:

- Learn how to develop and employ circuit models for elementary electronic components, e.g., resistors, sources, inductors, capacitors, diodes and transistors;
- Become adept at using various methods of circuit analysis.
- Use basic techniques for analyzing analogue and digital electronic circuits

Suggested learning resources:

1. Allen Mottershed, “Electronic Devices and Circuits”, Prentice Hall International, Third Edition
2. M. D. Singh and J. G. Joshi, “Mechatronics – Principles and Applications”, Prentice Hall India publication-EEE.

Course: Power Electronics and Drives

Course Code	MCH-25004	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-1-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	4	**ESE**	50

Corse Objectives:

1. To study rotational drives, motion converters, and hydraulic and pneumatic circuits used in mechatronic systems.
2. To analyze mechanical system design using a mechatronics approach, including control strategies, ergonomics, safety, and man–machine interface.
3. To study real-time interfacing, data acquisition, and I/O systems for measurement and control applications.
4. To apply microcontrollers and open-source hardware platforms for sensor integration, communication, and automation.
5. To analyze real-world mechatronic systems through case studies in data acquisition, control, and product design.

Syllabus:

Contents	lecture
• Need for power conversion; Power electronic converters. classifications and scope; Power semiconductor switches diodes, SCR , GTO and transistors (BJT, MOSFET and IGBT) Ratings, static and dynamic characteristics, drive and switching aid circuits and cooling; DC to DC conversion Buck, Boost and Buck-Boost converters circuit configuration and analysis with different kinds of loads; Choppers single quadrant and two quadrant operation with DC motor load and steady state analysis; Rectifiers: single phase and three phase operation, power factor, harmonics and effect of source inductance; Dual converters; Drive concept Four quadrant drive and load characteristics, selection of motor, control and stability of electric drives, feed back control of drives; DC motor drive; Inverters single phase and three phase bridge inverters and PWM inverters; Single phase AC voltage regulators and cyclo converter; Induction motor drive - Variable frequency operation of 3- phase induction motor, stator voltage control and V/f control methods; Non-drive application of power electronic converters UPS, active power line conditioner, electronic ballast and induction heater.	4 Hrs./ Week

Course outcomes:

- Apply switches like diodes, SCR, GTO and transistors (BJT, MOSFET and IGBT) in various power electronic circuit analysis
- Ability to identify, formulate and solve problems based on rectifiers, inverters and choppers and use different topologies of these converters in various applications.

- Use various topologies of converters in applications of drives and use these ac and dc drives in applications like rolling mills, paper industries etc.

Suggested learning resources:

1. G K Dubey, Thyristorised Power Controllers , Wiley Eastern Ltd.
2. B K Bose, Modern Power Electronics and AC Drives, Pearson Edn(Asia)
3. Ned Mohan, Power Electronics ,John Wiley and Sons
4. P C Sen, Power Electronics , TMH

Course: Mechatronics System Design

Course Code	MCH-25005	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the principles of rotational drives, motion converters, and hydraulic and pneumatic circuits used in mechatronic systems.
2. To analyze mechanical system design using a mechatronics approach, considering load conditions, flexibility, ergonomics, and safety.
3. To implement real-time interfacing and microcontroller-based data acquisition and control systems using open-source hardware.
4. To apply data acquisition, control techniques, and integrated design concepts through practical industrial and automotive case studies.

Syllabus:

Contents	lecture
• **Rotational drives** - Pneumatic Motors: continuous and limited rotation - Hydraulic Motors: continuous and limited rotation - Brushless DC Motors - Motion convertors, Fixed ratio, invariant motion profile, variators, remotely controlled couplings Hydraulic Circuits and Pneumatic Circuits. • **Mechanical Systems and Design** - Mechatronics approach - Control program control, adaptive control and distributed systems - Design process - Types of Design - Integrated product design - Mechanisms, load conditions, design and flexibility Structures, load conditions, flexibility and environmental isolation – Man machine interface, industrial design and ergonomics, information transfer from machine from machine to man and man to machine, safety. • **Real time interfacing** - Introduction Elements of data acquisition and control Overview of I/O process-Installation of I/O card and software - Installation of application software-Over framing. • **Microcontrollers**: Introduction to use of open source hardware (Arduino & Raspberry Pi); shields/modules for GPS, GPRS/GSM, Bluetooth, RFID, and Xbee, integration with wireless networks, databases and web pages; web and mobile phone apps. • **Case studies on Data Acquisition** - Transducer calibration system for Automotive applications Strain Gauge weighing system - Solenoid force - Displacement calibration system - Rotary optical encoder - Inverted pendulum control - Controlling temperature of a hot/cold reservoir -Pick and place robot - Carpark barriers. • **Case studies on Data Acquisition and Control** - Thermal cycle fatigue of a ceramic plate - pH control system - De-Icing Temperature Control System - Skip control of a CD Player - Autofocus Camera, exposure control. • **Case studies on design of Mechatronics products** - Motion control using D.C. Motor, A.C. Motor & Solenoids - Car engine management - Barcode reader.	3 Hrs./ Week

Course outcomes:

- Demonstrate how mechatronics integrates knowledge from different disciplines in order to realize engineering and consumer products that are useful in everyday life.
- Apply theoretical knowledge: understanding selection of suitable sensors and actuators; designing electro-mechanical systems.
- Work with mechanical systems that include digital and analogue electronics as a data acquisition model.

Suggested learning resources:

1. W. Bolton, Mechatronics - Electronic Control systems in Mechanical and Electrical Engineering-, 2nd Edition, Addison Wesley Longman Ltd., 1999.
2. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, PWS Publishing company, 1997
3. Bradley, D. Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Processes, Chapman and Hall, London, 1991.
4. Brian Morris, Automated Manufacturing Systems - Actuators, Controls, Sensors and Robotics, Mc Graw Hill International Edition, 1995.
5. Gopal, Sensors- A comprehensive Survey Vol I & Vol VIII, BCH Publisher.

Course: Advanced Sensor Systems and Instrumentation

Course Code	MCH-25006	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the principles, classification, and sensing mechanisms of physical, chemical, and biological sensors.
2. To analyze sensor characteristics, calibration methods, reliability, aging, and failure mechanisms.
3. To model and design sensors considering numerical modeling techniques, fabrication technologies, and packaging constraints.
4. To apply sensor interfacing, signal processing, and smart sensor concepts to industrial, medical, and environmental applications.

Syllabus:

Contents	lecture
Principles of Physical and Chemical Sensors: Sensor classification, Sensing mechanism of Mechanical, Electrical, Thermal, Magnetic, Optical, Chemical and Biological Sensors. Sensor Characterization and Calibration: Study of Static and Dynamic Characteristics, Sensor reliability, aging test, failure mechanisms and their evaluation and stability study. Sensor Modeling: Numerical modeling techniques, Model equations, Different effects on modeling (Mechanical, Electrical, Thermal, Magnetic, Optical, Chemical and Biological) and examples of modeling. Sensor Design and Packaging: Partitioning, Layout, technology constraints, scaling, compatibility study. Sensor Technology: Thick and thin films fabrication process, Micro machining, IOC (Integrated Optical circuit) fabrication process, Ceramic material fabrication process, Wire bonding, and Packaging. Sensor Interfaces: Signal processing, Multi sensor signal processing, Smart Sensors, Interface Systems. Sensor Applications: Process Engineering, Medical Diagnostic and Patient monitoring, Environmental monitoring etc	3 Hrs./ Week

Course outcomes:

- Comprehensive fundamental and technical knowledge of advanced sensor systems and instrumentation.
- Understand the problem and select a sensor and design, model the system.
- Use Numerical modeling for sensors

Suggested learning resources:

1. Eric Udd, Fiber Optic Sensors: An Introduction for Engineers and Scientists, John Wiley & Sons, New York, 1991 (ISBN: 0471830070).
2. André Preumont, Vibration Control of Active Structures: An Introduction, 2nd

Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966).
3. Hojjat Adeli, Control, Optimization, and Smart Structures: High-Performance Bridges and Buildings of the Future, John Wiley, New York, 1999 (ISBN: 047135094X).
4. T.T. Soong, Passive Energy Dissipation Systems in Structural Engineering, Wiley, Chichester; New York, 1997 (ISBN: 0471968218).
5. G. Engdahl, Handbook of Giant Magnetostrictive Materials, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
6. K. Otsuka and C.M. Wayman, Shape Memory Materials, Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X).

Course: Mechatronics System Design Laboratory

Course Code	MCH-25007	**Scheme of Evaluation**	CE & ESE
Teaching Plan	0-0-2-0 = 2	**ISE**	50 Marks
Credits	1	**ESE**	50

Corse Objectives:

1. To calibrate and measure process variables such as flow, temperature, displacement, and level using standard sensors and instruments.
2. To study and verify different control actions (P, PI, PD, and PID) and positioning control systems used in industrial applications.
3. To analyze and simulate control systems using software tools such as MATLAB/SIMULINK or equivalent platforms.
4. To develop and implement microcontroller-, PLC-, and microcomputer-based control and data acquisition systems using Arduino and Raspberry Pi.

Syllabus:

Contents	Lab
1. Calibration of flow meters, Thermocouples and RTD. 2. Displacement and level measurement. 3. Verification of P, P+I, P+D, P+I+D control actions. 4. Study of XY position control systems, linear conveyor control system and rotary table positioning systems. 5. Analysis of control system using software like MATLAB/SIMULINK or equivalent. 6. Development of ladder diagram/programming PLC for level control, position control or any other mechanical engineering application. 7. Arduino microcontroller I/O and interfacing 8. Basic sensors interfacing with Arduino 9. Networking with Arduino: GSM and Bluetooth 10. GPS and data logging with Arduino 11. Raspberry Pi microcomputer I/O and interfacing	2 Hrs./ Week

Course outcomes:

At the end of this course, students will be able to:

- Calibrate and analyze industrial sensors and instruments such as flow meters, thermocouples, RTDs, and displacement/level measurement devices to evaluate their performance and accuracy.
- Demonstrate and verify the functioning of control strategies including P, PI, PD, and PID control actions, and interpret their effect on system stability and response.
- Model, simulate, and analyze mechanical and electromechanical control systems (e.g., XY positioning systems, conveyors, rotary tables) using software tools such as MATLAB/Simulink or equivalent.
- Design and implement PLC ladder logic programs for automation applications such as

level control, position control, and other mechanical engineering systems.

- Interface and integrate microcontroller and microcomputer platforms (Arduino and Raspberry Pi) with sensors, actuators, and communication modules (GSM, Bluetooth, GPS) for data acquisition, control, networking, and logging applications.

Suggested learning resources:

1. Doebelin E. O., Measurement System – Application and Design, Tata McGraw Hill Publications Ltd, New Delhi.
2. Bolton W. , Mechatronics – Electronics Control Systems in Mechanical and Electrical Engineering, Pearson – Education (Singapore) Pvt.Ltd

Course: System Modeling and Simulation Laboratory

Course Code	MCH-25008	**Scheme of Evaluation**	CE
Teaching Plan	0-0-2-0 = 2	ISE	50
Credits	1	ESE	50

Corse Objectives:

1. To generate and test random numbers using statistical methods such as Chi-square and Kolmogorov–Smirnov tests.
2. To analyze probability distributions and validate random number generators through standard normality tests.
3. To apply Monte Carlo simulation techniques to model stochastic systems and queuing systems.
4. To simulate and control discrete-event and industrial systems such as conveyor belts and multi-server queuing models.

Syllabus:

Contents	Lab
1. Computer Generation of Random Numbers. 2. Chi-square goodness-of-fit test. 3. One-sample Kolmogorov-Smirnov test 4. Test for Standard Normal Distribution. 5. Testing Random Number Generators. 6. Monte-Carlo Simulation 7. Simulation of Single Server Queuing System. 8. Simulation of Two-Server Queuing System. 9. Simulate and control a conveyor belt system 10. Two-sample Kolmogorov-Smirnov test.	2 Hrs./ Week

Course Outcomes

At the end of this course, students will be able to:

- Generate and evaluate random numbers using computational techniques and apply statistical tests such as Chi-square and Kolmogorov–Smirnov tests to assess randomness and distribution characteristics.
- Perform and interpret goodness-of-fit tests, including tests for standard normal distribution and one-sample and two-sample Kolmogorov–Smirnov tests, for validating probabilistic models.
- Apply Monte Carlo simulation techniques to model uncertainty and analyze complex engineering and statistical problems.
- Model, simulate, and analyze queuing systems such as single-server and two-server systems to evaluate system performance measures including waiting time, queue length, and system utilization.
- Develop and simulate discrete-event and control-based models for practical engineering applications such as conveyor belt systems, and analyze their operational behavior.

Suggested learning resources:

1. Simulation Modeling and Analysis Averill M. Law & W. David Kelton McGraw-Hill Education
2. Discrete-Event System Simulation Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol
3. MATLAB & Simulink – Documentation & Tutorials
   The MathWorks Inc. Random number generation and statistical testing tools Monte Carlo simulation Modeling and simulation of conveyor and control systems Ideal for laboratory implementation and visualization.
4. Minitab for statistical testing

Course: Control Systems and Control Engineering

Course Code	MCH(PE)-25001	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the fundamentals of control systems, including modeling, transfer functions, stability analysis, and time- and frequency-domain methods.
2. To analyze control system behavior using classical techniques such as root locus, stability margins, block diagrams, and signal flow graphs.
3. To design and compensate continuous control systems by correlating time-domain and frequency-domain performance specifications.

Syllabus:

Contents	lecture
• Introduction to Control Systems, Laplace Transforms, Transfer Function, Stability, Block Diagrams and Signal Flow Graphs, Physical Systems Modeling, Root Locus Analysis, Time Domain Analysis of Control Systems, Frequency Domain Analysis of Control Systems, Control System Design • Review of classical control theory: Stability margins, correlation of frequency domain and time domain parameters, design specifications, compensation of continuous systems, actuator selection and design. State variable modelling of linear continuous systems, controllability and observability. Concepts of linear sampled data systems: Discrete equivalents of continuous data systems, reconstruction of sampled signals, sample and 0 order holds, stability of linear sampled data systems. State variable modelling of linear discrete data systems, controllability and observability.	3 Hrs./ Week

Course outcomes:

- Express and solve system equations in state-variable form (state variable models).
- Determine the time and frequency-domain responses of first and second-order systems to step and sinusoidal (and to some extent, ramp) inputs.
- Determine the (absolute) stability of a closed-loop control system
- Apply root-locus technique to analyze and design control systems.
- Communicate design results in written reports.

Suggested learning resources:

1. Rajeev Gupta (Author), Nise's Control System Engineering, Wiley India.
2. Madan Gopal, Control Systems Engineering,NEW AGE INTERNATIONAL PUBLISHERS LTD.- NEW DELHI

Course: Product Design and Development

Course Code	MCH(PE)-25002	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the complete product development process, including types of design, reverse engineering, planning, and team-based product development.
2. To identify and analyze customer needs and translate them into product functions, engineering specifications, and benchmarked design requirements.
3. To generate, evaluate, and embody product concepts using systematic concept generation, selection, modeling, and optimization techniques.
4. To design robust, manufacturable, and environmentally responsible products through prototyping, experimentation, design for manufacture, assembly, environment, and robustness principles.

Syllabus:

Contents	lecture
• Definition: Product development Process, Product Design; Types of design, engineering design; phases of modern product development process; Reverse engineering and redesign product development process. • Product Development Process Tools & Scoping Product Developments Product development team: definition, composition, team roles, Myer-Briggs type indicator, team structure, team building, team evaluation; Product Development Planning: Steps of planning, basic planning and scheduling tools; S-curves: definition, scurves and new product development, technology forecasting; Basic method: technical questioning, mission statement; Advanced method: Business case analysis, design drivers; • Customer Needs Customer satisfaction: Kano diagram, customer populations, types of customer needs, customer need models; Customer needs gathering methods: interviews, questionnaires, focus groups, be the customer need models; Customer Need Gathering Methods: Interviews, questionnaires, focus graphs, be the customer. Grouping the needs: affinity diagram method, customer sort method; determining need importance; interview data method, questionnaire method; cluster analysis method; • Establishing Product Function Product Teardown & Experimentation Functional Decomposition: product function, sub function, abstraction, constraints; Modeling process: Function Analysis System Technique (FAST), Subtract and Operate procedure; Function structure: phases modeling process; Function structure decomposition; Product Teardown: phases of product teardown process; teardown methods; measurement and experimentation; Post teardown reporting; application of	3 Hrs./ Week

Contents	lecture
product teardown. • Benchmarking & Establishing Engineering Specification Benchmarking: steps of benchmarking, support tools for benchmarking; Setting product specifications: Specification process, fundamental requirements & constraints, specifications sheets, House of Quality, value analysis. • Product portfolios, Portfolio architecture & Product Architecture Product portfolio architecture: definition, types, choosing an architecture type; Platform architecture: Modular family platform, functional architecting, steps of platform design method, functional architecting, non-platform based products, platform based products; Product architecture types: integral, modular; Product modularity: type of modularity, cluttering methods, advanced functional method, Architecture-based development teams. • Generating Concepts, Concept Selection and Concept Embodiment Concept Generating Process: basic methods, advanced methods, morphological analysis, combining solution principles; Estimating Technical Feasibility, Concept Selection Process, Pugh Concept Selection Chart, Measurement theory, Numerical Concept Scoring; Refining geometry and layout, Systems modeling. • Modeling of Product Metrics Model selection by performance specifications, Mathematical modeling, physical prototyping, constructing product models. • Design for Manufacture and Environment Assembly Design guidelines, Manufacturing cost Analysis. • Design for Environment Environment objectives, Basic design for environmental methods, life cycle assessment, techniques to reduce environmental impacts. • Analytical and Numerical Model Solutions Solution definition, Pareto optimality, Spreadsheet search, concept of optimization, Analytical formulations, practical optimization • Physical Prototypes Physical Models and Experimentation Physical models, Prototypes, Types of prototypes, uses of prototypes. Rapid prototyping techniques, Scale, Dimensional analysis, Similitude, Physical prototype design and planning. Design of experiments, Reduced tests, Fractional experiments, Statistical analysis of experiments. • Design for Robustness Quality design theory, Taguchi's method.	

Course outcomes:

- Identify and analyse the product design and development processes in manufacturing industry.
- Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.
- Analyse, evaluate and apply the methodologies for product design, development and management.
- Undertake a methodical approach to the management of product development to satisfy customer needs.

- Carry out cost and benefit analysis through various cost models.
- Familiar with design protection and Intellectual Property.

Suggested learning resources:

1. Daniel Ling, Complete Design Thinking Guide for Successful Professionals, Kindle Edition
2. Karl Ulrich, Steven Eppinger, Product Design and Development, McGraw Hill India.
3. Seider, Seader, Lewin, Widagdo, Product and Process Design Principles: Synthesis, Analysis and Evaluation, 3ed, ISV: Synthesis, Analysis and Evaluation – ISV

Course: Optimization techniques

Course Code	MCH(PE)-25003	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand nonlinear programming concepts including convexity, generalized convex functions, and optimality conditions using KKT criteria.
2. To formulate and solve optimization problems using goal programming, separable programming, and geometric programming techniques.
3. To apply search and gradient-based optimization methods for solving unimodal and multivariable optimization problems.

Syllabus:

Contents	lecture
• Nonlinear programming: Convex sets and convex functions, their properties, convex programming problem, generalized convexity, Pseudo and Quasi convex functions, Invex functions and their properties, KKT conditions. • Goal Programming: Concept of Goal Programming, Model Formulation, Graphical solution method. • Separable programming. Geometric programming: Problems with positive coefficients up to one degree of difficulty, Generalized method for the positive and negative coefficients. • Search Techniques: Direct search and gradient methods, Unimodal functions, Fibonacci method, Golden Section method, Method of steepest descent, Newton-Raphson method, Conjugate gradient methods. • Dynamic Programming: Deterministic and Probabilistic Dynamic Programming, Discrete and continuous dynamic programming, simple illustrations. • Multiobjective Programming: Efficient solutions, Domination cones	3 Hrs./ Week

Course outcomes:

- Understand importance of optimization of industrial process management
- Apply basic concepts of mathematics to formulate an optimization problem
- Analyze and appreciate variety of performance measures for various optimization problems

Suggested learning resources:

1. Mokhtar S. Bazaaraa, Hanif D. Shirali and M.C.Shetty, Nonlinear Programming, Theory and Algorithms, John Wiley & Sons, New York (2004).
2. D. G. Luenberger, Linear and Nonlinear Programming, Second Edition, Addison Wesley (2003).
3. R. E. Steuer, Multi Criteria Optimization, Theory, Computation and Application, John Wiley and Sons, New York (1986).

Course: Digital Signal Processing and Machine Vision

Course Code	MCH(PE)-25004	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand discrete Fourier transform techniques, FFT algorithms, and FIR/IIR digital filter design methods for signal and image processing applications.
2. To analyze digital image fundamentals including image formation, digitization, noise, image quality, and data structures for image representation.
3. To apply image pre-processing, segmentation, and feature extraction techniques for effective image analysis.
4. To develop image understanding and interpretation strategies using pattern recognition, probabilistic models, and semantic image analysis methods

Syllabus:

Contents	lecture
• **Discrete Fourier Transform:** DTFT, DFT, Properties, IDF, Linear Filtering Methods Based On DFT, FFT Algorithms, Goertzel Algorithm, Linear Convolution, Circular Convolution. Applications Of FFT • **FIR Filter Design:** Symmetric And Antisymmetric FIR Filters, Design Of FIR Digital Filters Window Method • **IIR Filter Design:** Design Of IIR Digital Filter Methods Like, Approximation Of Derivatives, Impulse Invariance, Bilinear Transformation, Characteristics Of Butterworth, Chebyshev, Frequency Transformations, IIR Filter Structures Like Direct Form, Parallel Form **Basic Concepts:** Image functions The Dirac distribution and convolution, The Fourier transform Images as a stochastic process, Images as linear systems, Image digitization, Sampling Quantization, Color images, Digital image properties, Metric and topological properties of digital images, Histograms, Visual perception of the image, Image quality, Noise in images • **Data structures for Image Analysis:** Levels of image data representation Traditional image Matrices, Chains, Topological data structures, Relational structures, Hierarchical data structures Pyramids, Quad trees • I**mage Pre-processing:** Pixel brightness transformations, Position- dependent brightness correction Grey scale transformation Geometric transformations, Pixel co-ordinate transformations Brightness interpolation, Local pre-processing, Image Smoothing Edge detectors Zero crossings of the second, Canny edge detection Edges in multispectral images, Other local pre-processing operators • **Segmentation:** Threshold detection methods Multispectral thresholding, Thresholding in hierarchical data structures, Edge-based segmentation Edge image thresholding, Edge relaxation, Border tracing, Hough transforms, Border detection using border location information, Region construction from borders, Region growing segmentation, Region merging, Region splitting, Splitting and merging, Matching,	3 Hrs./ Week

Contents	lecture
Matching criteria, Control strategies of matching • **Image Understanding:** Image understanding control strategies, Parallel and serial processing control Hierarchical control, Bottom-up control strategies, Model-based control strategies, Combined control strategies, Non-hierarchical control, Active contour models – snakes, Point distribution models, Pattern recognition methods in image understanding, Contextual image classification Scene labeling and constraint propagation, Discrete relaxation, Probabilistic relaxation, Searching interpretation trees, Semantic image segmentation and understanding, Semantic region growing, Genetic image interpretation Hidden Markov Models	

Course outcomes:

- Understand the concepts of image functions distribution and convolution.
- Design different filters
- Apply concepts of segmentation and models of strategies.
- Adept to growing semantic region and genetic image interpretation.

Suggested learning resources:

1. Ifeachor Jervis, Digital Signal Processing , Pearson Education
2. Gonzalez & Woods, Digital Image Processing , Pearson Publication.
3. John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing. Principles, algorithms, and applications, PHI, 1997.
4. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing Analysis and Machine Vision".

Course: Research Methodology and IPR

Course Code	SET-25001	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand and formulate research problems by identifying appropriate sources, defining scope and objectives, and selecting suitable methodologies for investigation, data collection, analysis, and interpretation.
2. To study and apply effective research practices including literature survey techniques, use of research instrumentation, plagiarism awareness, research ethics, and principles of effective technical writing for reports, papers, and theses.
3. To develop competence in preparing research proposals, understanding proposal formats, and presenting research work effectively for evaluation by review committees.
4. To understand the fundamentals and importance of Intellectual Property Rights (IPR), including the nature, objectives, and role of IPR in technological innovation, research, and commercialization.
5. To analyze and apply various forms of Intellectual Property protection—such as patents, trademarks, copyrights, industrial designs, geographical indications, and trade secrets—with particular emphasis on the Indian Patent system and the international IPR framework involving World Intellectual Property Organization, TRIPS Agreement, and the Patent Cooperation Treaty (PCT).

Syllabus:

Contents	lecture
Research Methodology Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations Effective literature studies approaches, analysis Plagiarism , Research ethics Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee. **Intellectual Property** Rights Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights Understanding the types of Intellectual Property Rights: - Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act , Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non Provisional Patent Application and Specification, Plant Patenting, Idea Patenting, Integrated Circuits,	3 Hrs./ Week

Contents	lecture
Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Patenting under PCT	

Course outcomes:

At the end of the course, students will demonstrate the ability to:

- Understand research problem formulation and approaches of investigation of solutions for research problems
- Learn ethical practices to be followed in research
- Apply research methodology in case studies
- Acquire skills required for presentation of research outcomes (report and technical paper writing, presentation etc.)
- Infer that tomorrow's world will be ruled by ideas, concept, and creativity
- Gather knowledge about Intellectual Property Rights which is important for students of engineering in particular as they are tomorrow's technocrats and creator of new technology
- Discover how IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario
- Study the national & International IP system
- Summarize that it is an incentive for further research work and investment in R & D, leading to creation of new and better products and generation of economic and social benefits

Suggested learning resources:

1.Aswani Kumar Bansal : Law of Trademarks in India,
2. B L Wadehra : Law Relating to Patents, Trademarks, Copyright,Designs and Geographical Indications.
3. G.V.G Krishnamurthy : The Law of Trademarks, Copyright, Patents and Design.
4. Satyawrat Ponkse: The Management of Intellectual Property.
5. S K Roy Chaudhary & H K Saharay : The Law of Trademarks, Copyright, Patents
6. T. Ramappa, S. Chand Intellectual Property Rights under WTO by.
7. Manual of Patent Office Practice and Procedure
8. WIPO : WIPO Guide To Using Patent Information
9. Halbert ,Resisting Intellectual Property, Taylor & Francis
10. Mayall Industrial Design , Mc Graw Hill
11. Niebel Product Design , Mc Graw Hill
12. Asimov Introduction to Design, Prentice Hall
13. Robert P. Merges, Peter S. Menell, Mark A. Lemley Intellectual Property in New Technological Age

SEMISTER II

Course: Robotics

Course Code	MCH-25009	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-2-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	4	**ESE**	50

Corse Objectives:

1. To understand basic robotics concepts including robot anatomy, configurations, drives, end effectors, sensors, and industrial applications with safety considerations.
2. To analyze robot kinematics and coordinate transformations for forward and inverse motion solutions.
3. To study robot dynamics, joint control, trajectory planning, and adaptive and optimal control techniques.

Syllabus:

Contents	lecture
• Basic concepts, Robot anatomy, Robot configurations, Basic robot motions, Types of drives, Applications-Material handling, processing -Assembly and Inspection, safety considerations. • End effectors, Classification, Mechanical, Magnetic, Vacuum, Adhesive. Force analysis and Gripper design. • Sensors in robot systems, non optical and optical position sensors, Velocity and Acceleration, Range, Proximity, touch, Slip, Force, Torque sensors, Machine vision system, Image components, Representation, Hardware , Picture coding , Object recognition and categorization - Software consideration, Vector operations • Translational transformations and Rotational transformations, Properties of transformation matrices-Homogeneous transformations and Manipulator, Robot kinematics, Forward solution, Inverse solution , Control system concepts, Analysis , control of joints ,Adaptive and optimal control ,Trajectory Planning, Robot Dynamics, Lagrangian formulation, D Alemberts principle • Robot programming Methods - Robot programming languages - VAL Language, Computer controller and Robot communication, Economics of Robots, Telechiric robots	3 Hrs./ Week **Th.** & 2 Hrs./ Week **Lab**

Course outcomes:

At the end of course students acquire following qualities:

- Comprehensive fundamental and technical knowledge of Robotics
- Ability to apply computing design criteria's of robot elements
- Ability to apply the knowledge of specifying the robot elements and selection of robots
- Ability to analyze robots through Kinematic and Dynamic study & its programming
- Ability to learn effective practices in uses of robots, robot economics and novel advancements in this area.

Suggested learning resources:

Textbooks:

1. M. P. Grover, M. Weiss, R. N. Nagel, N. G. Odrey, : Industrial Robotics Technology, Mc Graw Hill book Co. 1995
2. Fu K.S., Gonzalez R.C.., and Lee C.S.G., "Robotics control, sensing, vision, and intelligence", McGraw-Hill Book Co., 1987

Reference Books:

1. Robert J. Schilling, Fundamentals of Robotics-Analysis and Control, Prentice Hall India, 1990.
2. Klafter R.D., Chmielewski T.A. and Negin M., " Robot Engineering An Intergrated approach", Prentice Hall of India, New Delhi, 1994.
3. Deb S.R., "Robotics Technology and Flexible Automation ", Tata McGraw-Hill Publishing Co., Ltd., 1994.
4. Craig J.J., "Introduction to Robotics Mechanics and Control", Addison-Wesley, 1999
5. Robot Dynamics and Control : Mark W. Spong and M. Vidyasagar, Wiley
6. Foundations of Robotics : T. Yoshikawa , PHI India
7. Advances Robotics – Redundancy and Optimization, Y. Nakamura , Addison-Wesley.

Course: Embedded System Design

Course Code	MCH-25010	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the fundamentals, architecture, and applications of embedded systems and 32-bit microcontrollers.
2. To develop embedded programs using assembly, C language, and Arduino sketches with proper use of variables, decision making, and loops.
3. To interface digital and analog input/output devices, sensors, displays, and communication buses with Arduino-based systems.
4. To design and implement simple embedded system projects using interrupts, libraries, and Arduino shields through practical case studies.

Syllabus:

Contents	lecture
• Introduction to Embedded System, Applications & Scope • 32 bit Microcontroller architecture, Assembly Language and C language programming, Microcontroller based development boards • Introduction to Arduino boards, Sketching in code • Working with variables, Making decisions and repetitive operations • Digital Ins and Outs, Analog Ins and Outs, Interfacing switches, buzzer, seven segment displays • Timings functions, Random Functions, Writing new functions, Hardware Interrupts • Arrays and Memory, Hardware Libraries • Using Serial and I2C bus • Case studies of a few projects using Arduino boards and Shields	3 Hrs./ Week

Course outcomes:

At the end of the course, students will demonstrate the ability to:

- Deploy low end applications using low and high level languages on microcontroller platform.
- Implements simple sketches on the Arduino boards involving several peripherals, Identify, design and implement applications on the Arduino boards producing custom shields

Suggested learning resources:

1. Joseph Yiu, “The definitive guide to ARM Cortex-M3”, Elsevier, 2nd Edition
2. Brian Evans, “Beginning Arduino Programming”, Springer, 2011
3. Michael J. Pont , “Embedded C”, Pearson Education, 2nd Edition, 2008
4. Raj Kamal, “ Embedded Systems – Architecture: Programming and Design”, TMH

Course: Fluid Power Automation

Course Code	MCH-25011	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the principles and characteristics of hydraulic power generators, pumps, actuators, and control valves used in fluid power systems.
2. To design and analyze hydraulic circuits for industrial applications including presses, machine tools, material handling, and mobile equipment with safety considerations.
3. To study pneumatic fundamentals, logic circuits, sequencing methods, and component selection for automated control systems.
4. To apply microprocessors, microcontrollers, and PLCs for sequencing, low-cost automation, and robotic fluid power circuits.

Syllabus:

Contents	lecture
• Hydraulic Power Generators - Selection and specification of pumps, pump characteristics. • Linear and Rotary Actuators - selection, specification and characteristics. • Pressure - direction and flow control valves - relief valves, non return and safety valves actuation systems. • Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits – press circuits - hydraulic milling machine - grinding, planning, copying, forklift, earth mover circuits - design and selection of components - safety and emergency mandrels. • Pneumatic fundamentals - control elements, position and pressure sensing • Pneumatic logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design - combination circuit design. • Pneumatic equipments - selection of components - design calculations -application - fault finding – hydro pneumatic circuits – • Use of microprocessors/microcontrollers for sequencing - PLC, Low cost automation - Robotic circuits.	3 Hrs./ Week

Course outcomes:

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

- Aware of the importance and the scope of hydraulics and pneumatics in the modern industry.
- Select and size the different components required to design a fluid power system.

- Select a control system to control the operation of designed fluid power system.
- Design and implement low cost automation system

Suggested learning resources:

1. Antony Esposito, "Fluid power with Applications", Prentice Hall India, 7th Edition, 2014.
2. Dudleyt, A.Pease and John J.Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
3. Andrew Parr, "Hydraulic and Pneumatics", Jaico Publishing House, 1999.
4. Bolton. W. “Pneumatic and Hydraulic Systems", Butterworth - Heinemann, 1997.
5. Anthon H. Hehn, “Fluid Power Troubleshooting”, 2nd Edition, Marcel Dekker.
6. S. R. Majumdar, “Pneumatic Systems: Principles and Maintenance”, Tata McGrawHill Publishing Company Limited, 1995.

Course: Embedded System Design Laboratory

Course Code	MCH-25012	**Scheme of Evaluation**	CE
Teaching Plan	0-0-2-0= 2	**ISE**	50 Marks
Credits	1	**ESE**	50 Marks

Corse Objectives:

1. To understand and implement 8051 instruction sets through basic arithmetic, logic, and data handling programs.
2. To develop assembly language programs for numerical operations such as addition, sorting, and table-based computations.
3. To interface peripheral devices such as LED displays, ADC, DAC, LCD, keypad, and stepper motors with the 8051 microcontroller.
4. To perform serial communication and analyze real-time input–output operations using the 8051 microcontroller.

Syllabus:

Contents	Lab
Laboratory Experiments 1. Experiments Based on 8051 Instruction sets 2. Addition of N- numbers 3. Sorting of 8- bit Nos. in ascending and descending order 4. Find square / square root of number from look up table 5. Interface 7 segment LED to 8051 to generate flashing action 6. Interface Analog to Digital converter to 8051 and display the result on LCD display 7. Interface Digital to Analog converter to 8051 and view the output on CRO Interface stepper motor to 8051 it through given number of steps 8. Perform serial communication using 8051 9. Interface hex keypad to 8051 and display key code on the LCD display	2 Hrs./ Week

Course Outcomes

At the end of this course, students will be able to:

- Write, debug, and execute assembly language programs using the 8051 instruction set to perform arithmetic, logical, and data manipulation operations such as addition of N-numbers and sorting of 8-bit numbers.
- Implement look-up table–based programs on the 8051 microcontroller to compute mathematical functions such as square and square root of a given number.

- Interface and control output devices including 7-segment LED displays, LCDs, DACs, and stepper motors using appropriate hardware and software techniques.
- Interface and acquire data from input devices such as ADCs and hexadecimal keypads, and display or analyze the acquired data using suitable display units and measurement tools (LCD, CRO).
- Demonstrate serial communication using the 8051 microcontroller for data transmission and reception, and analyze system performance for embedded applications.

Suggested Learning Resources

1. The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay.

2. Microcontrollers: Architecture, Programming, Interfacing and System Design *Raj Kamal*, McGraw-Hill Education. Strong fundamentals of microcontroller programming. Practical examples of peripheral interfacing. Suitable for both theory *and laboratory reference*

3. *Keil µVision – User Manuals & Application Notes*
   Keil (Arm Ltd.) Assembly and C programming environment for 8051. Debugging and simulation support. Useful for program development, testing, and verification

Course: Fluid Power Automation Laboratory

Course Code	MCH-25013	**Scheme of Evaluation**	CE
Teaching Plan	0-0-2-0 = 2	**ISE**	50 Marks
Credits	1	ESE	50 Marks

Corse Objectives:

1. To design and analyze basic and advanced hydraulic and pneumatic circuits for industrial applications.
2. To develop electro-hydraulic and electro-pneumatic control circuits integrating electrical and fluid power components.
3. To implement ladder logic programs for PLC-based control of fluid power systems.
4. To operate, monitor, and troubleshoot hydraulic, pneumatic, and PLC-controlled fluid power systems.

Syllabus:

Contents	Lab
Laboratory Experiments 1. Design of basic hydraulic circuits 2. Design of basic pneumatic circuits 3. Design of advanced hydraulic circuits 4. Design of advanced pneumatic circuits 5. Design of electro-hydraulic circuits 6. Design of electro-pneumatic circuits 7. Ladder logic programming for Programmable Logic Controller (PLC) 8. Control of fluid power systems using PLC 9. Operation and troubleshooting of fluid power systems	2 Hrs./ Week

Course outcomes:

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

- Design and implement fluid power systems.
- Understand the operation and troubleshooting of the fluid power system components.

Suggested Learning Resources

1. Industrial Hydraulics and Pneumatics, Andrew Parr, Butterworth-Heinemann, (Elsevier).
2. Fluid Power with Applications, Anthony Esposito.
3. Siemens TIA Portal / RSLogix – Manuals & Training Resources

Course: Technical Communication Skills

Course Code	SET-25002	**Scheme of Evaluation**	CE & ESE
Teaching Plan	1-0-2-1 = 2	**MSE and TA**	30 and 20 Marks
Credits	2	**ESE**	50

Corse Objectives:

1. To understand the fundamentals of communication, including the 7 Cs, vocabulary enrichment, styles, and common errors in English.
2. To develop aural and oral communication skills, including listening, stress and intonation, group discussions, and oral presentations.
3. To enhance reading skills for different types of texts and improve comprehension of technical reports and research papers.
4. To improve written communication skills, including effective writing, business correspondence, and technical report interpretation.

Syllabus:

Contents	lecture
Unit 1: Fundamentals of Communication 7 Cs of communication, common errors in English, enriching vocabulary, styles and registers Unit 2: Aural-Oral Communication The art of listening, stress and intonation, group discussion, oral presentation skills Unit 3: Reading and Writing Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers	1 Hrs./ Week Th. & 2 Hrs./ Week Lab.

Course outcomes:

At the end of the course, students will demonstrate the ability to:

- Produce effective dialogue for business related situations
- Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively
- Analyze critically different concepts / principles of communication skills
- Demonstrate productive skills and have a knack for structured conversations
- Appreciate, analyze, evaluate business reports and research papers.

Suggested learning resources:

1. Raman Sharma, “Technical Communication”, Oxford University Press.
2. Raymond Murphy “Essential English Grammar” (Elementary & Intermediate) Cambridge University Press.
3. Mark Hancock “English Pronunciation in Use” Cambridge University Press.
4. Shirley Taylor, “Model Business Letters, Emails and Other Business Documents” (seventh edition), Prentise Hall
5. Thomas Huckin, Leslie Olsen “Technical writing and Professional Communications for Non-native speakers of English”, McGraw Hill.

Course: Micro-Electro Mechanical Systems

Course Code	MCH(PE)-25005	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the fundamentals of MEMS and Microsystems, including their evolution, applications, materials, and miniaturization techniques.
2. To study smart materials, their properties, and applications in aerospace, automotive, and biomedical fields.
3. To analyze design considerations for MEMS devices, including process and mechanical design aspects.
4. To explore microfabrication techniques, and the development and applications of micro sensors, actuators, and smart transducers.

Syllabus:

Contents	lecture
Introduction Overview of MEMS & Microsystems: Evolution of microsensors, MEMS & microfabrication – typical MEMS and Microsystems and miniaturization – applications of Microsystems. Materials demand for Extreme conditions of operation, material property mapping, Processing, strengthening methods, treatment and properties **MEMS materials**: Overview of Smart Materials, Structures and Products Technologies Smart Materials (Physical Properties) Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Magneto electric Materials, Magneto rheological Fluids Electro rheological Fluids, Shape Memory Materials, Bio-Materials, metal matrix composites (MMC), their applications in aerospace and automobiles, Super-plastic materials **Design** Design consideration – process design – mechanical design **Micro manufacturing/Micro fabrication** Preparation of the substrate, Physical Vapour Deposition, Chemical Vapour Deposition, Ion Implantation, Coatings for high temperature performance, Electrochemical and spark discharge and Plasma coating methods, electron beam and laser surface processing, Organic and Powder coatings, Thermal barrier coating, LIGA process **Micro sensors** Smart Sensor, Actuator and Transducer Technologies, Smart Sensors: Accelerometers; Force Sensors; Load Cells; Torque Sensors; Pressure Sensors; Microphones; Sensor Arrays	3 Hrs./ Week

Contents	lecture
Micro actuators Smart Actuators: Displacement Actuators; Force Actuators; Power Actuators; Vibration Dampers; Shakers; micro Fluidic Pumps; micro Motors Smart Transducers: Ultrasonic Transducers; Sonic Transducers;	

Course outcomes:

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

- Understand the scope, importance and applications of MEMS products and devices
- Select the materials for MEMS devices fabrication as well as the materials for indirect use.
- Learn the principles, design, working and applications of microsensors and microactuators.
- Understand and select packaging method for a MEMS product.

Suggested learning resources:

1. MEMS and Microsystems: Design and Manufacture, Tai Ran Hsu, Tata McGraw Hill, 2002.
2. Smart Materials and Structures, M.V. Gandhi and B.S. Thompson, Chapman & Hall, London; New York, 1992 (ISBN: 0412370107).
3. Intermetallic compounds VOL I & II, Westbrook J.H & Fleischer R.L., John Wiley, Chichester 1995.
4. Micro sensors, MEMS and smart Devices, Julian W. Gardner & Vijay K. Varadan, John Wiley & Sons, 2001.
5. Smart Structures: Analysis and Design, A.V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).
6. Smart Structures and Materials, B. Culshaw, Artech House, Boston, 1996 (ISBN: 0890066817).

Course: Autotronics and Vehicle Intelligence

Course Code	MCH(PE)-25006	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the fundamentals of automotive electrical systems, including batteries, starters, alternators, ignition systems, and vehicle auxiliary components.
2. To study automotive sensors and actuators, their working principles, and applications in engine and vehicle control systems.
3. To analyze engine management systems for SI and CI engines, fuel injection, electronic ignition, emissions control, and transmission and chassis control systems.
4. To apply model-based design techniques using MATLAB/Simulink for simulation, verification, and real-time implementation of automotive embedded systems.

Syllabus:

Contents	lecture
Fundamentals of Automotive Electric Systems, Batteries, alternator, starter motor, ignition systems, headlamp, wiper motor, etc Sensors & Actuators: Hall Effect, hot wire, thermistor, piezo electric, piezoresistive, based sensors. Introduction, basic sensor arrangement, types of sensors, oxygen concentration sensor, lambda sensor, crankshaft angular position sensor, cam position sensor, Mass air flow (MAF) rate, Manifold absolute pressure (MAP), Throttle plate angular position, engine oil pressure sensor, vehicle speed sensor, stepper motors, relays, detonation sensor, emission sensors. Powertrain , SI Engine Management ,Layout, Components of SI FI systems, types of FI systems: Throttle body, MPFI, GDI. Group and sequential injection techniques. Electronic ignition systems: Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control. CI Engine Management, Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection - system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems. On-board DIagnostics: OBD-I, OBD-I.I, EOBD, Indian Scenario Transmission Systems: AMT, OCT, AT , Chassis Control Systems, ABS, ESP, RSC, ASBRS, EPS, Active suspension systems Model Based Design: Overview of The Math Works and MATLAB- System modeling in the Simulink environment. Traditional system design process -Model-Based Design in the Simulink environment. Model-Based Design for embedded system development - Algorithm simulation -Software-in-the.loop (SIL) verification. Processor-in-the-loop (PIL) verification -Real-time deploy- Hardware in Loop development.	3 Hrs./ Week

Course outcomes:

- Comprehensive fundamental and technical knowledge of sensors and transducers used in auto vehicles and vehicle intelligence
- Ability to understand, analyze and use various SI and CI Management systems
- Ability to use MATLAB and Simulink for On Board diagnostics

Suggested learning resources:

1. Young and Griffith, , Automotive Electrical systems, Butterworth Pub.
2. C. P. Nakra Basic automotive electrical systems, Dhanpat Rai Pub.
3. William H. Grouse, Automotive mechanics, TMH
4. A. W. Judge Modem Electrical Equipments,
5. P.L. Kohli, Automotive Electrical Equipment, TMH
6. N. R. Khatawale, Automotive Electrical Auxiliary Systems
7. Mano, Digital Logic and Computer Design, Prentice Hall India

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Course: Nanotechnology

Course Code	MCH(PE)-25007	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the fundamentals of nanomaterials, their size-dependent properties, and various synthesis methods for nanoparticles, nanowires, nanorods, and nanostructured films.
2. To study experimental techniques for characterization of nanomaterials, including XRD, SEM, TEM, AFM, spectroscopy methods, and thermal analysis.
3. To analyze the structure, properties, synthesis, and applications of carbon-based nanomaterials such as fullerenes, graphene, and carbon nanotubes.
4. To explore nanolithography techniques and the design, synthesis, and applications of nanocomposites for optical, electrical, magnetic, and multifunctional applications.

Syllabus:

Contents	lecture
INTRODUCTION TO NANOMATERIALS Zero-dimensional, one-dimensional and two- dimensional nanostructures, size dependent properties – quantum confinement – optical properties - specific heat and melting point- mechanical properties – super plasticity - plastic deformation of ceramics - nanoceramics - catalytic properties. Synthesis of nanomaterials - bottom-up and top-down approaches - nanoparticles - colloidal technique - homogeneous and heterogeneous nucleation - synthesis of metallic and semiconductor nanoparticles - stabilization of nanoparticles - sonochemical method-synthesis and properties of core-shell nanoparticles. Nanowires and nanorods - spontaneous growth - vapour-liquid-solid growth – template-based synthesis - nanostructured films - self-assembly - molecular self-assembly in solutions – self assembly of nanoparticles - Langmuir-Blodgett films - electrochemical deposition. EXPERIMENTAL TECHNIQUES Principle, working and interpretation of results of – XRD – XPS - AES – EDS - SEM - STM – AFM – TEM - HRTEM - BET surface area and porosimetry - UV-Vis - FTIR and Raman spectroscopy - Thermal analysis – TGA, DTA and DSC. CARBON NANOTUBES Fullerenes - graphene - carbon nanotubes (CNTs) - SWCNT- MWCNT – synthesis - methods of opening, filling and purifying carbon nanotubes – geometrical structure of CNTs – electronic structure of CNTs – metallic and semiconducting CNTs – CNTFETs – CNT circuits - prospects of an all-CNT nanoelectronics. (ref. 22, 24-26) NANOLITHOGRAPHY Nanostructures fabricated by physical techniques – lithography – photo, electron beam, X-ray, ion beam, and AFM and STM based lithography – nanolithography – soft lithography – microcontact printing – dip-pen nanolithography – assembly of nanostructures. NANOCOMPOSITES Ceramic/metal nanocomposites - nanocomposites by mechanical alloying – nanocomposites from sol – gel synthesis – nanocomposites by thermal spray synthesis – thin- film	3 Hrs./ Week

Contents	lecture
nanocomposites: multilayers and granular films – carbon nanotube-based nanocomposites – inorganic nanocomposites for optical applications – inorganic nanocomposites for electrical applications – percolation effects and transport phenomena in composite systems – nanoporous structures and membranes – nanocomposites for magnetic applications - nanocomposite structures having miscellaneous properties.	

Course outcomes:

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

- Understand the basic knowledge of Nanobiotechnology and DNA structures.
- Understand the application of Nanomaterials in biotechnology and acquire the knowledge about the DNA, proteins, amino acids, drug delivery, biomedicine etc.
- Provide the knowledge in basics of nanotechnology in biotechnology
- Understand about the functional principles of bionanotechnology

Suggested learning resources:

1. C. N. R. Rao, A. Mu¨ller, A. K. Cheetham, The Chemistry of Nanomaterials :Synthesis, Properties and Applications, Volume 1, Wiley-VCH, Verlag GmbH, Germany (2004).
2. C. Bre´chignac P. Houdy M. Lahmani, Nanomaterials and Nanochemistry, Springer Berlin Heidelberg, Germany (2006).
3. Guozhong Cao, Nanostructures & Nanomaterials Synthesis, Properties G;Z: Applications, World Scientific Publishing Private, Ltd., Singapore (2004).
4. Zhong Lin Wang, Characterization Of Nanophase Materials, Wiley-VCH, Verlag GmbH, Germany (2004).
5. Carl C. Koch, Nanostructured Materials: Processing, Properties and Potential Applications, Noyes Publications, William Andrew Publishing Norwich, New York, U.S.A (2002).

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Course: Industrial Instrumentation and Control

Course Code	MCH(PE)-25008	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the fundamentals of measurement systems, including static and dynamic characteristics, errors, standards, and calibration procedures.
2. To study the principles, construction, and design of active and passive transducers, including semiconductor sensors and their applications.
3. To design signal conditioning circuits and transmitters, including two-wire, four-wire, smart, and intelligent transmitters for various sensor types.
4. To learn safety practices, EMC concepts, interference mitigation, and protection methods for hazardous and non-hazardous areas in industrial measurement systems.

Syllabus:

Contents	lecture
General concepts and terminology of measurement systems, static and dynamic characteristics, errors, standards and calibration. Introduction, principle, construction and design of various active and passive transducers. Introduction to semiconductor sensors and its applications. Design of signal conditioning circuits for various Resistive, Capacitive and Inductive transducers and piezoelectric transducer. Introduction to transmitters, two wire and four wire transmitters, Smart and intelligent Transmitters. Design of transmitters. Introduction to EMC, interference coupling mechanism, basics of circuit layout and grounding, concept of interfaces, filtering and shielding. Safety: Introduction, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures – NEMA types, fuses and circuit breakers. Protection methods: Purging, explosion proofing and intrinsic safety.	3 Hrs./ Week

Course outcomes:

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

- Identify, formulate and solve a problem of Instrumentation and Control Engineering
- Design and conduct experiments for measurement and ability to analyze and interprets data.
- Demonstrate an understanding of sensors / transducers.

Suggested learning resources:

1. M. Sze, “Semiconductor sensors”, John Wiley & Sons Inc., Singapore, 1994.
2. Noltingk B. E., “Instrumentation Reference Book”, 2nd Edition, Butterworth Heinemann, 1995.

3. L. D. Goettsche, “Maintenance of Instruments and Systems – Practical guides for measurements and control”, ISA, 1995.
4. John P. Bentley, Principles of Measurement Systems, Third edition, Addison Wesley Longman Ltd., UK, 2000.
5. Doebelin E. O, Measurement Systems - Application and Design, Fourth edition, McGraw-Hill International Edition, New York, 1992.

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Course: Computer Integrated Manufacturing

Course Code	MCH(PE)-25009	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand computer systems, input/output devices, CAD/CAM software, graphics operations, and modeling techniques for engineering applications.
2. To apply 2D and 3D geometric transformations, wireframe, surface, and solid modeling, including parametric representations of curves.
3. To learn the basics of Finite Element Analysis (FEA), solution techniques, and use of FEA software for engineering problems.
4. To study manufacturing planning and control, computer-integrated manufacturing, process planning, and production management using CAD/CAM integration.

Syllabus:

Contents	lecture
Types of Computer systems - Input devices - Output devices - CAD/CAM Software - Graphics standards, Basic Definitions Modes of Graphics Operations, User Interface, Software modules, Modelling and Viewing, Software Development, Efficient use of CAD/CAM Software, Microcomputer based CAD/CAM. 2D Representation and Transformation of Points, Transformation of Lines, Rotation, Reflection, Scaling and combined transformations, 3Dscaling, shearing, Rotation, Reflection, Translation, Projections parametric representation of Ellipse, Parabola, Hyperbola. Wire frame, Surface and Solid modelling - Solid modelling packages - Finite Element Analysis (FEA) - Introduction and procedures - Solution Techniques- Introduction to FEA packages. Manufacturing Planning and Control - CAD/CAM Integration - Principles of Computer Integrated Manufacturing - Hierarchical Network of Computers - Local Area Networks – Process Planning – Computer Aided Process Planning - Retrieval and Generative approaches. Computer Integrated Production Management System - Master Production Schedule - Material Requirement Planning - Inventory Management - Manufacturing and Design Data Base - Capacity Planning - Shop Floor Control - Functions - Order release - Order Scheduling - Order progress - Factory data collection.	3 Hrs./ Week

Course outcomes:

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

- Understand various concepts of scaling and transportation in CAD.
- Analyse and understand the MRP I and II.
- Understand Computer Aided Process planning and its various types.

Suggested learning resources:

1. Ibrahim Zeid, CAD/CAM, " Theory and Practaice ", Tata McGraw-Hill Ed., 1998.
2. David F.Rogers and Alan Adams.J, " Mathematical Elements for Computer Graphics ", McGraw-Hill Publishing Company International Edition, 1990.

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Course: Fuzzy Logic and Neural Networks

Course Code	MCH(PE)-25010	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the fundamentals of fuzzy set theory, fuzzy logic control, and the design of knowledge and rule-based systems.
2. To study adaptive fuzzy systems, including modification of rule bases, membership functions, and integration with genetic algorithms and neuro-fuzzy approaches.
3. To learn artificial neural network concepts, architectures, learning algorithms, and different types of neural networks including multilayer perceptrons and recurrent networks.
4. To apply fuzzy logic and neural network techniques to real-world measurement and control problems through case studies.

Syllabus:

Contents	lecture
• **Fuzzy Set Theory and Fuzzy Logic Control:** Basic concepts of fuzzy sets – Operations on fuzzy sets –Fuzzy relation equations – Fuzzy logic control – Fuzzification – Defuzzification – Knowledge base – Decision making logic – Membership functions – Rule base. • **Adaptive Fuzzy Systems:** Performance index – Modification of rule base – Modification of member ship functions –simultaneous modification of rule base and membership functions – Genetic algorithms – Adaptive fuzzy system- Neuro fuzzy systems. • **Artificial Neural Networks:** Introduction – history of neural networks – multilayer perceptrons –Back propagation algorithm and its variants – Different types of learning, examples • **Mapping and Recurrent Net Works:** Counter propagation – Self organization Map – Cognitron and Neocognitron - Hopfield Net- kohonnen Nets- Grossberg Nets- Art-I, Art-II reinforcement learning • **Case Studies:** Application of fuzzy logic and Neural network to Measurement- control – Adaptive Neural controllers, Signal processing and Image processing.	3 Hrs./ Week

Course outcomes:

Upon completion of the said course the student will be able to:

- Comprehend the concepts of feed forward neural networks
- Analyze the various feedback networks.

- Understand the concept of fuzziness involved in various systems and fuzzy set theory.
- Comprehend the fuzzy logic control and adaptive fuzzy logic and to design the fuzzy control using genetic algorithm.
- Analyze the application of fuzzy logic control to real time systems.

Suggested learning resources:

1. Millon W.T , Sutton R.S and Werbos P.J, Neural Networks for control MIT Press 1992
2. Klir ,G.J and Yuan B.B Fuzzy sets and Fuzzy logic , Prentice Hall of India Pvt. Ltd. ,, New Delhi 1997
3. Kosko. Neural Networks and Fuzzy systems,. Prentice hall of India Pvt. Ltd. New Delhi 1994
4. Dirankov D. Hellendoorn H, Reinfrank M ,.Introduction to Fuzzy control , Narosa Publishing House .. New Delhi 1996
5. Zurada J.M Introduction to Artificial Neural Systems Jaico Publishing House , New Delhi 1994
6. Vallum B.R and Hayagriva V.R C++, Neural networks and Fuzzy logic , BPB Publications , New Delhi , 1996.

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Course: Advanced Control System

Course Code	MCH(PE)-25011	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand state-space representation, solution of state equations, canonical forms, and concepts of controllability and observability for continuous-time systems.
2. To analyze nonlinear control systems using describing function and phase-plane methods, and to study stability using Lyapunov's direct and indirect methods.
3. To design state feedback controllers, full-order and reduced-order observers, and apply modal control techniques for linear systems.
4. To formulate and solve optimal control problems, including minimum time, minimum energy, minimum fuel, state regulator, output regulator, and tracking problems using calculus of variations and the minimum principle.

Syllabus:

Contents	lecture
State space Analysis State Space Representation, Solution Of State Equation, State Transition Matrix, Canonical Forms – Controllable Canonical Form, Observable Canonical Form, Jordan Canonical Form. Tests For Controllability And Observability For Continuous Time Systems – Time Varying Case, Minimum Energy Control, Time Invariant Case, Principle Of Duality, Controllability And Observability Form Jordan Canonical Form And Other Canonical Forms. Describing Function Analysis -Introduction To Nonlinear Systems, Types Of Nonlinearities, Describing Functions, Describing Function Analysis Of Nonlinear Control Systems. Phase-Plane Analysis Introduction To Phase-Plane Analysis, Method Of Isoclines For Constructing Trajectories, Singular Points, Phase-Plane Analysis Of Nonlinear Control Systems. Stability Analysis Stability In The Sense Of Lyapunov., Lyapunov's Stability And Lypanov's Instability Theorems. Direct Method Of Lypanov For The Linear And Nonlinear Continuous Time Autonomous Systems. Modal Control Effect Of State Feedback On Controllability And Observability, Design Of State Feedback Control Through Pole Placement. Full Order Observer And Reduced Order Observer. Calculus Of Variations Minimization Of Functionals Of Single Function, Constrained Minimization. Minimum Principle. Control Variable Inequality Constraints. Control And State Variable Inequality Constraints. Euler Lagrangine Equation. Optimal Control Formulation Of Optimal Control Problem. Minimum Time, Minimum Energy, Minimum Fuel Problems. State Regulator Problem. Output Regulator Problem. Tracking Problem, Continuous-Time Linear Regulators.	3 Hrs./ Week

Course outcomes:

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

- Demonstrate non-linear system behavior by phase plane and describing function methods
- Perform the stability analysis nonlinear systems by Lyapunov method
- Develop design skills in optimal control problems
- Derive discrete-time mathematical models in both time domain (difference equations, state equations) and zdomain (transfer function using z-transform).
- Predict and analyze transient and steady-state responses and stability and sensitivity of both open- loop and closed-loop linear, time-invariant, discrete-time control systems.
- Acquire knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers

Suggested learning resources:

1. K. Ogata, Modern Control Engineering, Prentice Hall of India, 3rd edition, 1998
2. I.J. Nagarath and M. Gopal, Control Systems Engineering , New Age International (P) Ltd.
3. M. Gopal, Digital Control and State Variable Methods, Tata Mc Graw-Hill Companies, 1997.
4. Stainslaw H. Zak, Systems and Control , Oxford Press, 2003.
5. M. Gopal Modern Control System Theory, New Age International Publishers, 2nd edition, 1996

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Course: Entrepreneurship Essentials

Course Code	MCH(PE)-25012	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-1 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the fundamentals of innovation, entrepreneurship, intrapreneurship, and the role of entrepreneurs in society.
2. To identify and analyze business opportunities through market analysis, competitive advantage, and demand–supply assessment.
3. To develop effective business models using value propositions, design thinking, and innovation tools.
4. To apply lean methods for product development and go-to-market strategies.
5. To gain practical knowledge of venture creation, including team building, business planning, financial analysis, funding, and legal aspects.

Syllabus:

Contents	lecture
Definition, Innovation and entrepreneurship, Contributions of entrepreneurs to the society, risk-opportunities perspective and mitigation of risks. Corporate entrepreneurship or intrapreneurship. Opportunity Identification, factors determining competitive advantage, Market segment, market structure, blue ocean strategy, Marketing research, Demand-supply analysis Value proposition, Business Model Canvas, Developing an Effective Business Model, Legal forms of business. Design Thinking, Design-Driven Innovation, TRIZ (Theory of Inventive Problem Solving), Zero-based design, SPRINT Lean product development, Lean entrepreneurship, Lean manufacturing, Go-to-market strategy Writing a business plan, what is a balance team and why is it important, Recruiting early employees, Role of industries/entrepreneur's associations and self-help groups concept-business incubators-angel investors- venture capital and private equity fund. Government incentives for entrepreneurship, Incubation, acceleration, Funding new ventures, Legal aspects of business	3 Hrs./ Week

Course outcomes:

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

- Identify a business opportunity
- Evaluate an idea and assess the market
- Explore the risks and rewards of entrepreneurship
- Leverage experiments to validate concepts and refine your business strategy
- Discover the key financial decisions entrepreneurs must make in the early stages of a startup

Suggested learning resources:

1. Norman M. Scarborough, Jeffrey R. Cornwell, Essentials of Entrepreneurship and Small Business Management, Pearson
2. H. Nandan, Fundamentals of Entrepreneurship 3rd Edition, PHI
3. Barringer, B., Entrepreneurship: Successfully Launching New Ventures, 3rd Edition, Pearson, 2011
4. Bessant, J., and Tidd, J., Innovation and Entrepreneurship, 2nd Edition, John Wiley &Sons, 2011.

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SEMISTER III

Course: Dissertation Phase – I

Course Code	MCH-26002	**Scheme of Evaluation**	CE & ESE
Teaching Plan	0-0-22-12	**ISE**	70 Marks
Credits	11	**ESE**	30

Corse Objectives:

1. To conduct research-oriented projects in Mechatronics involving analysis, modeling, or development of advanced mechatronic systems.
2. To develop detailed mathematical, simulation, or physical models related to Mechatronics applications.
3. To perform extensive literature survey to identify research gaps and inform the dissertation work.
4. To integrate theoretical knowledge and practical experimentation for innovation and problem-solving in Mechatronics research projects.

Syllabus:

Contents	lecture
Project should be research oriented with Mechatronics system involving detailed analysis or development of the models related to Mechatronics and as per the common instructions for all programs of M.Tech. Extensive literature survey of the area undertaken for the dissertation work.	18 Hrs./ Week

Course outcomes:

Students will demonstrate the ability to:

- Identify the problem and formulate it.
- Carry out an extensive literature review will help them in understanding the latest happenings in the field.
- Understand and analyze the problem.

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SEMISTER IV

Course: Dissertation Phase – II

Course Code	MCH-26003	**Scheme of Evaluation**	CE & ESE
Teaching Plan	0-0-22-12	**ISE**	70 Marks
Credits	11	**ESE**	30 Marks

Corse Objectives:

1. To carry out research-oriented experimental work on Mechatronics systems.
2. To develop and analyze detailed models or prototypes related to Mechatronics applications.
3. To apply theoretical knowledge to design, testing, and validation of Mechatronics systems.
4. To integrate experimentation and modeling to solve practical problems and contribute to M.Tech. dissertation work.

Syllabus:

Contents	lecture
Project should be research oriented experimental work, involving detailed analysis or development of Model/ Prototype related to Mechatronics system and as per the common instructions for all programs of M. Tech.	18 Hrs./ Week

Course outcomes:

- Apply the techniques/knowledge learned in the various courses.
- Model, analyze, prototype and provide solution to the identified problem.
- Publish his/her work in reputed conference and Journals.

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Course: Interdisciplinary Open Course offered to other Programmes

(IOC) Reliability Engineering

Course Code	OEC-25031	**Scheme of Evaluation**	CE & ESE
Teaching Plan	3-0-0-0 = 3	**MSE and TA**	30 and 20 Marks
Credits	3	**ESE**	50

Corse Objectives:

1. To understand the fundamentals of probability, reliability concepts, and analysis of systems using series, parallel, and complex configurations.
2. To evaluate system reliability using techniques such as event tree analysis, fault tree analysis, and Monte Carlo simulation.
3. To analyze engineering design reliability, safety margins, and component allocation methods to optimize overall system performance.
4. To apply reliability, availability, and maintainability (RAM) concepts, including FMEA, FMECA, and diagnostic maintenance, through practical case studies.

Syllabus:

Contents	lecture
• Basic Probability, concept and various distributions. Concept of Reliability and analysis of various configurations of assemblies and sub-assemblies. Series, Parallel and other grouping. System reliability. Set theory, optimal Cut Set and Tie Set, 'star-delta' method, matrix method etc. System reliability determination through 'Event Tree' analysis and Fault tree analysis. • Usage monitoring of plant and evaluation of reliability through failure data analysis. • Concept of loading roughness, probability in design including evaluation of safety margin. Reliability of Engineering Design; Mean, Median & K statistics for Reliability evaluation (non parametric, Short Sample). • Monte-Carlo simulation and Techno economic life. • Optimal allocation of component reliability to achieve maximum system reliability – various techniques and methods such as Proportional, Conditional, AGREE, ARINC etc. • Reliability, Availability and Maintainability of equipment. • A number of case studies done in Indian perspectives using Short Sample, nonparametric reliability. • Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), Failure Modes, Effects and Criticality Analysis (FMECA). R.P.N., Graph theory etc. Diagnostic maintenance through ferrography, Vibration Signature, SOAP and other programme	3 Hrs./ Week

Course outcomes:

- Understand the importance and application of reliability.
- Use the concepts of reliability in designing and maintenance of products.
- Simulate techno economic life which is very important for industry application.

Suggested learning resources:

1. C. Singh and C.S. Dhillon, Engineering Relaibility-New Techniques and Applications –John Wiley and Sons
2. K. C. Kapoor and L. R. Lubersome, Reliability in Engineering Design Willey Publication.
3. L. S. Srinath, Concepts in Reliability Engineering- Affiliated West Press.