With effect from academic year 2021-22

DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction

and

Syllabus of

M.E. (MECHANICAL ENGG)

AUTOMATION & ROBOTICS

Full Time & PTPG

AICTE Model Curriculum

2021-22

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TS, INDIA

With effect from academic year 2021-22

AICTE-Model Scheme
Scheme of Instructions & Examination
M.E. (Mechanical Engineering) 4 Semesters (Full Time)

S.No.	Subject	Scheme of Studies per Week			Max. Marks		Credits
		L	T	P	CIE	SEE	
Semester-I							
1.	Program Core I	3	0	0	30	70	3
2.	Program Core II	3	0	0	30	70	3
3.	Program Elective I	3	0	0	30	70	3
4.	Program Elective II	3	0	0	30	70	3
5.	Mandatory Course	3	0	0	30	70	3
6.	*Audit Course I	2	0	0	30	70	0
7.	Laboratory I	0	0	3	50	--	1.5
8.	Seminar	0	0	3	50	--	1.5
	Total	**17**	**0**	**6**	**280**	**420**	**18**
Semester-II							
1.	Program Core III	3	0	0	30	70	3
2.	Program Core IV	3	0	0	30	70	3
3.	Program Elective III	3	0	0	30	70	3
4.	Program Elective IV	3	0	0	30	70	3
5.	*Audit Course II	2	0	0	30	70	0
6.	Laboratory II	0	0	3	50	--	1.5
7.	Laboratory III	0	0	3	50	--	1.5
8.	**Mini Project	0	0	6	50	--	3
	Total	**14**	**0**	**12**	**300**	**350**	**18**
Semester-III							
1.	Program Elective V	3	0	0	30	70	3
2.	Open Elective	3	0	0	30	70	3
3.	*** Dissertation Phase I	0	0	20	100	--	10
	Total	**6**	**0**	**20**	**160**	**140**	**16**
Semester-IV							
1.	****Dissertation Phase II	0	0	32		200	16
	Total	**0**	**0**	**32**		**200**	**16**

Total Credits: 18 + 18 + 16 + 16 = 68

Note:

1. *For Audit Course even though the credits are Zero. It is mandatory for the students to secure 50% marks in that particular subject.
2. ** Mini Project total marks 50 out of which 25 marks will be awarded by Guide and 25 marks by internal committee.
3. *** Major Project Phase I total marks 100 out of which 50 marks will be awarded by Guide and 50 marks by internal committee.
4. **** Major Project Phase II, Total marks 200 to be awarded by External Examiner.
5. At least two laboratory course should be completed.
6. For Program Elective-V and Open Elective

*If the student is selected for Industry Internship, then he/she has to complete the required courses of Program elective V and Open Elective through **SWAYAM-NPTEL MOOCS***

Courses for getting the required credits. However the students are required to consult Head & CBoS (Autonomous) for due approval, before he/ she registers for the course in SWAYAM-NPTEL portal.

With effect from academic year 2021-22

AICTE-Model Scheme
Scheme of Instructions & Examination
M.E.(Mechanical Engineering) 6 Semesters (Part Time)
Semester-I

S.No.	Subject	Scheme of Studies per Week			Max.Marks		Credits
		L	T	P	CIE	SEE	
1.	Program Core -I	3	0	0	30	70	3
2.	Program Elective -I	3	0	0	30	70	3
3.	Program Elective -II	3	0	0	30	70	3
4.	Laboratory-I	0	0	3	50	--	1.5
	Total	**9**	**0**	**3**	**140**	**210**	**10.5**
Semester -II							
1.	Program Core-II	3	0	0	30	70	3
2.	Program Elective-III	3	0	0	30	70	3
3.	Program Elective-IV	3	0	0	30	70	3
4.	Seminar	0	0	3	50	--	1.5
	Total	**9**	**0**	**4**	**140**	**210**	**10.5**
Semester -III							
1.	Program Core-III	3	0	0	30	70	3
2.	Program Elective-V	3	0	0	30	70	3
3.	Research Methodology in Mechanical Engineering	3	0	0	30	70	3
4.	*Audit Course I	2	0	0	30	70	0
	Total	**11**	**0**	**0**	**120**	**280**	**9**
Semester -IV							
1.	Program Core-V	3	0	0	30	70	3
2.	Open Elective	3	0	0	30	70	3
3.	**Mini Project	0	0	6	50	--	3
4.	Laboratory-II (Computational Lab for A&R)	0	0	3	50	--	1.5

	Total	**6**	**0**	**9**	**160**	**140**	**10.5**
Semester -V							
1.	*Audit Course II	2	0	0	30	70	0
2.	Laboratory-III (Drives and Control Lab)	0	0	3	50	--	1.5
3.	***Major Project Phase I	0	0	20	100	--	10
	Total	**2**	**0**	**23**	**180**	**70**	**11.5**
Semester -VI							
1.	****Major Project Phase II	0	0	32		200	16
	Total			**32**		**200**	**16**

Total Credits: 10.5 + 10.5 + 9 + 10.5+11.5+16 = 68

Note:

1. *For Audit Course even though the credits are Zero. It is mandatory for the students to secure 50% marks in that particular subject.
2. ** Mini Project total marks 50 out of which, 25 marks will be awarded by Guide and 25 marks by internal committee.
3. *** Major Project Phase I total marks 100 out of which 50 marks will be awarded by Guide and 50 marks by internal committee.
4. **** Major Project Phase II, Total marks 200 to be awarded by External Examiner.
5. For Program Elective-V and Open Elective

With effect from academic year 2021-22

SCHEME: M.E. Mechanical Engineering (AUTOMATION & ROBOTICS)

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	ME301	Robotic Engineering	3			30	70	3
Core-II	ME302	Drives & Controls for Automation	3			30	70	3
Program Elective-I	ME501	Finite Element Techniques	3			30	70	3
	ME111	Manufacturing Automation						
	ME311	Modal Analysis: Theory and Practice						
	ME319	Numerical Methods						
	ME323	Data Analytics						
	ME126	Industry 4.0						
Program Elective-II	ME313	Vibration Analysis & Condition Monitoring	3			30	70	3
	ME336	Embedded Systems						
	ME320	Smart Materials						
	ME330	Deep Neural Networks & Fuzzy Logic						
	ME322	Bio-Mechanics						
	ME332	Computer Control of Mechanical Systems						
Audit-I	AC031	English for Research Paper Writing	2			30	70	0
	AC032	Disaster Management						
	AC033	Sanskrit for Technical Knowledge						
	AC034	Value Education						
Lab-I	ME351	Automation & Robotics Lab			3	50	-	1.5
Seminar	ME361	Seminar			3	50	-	1.5
Mandatory Core	ME100	Research Methodology in Mechanical Engineering	3			30	70	3
TOTAL			**17**		**6**	**280**	**420**	**18**
SEMESTER-II								
Core-III	ME303	Control of Dynamic Systems	3	-	-	30	70	3
Core-IV	ME304	Fluid Power Systems	3	-	-	30	70	3
Program Elective-III	ME602	Additive Manufacturing Technologies and Applications	3	-	-	30	70	3
	ME314	Mechanics of Composite Materials						
	ME502	Failure Analysis & Design						
	ME324	Robot Motion Planning						
	ME326	Aerial robots						
	ME316	Image Processing						
Program Elective-IV	ME337	Digital Signal Processing	3	-	-	30	70	3
	ME619	Design of Experiments						
	ME315	Advanced Solid Mechanics						
	ME325	Under Actuated Robots						
	ME321	Modern Control Systems						
	ME317	Planar Multibody Dynamics						
Audit-II	AC035	Stress management by Yoga	2	-	-	30	70	0
	AC036	Personality Development						
	AC037	Constitution of India						
	AC038	Pedagogy studies						
Core	MC070	Mini Project	-	-	6	50	-	3
Lab-II	ME352	Drives & Controls Lab	-	-	3	50	-	1.5

Lab-III	ME353	Computational Lab for A&R	-	-	3	50	-	1.5
TOTAL			**14**	**-**	**12**	**300**	**350**	**18**
SEMESTER-III								
Program Elective-V	ME331	Internet of Things	3	-	-	30	70	3
	ME329	Nonlinear dynamics and chaos						
	ME327	Machine Learning Applications						
	ME318	Optimization in Engineering Design						
	ME328	VR/AR systems						
	ME312	Rotor Dynamics						
Open Elective	OE941	Business Analytics	3	-	-	30	70	3
	OE942	Industrial Safety						
	OE943	Operations Research						
	OE944	Cost Management of Engineering Projects						
	OE945	Composite Materials						
	OE946	Waste to Energy						
	OE947	Intellectual Property rights						
	ME381	Major Project Phase -I	-	-	20	100	--	10
TOTAL			**06**	**-**	**20**	**160**	**140**	**16**
SEMESTER-IV								
	ME382	Major Project Phase -II	-	-	**32**	-	**200**	**16**
GRAND TOTAL			-	-	-	-	-	**68**

CIE : Continuous Internal Evaluation SEE : Semester End Examination

SEMESTER-I

ME 301

ROBOTIC ENGINEERING

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Familiarize students with various robot configurations.*
- *Learn to perform forward and inverse kinematics for general robot configurations*
- *Importance of robot dynamics and methods to solve it*
- *Familiarize with various trajectory planning and control techniques*
- *Will learn to integrate various components in to a robotic system*

Course Outcomes: *After completion of the course student will be able to*

1. *Identify and classify various robot configurations with their workspaces & their usage in industry.*
2. *Perform forward and inverse kinematics operations & determine singularity conditions for various robot configurations.*
3. *Compare and contrast various techniques available to find forward and inverse dynamic solutions for various general robot configurations*
4. *Implement various path planning techniques & control algorithms forcomputing end effector motions for generalized robotic tasks*
5. *Interface various hardware and software components to develop robotic systems for industry including the effects of multiple finger kinematics.*

UNIT – I

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT – II

Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT – III

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks.

UNIT – IV

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangian and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, Computed torque control, force control, hybrid control.

UNIT – V

Multifingured Hand Kinematics: Introduction to Grasping, Force-Closure, Grasp Planning, Grasp Constraints, Lagrange's Equations with Constraints, Robot Hand Dynamics, Redundant and Nonmanipulable Robot Systems,

Suggested Readings:

1. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and sons, 2008.
2. Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, 2003.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
4. Harry Asada & Slottine “Robot Analysis& Control” , Wiley Publications, 2014
5. S K Saha, “introduction to Robotics “, 2nd edition, TMH, 2013
6. A Mathematical Introduction to Robotic Manipulations- Richard M. Murray, Zexiang Li, S.Shankar Sastry CRC Press.Inc. 1st edition, 1994

ME302

DRIVES AND CONTROLS FOR AUTOMATION

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Know the basic principles of drives and controls*
- *Understand the various performance characteristics of industrial drives*
- *Introduce PLC programming*
- *Learn basic programs in PLC*
- *Learn to develop applications based on PLC and SCADA*

Course Outcomes: *After completion of the course student will be able to*

1. *To understand working principles of various types of motors, differences.*
2. *To apply the knowledge in selection of motors, heating effects and braking concepts in various industrial applications*
3. *To elucidate various linear and rotary motion principles and methods and use the same to application areas*
4. *To carry out programming using PLC and use of various PLCs to Automation problems in industries.*
5. *To discuss supervisory control and data acquisition method and use the same in complex automation areas.*

UNIT – I

Introduction: Working principle of synchronous, Asynchronous & stepper motors, Difference between Induction and servo motors, Torque v/s speed characteristics, Power v/s. Speed characteristics, Vector duty induction motors, Concepts of linear and frameless motors, Selection of feedback system, Duty cycle, , V/F control, Flux Vector control.

UNIT – II

Industrials Drives: DC and AC motors operation and selection, method of control and application of brushless DC motor, PMSM, stepper motor, A.C servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects, electric braking, converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, Selection of converting systems, Dynamic response gearing.

UNIT – III

Introduction to Programmable Logic Controllers: Definitions of PLC, basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing's, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), methods of PLC programming (LD, ST, FBD & SFC), function blocks logical / mathematical operators & data types, array & data structure, PID, types of tasks and configuration, difference between relay logic and PLC, selection of PLC controller (case study)

UNIT – IV

Logic, instructions & Application of PLC: What is logic, Conventional Ladder v/s PLC ladder, series and parallel function of OR, AND, NOT logic, Ex Or logic, Analysis of rung. Timer and Counter Instructions; on delay and Off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers,data handling instructions, Sequencer instruction, Visualization Systems, Types of visualization system, PC based Controller, Applications of HMI

UNIT – V

Supervisory control & data Acquisitions: Introduction to Supervisory control & data Acquisitions, distributed Control System (DCS): computer networks and communication in DCS. Different BUS configurations used for industrial automation – GPIB, HART and OLE protocol, Interfacing of SCADA with controllers, Basic programming of SCADA, SCADA in PC based Controller / HMI.

Suggested Readings:

1. Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition
2. Andrew Parr, Industrial drives, Butterworth – Heineamann
3. G.K.Dubey.Fundamentals of electrical drives
4. Programmable Logic Controllers by W.Bolton
5. A.E. Fitzerald ,C.Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. Student edition
6. Programmable Logic Controllers by Hugh Jack.

ME501

FINITE ELEMENT TECHNIQUES
(Program Elective - I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.*
- *To provides a bridge between hand calculations and numerical solutions for more complex geometries and loading states.*
- *To study approximate nature of the finite element method and convergence of results are examined.*
- *It provides some experience with a commercial FEM code and some practical modeling exercises.*

Course Outcomes: *After completion of the course student will be able to*

1. *Summarize the basics of finite element formulation*
2. *Derive interpolation functions and characteristic matrices for different 1D, 2D and 3D elements.*
3. *Apply the knowledge in solving one dimension and two dimensional static stress and dynamic analysis problems.*
4. *Solve the steady state and transient heat transfer analysis using FEA.*
5. *Analyze three dimensional stress analysis and fluid flow problems.*

UNIT-I

Introduction: Historical Background, General description of the finite element method, Mathematical Modeling of field problems in Engineering, Governing Equations, Discrete and continuous models, Boundary, Initial and Eigen Value problems, Weighted Residual Methods, Variational Formulation of Boundary Value Problems, Potential energy method, Rayleigh Ritz method, Galerkin's method of finite element formulation. Strain displacement relations, Stress strain relations, Interpolation models: Simplex, complex and multiplex elements, Linear interpolation polynomials in terms of local, natural and global coordinates for 1D, 2D, 3D Simplex Elements. Finite element equations, treatment of boundary conditions.

UNIT-II

One-Dimensional Elements-Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for 1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element. Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.

UNIT-III

Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Plane stress, plane strain and axisymmetric problems, Body forces and temperature effects. Stress calculations, Plate and shell elements. Elements. Convergence requirements and geometric isotropy. Application to Field Problems, Thermal problems, Analysis of a uniform shaft subjected to torsion using Finite Element Analysis. Quadrilateral elements and Higher Order Elements.

UNIT-IV

Steady state heat transfer analysis: One dimensional analysis of a fin, composite walls and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod. Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigenvectors.

UNIT-V

Finite element formulation of three dimensional problems in stress analysis. Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic net works.Finite Element formulation of an incompressible fluid. Potential flow problems Bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Suggested Readings:

1. Tirupathi R Chandraputla and Ashok.D.Belegundu, Introduction of Finite Element in Engineering, Prentice Hall of India, 1997.
2. Rao S.S., The Finite Element Methods in Engineering, Pergamon Press,1989.
3. Segerland. L.J., Applied Finite Element Analysis, Wiley Publication,1984.
4. Reddy J.N., An Introduction to Finite Element Methods, Mc Graw Hill Company,1984.
5. P.Seshu, Text book of Finite Element Analysis, PHI Learning Pvt. Ltd., 2003

ME111

MANUFACTURING AUTOMATION

(Programme Elective - I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To learn the concepts and principles of manufacturing automation*
- *To understand the components of automation and their practical use in manufacturing application*
- *Learn principles of assembly systems and material handling systems.*
- *Understand quality control and other support systems used in automated system*
- *To provide information integration and data warehousing*

Course Outcomes: *After completion of the course student will be able to*

1. *Understand the concepts and the effect of manufacturing automation strategies*
2. *Apply the principles of automation*
3. *Design automated material handling and storage systems*
4. *Analyze automated flow lines and assembly systems, and balance the line.*
5. *Make use of automated inspection methods.*

UNIT – I

Introduction: Definition of automation, Types of production, Functions of Manufacturing, Organization and Information Processing in Manufacturing, Production concepts and Mathematical Models, Automation Strategies, Production Economics: Costs in Manufacturing, Break-Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

UNIT – II

Automation Production Lines: Automated Flow lines, Methods of Workpart Transport, Transfer Mechanism, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Simulation of Automated Flow Lines.

UNIT – III

Assembly Systems and Line Balancing: The Assembly Process, Assembly Systems, Manual Assembly Lines, Methods of Line Balancing, Other ways to improve the Line Balancing, The Line Balancing Problem, Flexible Manual Assembly Lines. Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine.

UNIT –IV

Automated Materials Handling: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Convey or Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Carousel Storage Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing.

UNIT – V

Automated Inspection and Testing: Inspection and testing, Statistical Quality Control, AutomatedInspectionPrinciplesandMethods,SensorTechnologiesforAutomatedInspection,Co ordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods. The Future Automated Factory: Trends in Manufacturing, The Future Automated Factory, Human workers in the Future Automated Factory and the social impact.

Suggested Readings:

1. Mikell P.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia.
2. Ray Asfahl, Robots and manufacturing automation, John Wiley and Sons New York.
3. Viswanadham and Y.Narahari, Performance Modeling of Automated Manufacturing Syetms, Printice Hall India Pvt. Ltd.
4. Stephen J. Derby, Design of Automatic Machinery, Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd, Chennai.
5. Nanua Singh, System Approach to Computer Integrated Manufacturing, Wiley & Sons Inc., 1996

ME311

MODAL ANALYSIS: THEORY AND PRACTICE

(Programme Elective - I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the theoretical basis for modal analysis*
- *Understand and investigate frequency response functions for SDOF/MDOF*
- *Learn working principles of various FRF instruments*
- *Know how to generate extract natural frequencies and develop modal and response models*
- *Learn methods to develop modal reduction, expansion and modal extraction*

Course Outcomes: After completion of the course student will be able to

1. *Understand the theoretical basis for modal analysis and Differentiate frequency response functions for SDOF/MDOF systems under free and force vibrations.*
2. *Identify and Classify functioning of vibration measuring instruments.*
3. *Work on digital processing of measurements, and perform detailed analysis of measured data.*
4. *Conduct various tests for monitoring of common structural components found in the machine tool/automotive/aerospace/ship building/civil industries.*
5. *Predict the performance of the components/machines based on the relevant mathematical models.*

UNIT- I:

Theoretical basis for modal analysis

Overview of modal analysis**,** Vibrations of single and multiple degree of freedom (SDOF, MDOF) systems**,** Frequency response functions (FRFs) for SDOF/MDOF systems. Types of FRFs.Orthogonality of modes and their application in modal analysis**.**

UNIT- II:

Theoretical basis for modal analysis

Theory of undamped, proportionally damped, and non-proportionally damped SDOF/MDOF systems**,** Analyses for complex modes and sensitivity analysis of modal models

UNIT- III:

FRF measurement considerations

Introduction to test planning**,** Excitation of structures (electromagnetic and electrohydraulic shakers, hammers, etc.)**,** Transducers and amplifiers for measurements (force transducer, accelerometers, laser vibrometers, signal conditioners, amplifiers etc.)**,** Actuator/sensor placement considerations**,** Revision of Fourier analysis and Fourier transforms**,** Discussions on aliasing, leakage, windowing, filtering and averaging**,** Role of excitations signals in structural testing

UNIT- IV:

Modal parameter extraction and derivation of mathematical models

Preliminary checks of FRF data (spectrum, coherence, asymptotic behavior, assessment using singular value decomposition (SVD))**,** Mode indicator functions**,** SDOF modal analysis

methods (peak-picking, circle-fit)**,** Treatment of residuals**,** MDOF modal analysis in the frequency domain (least square methods, rational fraction polynomial methods)**,** Extraction of natural frequencies, damping ratios and shapes.**,** Discussion on modal models, response models and spatial models

UNIT- V:

Applications and advanced topics.

Model correlation. Concepts of modal assurance criterion and some of its variants**,** Dynamic sub structuring, Modal reduction and expansion**,** Model updating**,** Advanced curve fitting for modal parameter extraction, Testing of weakly nonlinear structures

Suggested Readings:

1. Modal testing: theory, practice and application by D. J. Ewins;
2. Theoretical and experimental modal analysis by N. Maia and J. Silva

ME319

NUMERICAL METHODS
(Programme Elective - I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Learn various methods to solve linear sets odd equations*
- *Learn various methods of linear interpolation techniques*
- *Learn various methods of numerical approximation methods*
- *Understand various numerical integration and differentiation techniques*
- *Know to solve various methods to solve ordinary differential equations*

Course Outcomes: *After completion of the course student will be able to*

1. *Classify various linear and non linear methods available in literature*
2. *Define the problem and the relevant strategy to solve the problem*
3. *Solve the problem based on linear or non linear analysis*
4. *Use relevant numerical integration & differentiation techniques to solve engineering problems*
5. *Use approximate techniques to solve ordinary and partial differential equations*

UNIT-I

Solving linear sets of equations Gauss Elimination, LV Decomposition, Matrix Inversion, Scalar Tridiagonal Matrix, Thomas Algorithm, Gauss Seidel Method, Secant Method

UNIT-II

Solving nonlinear sets of equations Minimization of function, Newton's Method, Quasi-Newton Method, Steepest Descent Method, Eigen Values & Vectors.

UNIT-III

Interpolation & Polynomial Approximation Least Squares Method, Lagrange Interpolation, Hermite Interpolation, Cubic Spline Interpolation, Chebeshev Polynomials & Series

UNIT-IV

Numerical Differentiation & Integration Numerical Differentiation, Richardson's Extrapolation, Definite & Indefinite Integrals, Simpson's Rule, Trapezoid Rule, Gaussian Quadrature

UNIT-V

Ordinary Differential Equations: First and Higher Order Taylor Series, First order Runge-kutta Method, Fourth order Runge-kutta Method, Stiff Equations, Errors, Convergence Criteria.

Suggested Reading:

1. Cheney E. Ward, Kincaid D.R., Numerical Methods and Applications, 2008, Cengage Learning
2. Gerald C.F., Wheatley P.O., Applied Numerical Analysis, 7th Ed, Pearson Education.
3. Burden R.L., Faires J.D., Numerical Analysis: Theory and Applications, 2005, Cengage Learning.
4. Chapra S.C., Canale R.P., Numerical Methods for Engineers, 4th Ed, Tata McGraw Hill.
5. Mathews J.H., Fink K.D., Numerical Methods using MA TLAB, 4th Ed, Pearson Education.
6. Press W.H., Taukolsky S.A., Vetterling W.T., Flannery B.P., Numerical Recipes in C++, 2nd Ed,Cambridge University Press.

ME323

DATA ANALYTICS
(Programme Elective - I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Know various methods of data characterization and management*
- *Learn the basics of R programming*
- *Learn to solve statistical analysis using R software*
- *Understand the basic of data analytics using R software*
- *Learn to use data analytics for data sets of practical applications*

Course Outcomes: *After completion of the course student will be able to*

1. *Classify various techniques and statistical measures used in data analysis*
2. *Find various statistical measures using R/python software*
3. *Apply various hypothetical testing methods for data analysis with and without software*
4. *Perform various regression and clustering techniques on the data provided*
5. *Apply the regression and clustering techniques for various case studies using Python and R software*

UNIT-1

Data Definitions and Analysis Techniques

Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing, Introduction to statistical learning and R-Programming

UNIT-II

Descriptive Statistics: Measures of central tendency, Measures of location of dispersions, Practice and analysis with R

UNIT-III

Basic analysis techniques: Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test, Practice and analysis with R

UNIT-IV

Data analysis techniques:Regression analysis, Classification techniques, Clustering, Association rules analysis, Practice and analysis with R

UNIT-V

Case studies and projects: Understanding business scenarios, Feature engineering and visualization, Scalable and parallel computing with Hadoop and Map-Reduce, Sensitivity Analysis

Suggested Readings:

1. Peter Bruce , Andrew Bruce, Practical Statistics for Data Scientists, June 2017
2. Hadley Wickham, Garrett Grolemund, R for data science : Import, Tidy, Transform, Visualize, And Model Data , January 2017
3. Anil Maheshwari, Data Analytics Paperback, July 2017
4. Seema Acharya, Data Analytics Using R Paperback, April 2018
5. U Dinesh Kumar Manaranjan Pradhan, Machine Learning using Python, January 2019.

ME126

INDUSTRY 4.0
(Programme Elective - I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To know the Main concepts and components of Industry 4.0*
- *To understand the role of data analytics, Internet of Things (IoT), robotics and augmented reality in the implementation of Industry 4.0*
- *To learn the working of various Additive Manufacturing (AM) Technologies, Virtual Factory and role of Cyber security in the successful implementation of Industry 4.0*

Course Outcomes: *After completion of the course student will be able to*

1. *Interpret the meaning and scope of Industry 4.0.*
2. *Illustrate the role of Data Analytics and IoT in a Manufacturing Industry.*
3. *Recognise the role of Robotics and Augmented Reality in the implementation of Industry 4.0*
4. *Identify the role of Additive Manufacturing Technology in Industry 4.0 and interpret the working of various AM technologies and their applications.*
5. *Analyse the role of virtual factory, digital traceability and Cyber Security in the implementation of Industry 4.0.*

UNIT – I

Introduction: Definition, Main concepts and components of Industry 4.0, Proposed Framework of Industry 4.0, Smart and Connected Product Business Models, Smart Manufacturing, Lean Production Systems for Industry 4.0, The changing role of Engineering Education in Industry 4.0 Era, Industry 4.0 laboratories, Opportunities and Challenges of Industry 4.0, Future Skills required by Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.

UNIT – II

Data Analytics and Internet of Things in Manufacturing: Introduction to data analytics, Techniques used for Predictive Analytics, Forecast Accuracy Calculations, A real world Case Study; Introduction to IoT, Examples for IoTs Value Creation in Different Industries.IoTs Value Creation Barriers: Standards, Security and Privacy Concerns.

UNIT – III

Robotics and Augmented Reality in Industry 4.0: Introduction, Recent Technological Components of Robots: Advanced Sensor Technologies, Artificial Intelligence, Internet of Robot Things, Cloud Robotics, Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications. Introduction to Augmented Reality: Augmented Reality Hardware and Software Technology, Industrial Applications of Augmented Reality

UNIT–IV: Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies: Stereolithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net shaping, Advantages and Disadvantages of Additive Manufacturing. Applications of Additive Manufacturing in Medical, Surgical Planning, Implant and Tissue Design, Automotive, Aerospace, Electronics, Education and Oceanography. Impact of AM Technologies on society: Impact on health care, Environment, Manufacturing and Supply Chain.

UNIT–V: Virtual Factory, Digital Traceability and Cyber Security: Introduction to Virtual Factory, Virtual Factory Software, Limitations of Commercial Software; Introduction to Digital Traceability, Digital Traceability Technologies, Architectural Framework, Applications, Project Management in Digital Traceability; Introduction to Cyber Security, Security Threats and Vulnerabilities of IoT, Industrial Challenges, Evolution of Cyber Attacks, Cases on Cyber Attacks and Solutions, Strategic Principles in Cyber Security, Cyber Security Measures.

Suggested Readings:

1. Alp Ustundag and Emre Cevikcan, Industry 4.0: Managing The Digital Transformation Springer Series, 1st ed. 2018 edition.
2. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 1st edition, 2019.
3. DrIng. Klaus Schwab, The fourth Industrial Revolution, Penguin Publisher; 1st edition, 2017.
4. Pascual D G, Handbook Of Industry 4.0 and Smart Systems, Taylor and Francis, 2020
5. Kumar K, Digital Manufacturing And Assembly Systems In Industry 4.0**,** Taylor and Francis, 2020

ME313

VIBRATION ANALYSIS & CONDITION MONITORING

(Programme Elective - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the theoretical basis for single and multi-degree freedom systems*
- *Learn to derive the mathematical models for free and forced vibration systems*
- *Understand the importance of various methods to solve multi degree freedom systems*
- *Know the working principles of various condition monitoring equipment*
- *Learn various methods of recording and displaying data*

Course Outcomes: *After completion of the course student will be able to*

1. *Fully understand importance of vibrations in mechanical design of machine parts that operate under vibratory conditions.*
2. *Write differential equation of motion of vibratory system and understand free and forced modes of vibration*
3. *Obtain linear vibratory models of dynamic systems of varying complexity (SDOF,MDOF)*
4. *Apply various condition monitoring techniques available in the literature.*
5. *Classify and use various devices available to record interpret and understand the vibration data.*

UNIT-I

Causes and effects of vibration. Vibrations of Single Degree of freedom systems. Free, Damped and Forced vibrations

UNIT-II

Two Degree of freedom systems. Bending vibrations of two degree of freedom systems, Steady state and transient characteristics of vibration, vibration absorber and vibration isolation.

UNIT-III

Multi degree of freedom systems: Dunkerley method, Rayleigh method, stodola method and holzers method. Modal analysis.

UNIT-IV

Introduction to Condition Monitoring, Failure types, investigation and occurrences. Causes of failure, Vibration measuring instruments, vibration transducers, signal conditioning elements. Display and recording elements. Vibration meters and analyzers. Condition Monitoring through vibration analysis.
Frequency analysis, Filters, Vibration signature of active systems, vibration limits and standards.

UNIT-V

Contaminant analysis, SOAP and other contaminant monitoring techniques. Special vibration measuring techniques – Change in sound method, Ultrasonic measurement method, Shock pulse measurement, Kurtosis, Acoustic emission monitoring, Cepstrum analysis, Modal analysis, critical speed analysis, Shaft –orbit & position analysis.

Suggested Readings:

1. Rao S .S Mechanical Vibrations , 5th Edition, Prentice Hall, 2011
2. V.P.Singh, Mechanical vibrations, Dhanpat Rai Publications, 2015
3. Collacott, R.A., Mechanical Fault Diagnosis and Condition Monitoring, Chapman & Hall, London, 1982.
4. John S. Mitchell, Introduction to Machinery Analysis and Monitoring, Penn Well Books, Penn Well Publishing Company, Tulsa, Oklahoma, 1993.
5. J S Rao, Vibration condition monitoring of machines, CRC Press, 2000
6. Nakra, B.C. Yadava, G.S. and Thuested, L., Vibration Measurement and Analysis, NationalProductivity Council, New Delhi, 1989.

ME336

EMBEDDED SYSTEMS
(Programme Elective - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand internal architecture of 8051 and ARM microcontrollers*
- *Learn to interface different peripheral devices with 8051 and ARM microcontrollers*
- *Learn to write basic programs in microcontrollers (8051 & ARM)*
- *Learn to design simple embedded systems*
- *Understand the importance of role of embedded systems in industry*

Course Outcomes: After completion of the course student will be able to

1. *Foster ability to understand the internal architecture and interfacing of different peripheral devices with Microcontrollers.*
2. *Foster ability to write the programs for microcontroller.*
3. *Foster ability to understand the role of embedded systems in industry.*
4. *Foster ability to understand the design concept of embedded systems.*
5. *Develop real time interface systems for industrial applications*

UNIT- I

Embedded Systems Programming in FPGA:

Embedded System Design Strategies: Microcontroller/DSP/FPGA, FPGA Design Flow,Embedded System Programming in FPGA, Project Design Flow, Overview of Verilog Modelingstyles: Structural, Data Flow, Behavioral and switch level Modeling of digital system. Tasks andFunctions, Test bench Design Timing Delays, Static timing analysis: Setup time & hold timeviolations and clock skew and Case studies.

UNIT -II

Embedded Systems Programming in CISC Micro-controller:

Overview of Intel 8051 Architecture, instruction set, Basic Programming: Assembly Languageand C programming, I/O port programming, Timer, UART and Interrupt Programming.

UNIT- III

Embedded Systems Programming in RISC Micro-controller: ARM Part I:

ARM architecture versions, Core Architecture, Register Organization, AMBA bus architecture,Instruction Set of ARM, Thumb Instruction set, Cache memory, Introduction to µVision IDE,Memory Accelerator Modulator, Interrupt Programming, GIC

UNIT- IV

Embedded Systems Programming in ARM Part II:

Timer Programming, PWM, RTC and Watch dog Timer, Interfaces: UART, I2C, SPI, JEDEC,Memory Management Unit

UNIT -V

Embedded Systems Programming with Real Time World Interface:

ADC, DAC, LED, LCD, Stepper Motor and Sensors

Suggested Reading:

1. Ming-Bo Lin., *Digital System Designs and Practices Using Verilog HDL and FPGAs,*Wiley India, 2008.
2. Samir Palnitkar, *Verilog HDL: A Guide to Digital Design and Synthesis*, PearsonEducation, 2005.
3. Mohammad Ali Mazidi, Rolin D McKinley, Janice G Mazidi, The 8051 Microcontrollerand Embedded Systems, Second Edition, Prentice Hall
4. Andrew N.Sloss, Domnic Symes, Chris Wright, ARM system developers guide, Elsevierpublications.

ME320

SMART MATERIALS
(Programme Elective - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Coarse Objectives:

- *Learn the physics behind the use of certain materials for sensing and actuation*
- *Understand the constitute equations developed for smart materials like piezo, SMA, EAP, IPMC, Magneto resistive*
- *Learn how to select smart materials for an application*
- *Understand the use of smart materials for precision equipment in industries*
- *Learn to use smart materials for developing cost effective systems*

Course Outcomes: After completion of the course student will be able to

1. *Classify and identify various smart materials with their applications*
2. *Illustrate the working principles of various smart materials like SMA,EAP & Magneto restrictive , IPMC*
3. *Develop constitutive models for various smart materials like SMA,EAP , IPMC & Magneto restrictive*
4. *Investigate design and control issues in Smart materials*
5. *Apply smart materials to develop cost efficient systems*

UNIT- I

Introduction: Smart materials and their application for sensing and actuation, Mechatronics aspects, Piezoelectric materials: Piezoelectricity and piezoelectric materials, Constitutive equations of piezoelectric materials, Piezoelectric actuator types, Control of piezoelectric actuators, Applications of piezoelectric actuators for precise positioning and scanning.

UNIT- II:

Shape memory alloys (SMA): Properties of shape memory alloys, Shape memory effects, Pseudo-elasticity in SMA, Design of shape memory actuator, selection of materials, Smart actuation and control, Applications of SMA in precision equipments for automobiles, trains and medical devices.

UNIT -III:

Electro-active polymers (EAPs): Ionic polymer metal composites (IPMC), Conductive polymers, Carbon nanotubes, Dielectric elastomers, Design & control issues for EAP actuators, Applications of EAP for biomemetic, tactile display and medical devices.

UNIT- IV:

Magnetostrictive materials: Basics of magnetic properties of materials, magnetostriction: constitutive equations, types of magnetostrictive materials, Design & control of magnetostrictive actuators, Applications of magnetostrictive materials for active vibration control. Summary, conclusion and future outlook: Comparative analysis of different smart materials based actuators,

UNIT - V:

Conclusions, Future research trend and applications trends of smart materials and smart materials based actuator technology.

Suggested Text books:

1. Jose L. Pons, Emerging Actuator Technologies, a Micromechatronics Approach, John Wiley & Sons Ltd, 2005.
2. Ralph Smith, Smart Material Systems: Model Development, SIAM, Society for Industrial and Applied Mathematics, 2005.
3. F. Carpi, D. De Rossi, R. Kornbluh, R. Pelrine, P. Sommer-Larsen, Dielectric Elastomers as Electromechanical Transducers, Elsevier, Hungry, 2008.
4. Y. B. Cohen, Electroactive Polymer (EAP) Actuators as Artificial Muscles Reality, Potential and Challenges, SPIE press, USA, 2004

ME330

DEEP NEURAL NETWORKS & FUZZY LOGIC
(Programme Elective - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the basics of Fuzzy and Neural networks*
- *Know when to apply Fuzzy logic and Neural network*
- *Understand the importance of various neural network models*
- *Learn to solve supervised problems using ML*
- *Learn to solve unsupervised problems using DL*
- *Learn to develop fuzzy logic based systems*

Course outcomes: *After completion of the course student will be able to*

1. *Differentiate between randomness and fuzziness and Apply the concept of fuzziness in real time systems*
2. *Differentiate between Neural nets and fuzzy logicbased systems and specify their merits and demerits.*
3. *Use various models of supervised learning for classification problems*
4. *Use various models of unsupervised learning for clustering problems*
5. *Apply the concepts of deep learning in real time systems*

UNIT-I

Concepts of fuzzy sets: Introduction – Crisps sets, notation of fuzzy sets, basic concepts of fuzzy sets, operation, fuzzy compliment, union, intersection, Binary relation, Equivalence and similarity relations, belief and plausibility measures, probability measures, computability, relations, ordering morphisms, possibility and necessary measures. Uncertainty and information: Types of uncertainty, measures of dissonance, measures of confusion, measures of nonspecificity, uncertainty and information. Complexity, Principle of uncertainity.

UNIT-II

Adaptive fuzzy systems: Neural and Fuzzy intelligence, Fuzziness as multivalent, fuzziness in probabilistic world, randomness verses ambiguity. Fuzzy association memories: Fuzzy and neural function estimates, FAN mapping, neural verses fuzzy representation of structural knowledge, FAM as mapping, Fuzzy hebb FAM's Bidirectional FAM theorem, Super imposition FAM Rules, FA System architecture.

UNIT-III

Introduction to Neural networks: Knowledge base information processing, general view of knowledge based algorithm, neural information processing, Hybrid intelligence, and artificial neurons.

UNIT-IV

Characteristics of artificial Neural Networks: Single Neural Networks, Multi Layer Neural Networks, Training of ANN – objective, supervise training, unsupervised training, overview of training. Neural networks Paradigms: Perception meculloch and Pitts Model, back

propagation algorithm and deviation, stopping criterion, Hopfield nets, Boldman's machine algorithm, Neural networks applications.

UNIT-V

Deep Learning: Principal Component Analysis and its interpretations, Singular Value Decomposition Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders. Regularization: Bias Variance Tradeo-, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying. Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization.

Suggested Reading:

1. Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press
2. Neural Networks: A Comprehensive Foundation, Simon S. Haykin, Prentice Hall, 1999
3. Neural networks using matlab, Deepa and Sivanandham, TMH,
4. Fuzzy Logic with Engineering Applications, By Timothy J. Ross, Wiley Publications

ME322

BIO-MECHANICS
(Programme Elective - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the importance of composition & properties with respect to structure of bones*
- *Learn to develop viscoelastic models of soft tissues*
- *Learn to determine the mechanical behavior of passive muscles*
- *Understand the behavior of muscle force production and transmission*
- *Learn to optimse the production of muscle force and transmission*

Course Outcomes: *After completion of the course student will be able to*

1. *Identify various bones with their composition & elastic properties and understand their importance with respect to structural strength of human skeleton*
2. *Determine the viscoelastic constitutive models of soft tissues and further modifying the muscle models as fibre composite materials*
3. *Determine the mechanical properties of muscles and tendons*
4. *Develop functional relationships between force applied and length & velocity developed in muscles*
5. *Optimise the muscle force production & transmission*

UNIT-I

Introduction to Biomechanics – Terminology – Anthropometry – Skeletal Mechanics – Structure of bones – Composition and properties of bones and relationship to structure – Elasticproperties of bones – Characterizing elastic anisotropy – Modeling and Remodeling of bones(Wolfe's law of bone remodeling)

UNIT-II

Viscoelasticity of soft tissues – Models of viscoelasticity (Maxwell, Voigt, Kelvin)Muscle mechanics – Muscle architecture and mechanics – Muscle fascicles and theirarrangement – Fiber architecture in fascicles – Muscle as a fiber reinforced composite – Musclecentroids – Muscle Cross sectional areas (Physiological & Anatomical)

UNIT-III

Properties of tendons and passive muscles – Viscoelastic behavior of tendons – Tendon interaction with surroundingtissues – Mechanical properties of passive muscles

UNIT-IV

Mechanics of Active muscle: Muscle force production and transmission – Functional relations (Force – length, Force – Velocity curves), History effects in muscle mechanics – Hill's model (derivation) – Sliding filament theory

UNIT-V

Muscle coordination – Problem of motor redundancy – Approach to studying muscle force

production using optimization (forward and inverse)Exemplary behavior: Dynamics of Reaching – Inverse dynamic modeling

Suggested Readings:

1. Principles of Biomechanics by Robert L.Huston, CRC Press
2. Berne & Levy Physiology, 6th Updated Edition, Bruce M. Koeppen and Bruce A. Stanton, Mosby, 2009 edition.

ME332

COMPUTER CONTROL OF MECHANICAL SYSTEMS
(Programme Elective - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand various levels of automation*
- *Understand various features of NC and CNC machines*
- *Learn the basics of NC and CNC programming for machining operations like turning, drilling machining etc*
- *Understand the tooling and control systems used in CNC machines*
- *Learn the basics of adaptive control in CNC machines*

Course outcomes: After completion of the course student will be able to

1. Identify Levels of Automation. & Explain the concept of Computer Process Control.
2. Describe the features of NC Machine tools & Apply the knowledge in selection of control l loops, drives, feedback devices and actuation systems.
3. Differentiate CNC Machining centres, CNC Turning centres and Tool Changing Systems
4. Develop part programs for given component on turning and milling machine
5. Explain CNC concept, Reference-pulse Technique, sampled-Data technique, Microcomputers in CNC & Adaptive Control Systems

UNIT -I

Automation and Control technologies: Levels of Automation, Continuous Versus Discrete Control - Continuous Control Systems -Discrete Control Systems Computer Process Control - Control Requirements - Capabilities of Computer Control. Computer Process Control: Forms of Computer Process Control - Computer Process Monitoring - Direct Digital Control - Numerical Control and Robotics - Programmable Logic Controllers - Supervisory Control - Distributed Control Systems and Personal Computers in process control, Enterprise - Wide Integration of Factory Data.

UNIT –II

Features of NC Machine tools: Fundamentals of numerical control, advantages and limitations of N.C systems-classification of N.C systems, Design consideration of N.C machine tools, Methods of improving machine accuracy, increasing productivity with N.C machines, Machining centers, MCU Functions. Control loops of N C Systems and CNC hardware basics: Introduction, control of point-to point systems, Control Loops in Contouring systems. CNC Hard ware Basics: Structure of CNC machine tools, Drives, Actuation systems, Feedback devices, Axes-standards.

UNIT- III

CNC Machine tools and control systems: CNC Machining centres, CNC Turning centres, Highspeed machine tools, Machine control unit, Support systems, Touch trigger probes. Tool Changing Systems: Turning-tool geometry, Milling Tooling Systems, Tool Presetting, Methods of optimizing output from NC machine tools, Automatic Tool Changers, Work holding.

UNIT –IV

CNC programming: Part Programming Fundamentals – Manual Part Programming methods using ISO codes, Preparatory functions, Miscellaneous functions, Tool length compensation, canned cycles, Cutter radius compensation, canned cycles, Part Programs on milling, Drilling and Tapping operations. Turning centre Programming: Comparisons between machining centre and turning centres, Tape format, Axes system, General programming functions, motion commands, cut planning, Thread cutting, canned cycles, Part programs onturning.

UNIT -V

Computerized Numerical Control: CNC concepts, advantages of CNC, Digital computer, Reference-pulse Technique, sampled-Data technique, Microcomputers in CNC. Adaptive Control Systems: Introduction, Adaptive control with optimization, Adaptive control with constraints, variable- gains AC systems, Adaptive control of Grinding.

Suggested textbooks:

1. Y. Koren, "Computer Controls of Manufacturing Systems," McGraw Hill,1983.
2. P.N. Rao, "CAD/CAM Principles and Applications,"3 rd Edition, McGraw Hill, Education Pvt. Ltd., New Delhi,26 May 2010, ISBN: 978-0070681934.
3. M.P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing," Prentice Hall India Pvt. Ltd.,3rd Edition, 24 July 2007, ISBN: 978-0132393218.
4. Martin J, "Numerical Control of Machine Tools," Butterworth-Heinemann, 20th May 1991, ISBN:9780750601191.
5. Y. Koren& J. Ben-Uri, "Numerical Control of Machine Tools," Khanna Publishers, Delhi, 19

AC 031

ENGLISH FOR RESEARCH PAPER WRITING
(AUDIT COURSE-I)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Course Objectives:

- *Understand that how to improve your writing skills and level of readability*
- *Learn about what to write in each section*
- *Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission*

Course Outcomes:

1. *Able to plan and prepare paragraphs, avoiding ambiguity*
2. *Writing of abstracts, paraphrasing and plagiarism*
3. *Providing of critical and thorough review of literature, discussions and conclusions*
4. *Able to exhibit key skills for writing titles, introduction, abstract.*
5. *Able to show key and necessary skills for paper writing, phrases, results.*

Unit I

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit IV

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

Unit V

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions -Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Studies:

1. Goldbort R, *Writing for Science*, Yale University Press (available on Google Books), 2006.
2. Day R, *How to Write and Publish a Scientific Paper*, Cambridge University Press, 2006.
3. Highman N *Handbook of Writing for the Mathematical Sciences*, SIAM. Highman'sbook. 1998
4. Adrian Wallwork English *for Writing Research Papers*, Springer New York Dordrecht Heidelberg London. 2011.

AC032

DISASTER MANAGEMENT
(AUDIT COURSE-I)

Instruction: 2 periods per week | Duration of SEE: 3 hours
CIE: 30 marks | SEE: 70 marks
Credits: 0

Course Objectives:

- *To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters*
- *To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters*
- *To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.*

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

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction
2. Humanitarian response
3. Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.
4. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

UNIT-I

Introduction

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT-III

Disaster Prone Areas in India

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

UNIT-IV

Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-V

Risk Assessment

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT-VI

Disaster Mitigation

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster
Mitigation in India.

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.), "Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L. Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

AC 033

SANSKRIT FOR TECHNICAL KNOWLEDGE
(AUDIT COURSE-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes:

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

UNIT-I:

- Alphabets in Sanskrit.
- Past/Present/Future Tense.
- Simple Sentences.

UNIT-II:

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

UNIT-III:

- Technical concepts of Engineering-Electrical,
- Mechanical,
- Architecture,
- Mathematics

References:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumb shastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

AC034

VALUE EDUCATION
(AUDIT COURSE-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Course Outcomes:

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

UNIT I:

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgements.

UNIT II:

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature, Discipline.

UNIT III:

- Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of labour.
- Universal brotherhood and religious tolerance, True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.
- Doing best for saving nature

UNIT IV:

- Character and Competence –Holy books vs Blind faith.
- Self-management and Good health.
- Science of reincarnation.
- Equality, Nonviolence,Humility, Role of Women.
- All religions and same message.
- Mind your Mind, Self-control, Honesty, Studying effectively

References:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

With effect from academic year 2021-22

ME351

AUTOMATION & ROBOTICS LAB

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 50 marks *SEE: 00 marks*
Credits: 2

Course Objectives:

- *Understand the basics of structural and modal analysis using Abaqus software*
- *Learn to Simulate simple mechanisms using MSC Adams software*
- *Learn to perform static and dynamic analysis using Abaqus software*
- *Perform kinematic and dynamic analysis of systems using MSC Adams*

Course Outcomes: After completion of the course student will be able to

1. Ability to perform simulations/ experiment and understand the phenomenon
2. Critically evaluate and interpret the results
3. Prepare a well-organized record

List of Experiments

Using Msc Adams Software

1. Kinematic analysis of Single Link Pendulum
2. Impact test of a falling stone body
3. Kinematic and dynamic analysis of a 4 bar mechanism
4. Kinematic and dynamic analysis of a slider crank mechanism
5. Dynamic analysis of a linear and non linear spring

Using ABAQUS SOFTWARE

1. Introduction to Finite Element Analysis Software.
2. Static analysis of a corner bracket.
3. Determination of Beam stresses and Deflection & bending analysis of Tee shaped beam.
4. Bending of a circular plate using axi-symmetric shell element.
5. Analysis of cylindrical shell under pressure.

ME361

SEMINAR

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 50 marks *SEE: 00 marks*
Credits: 1.5

Course Objectives:

- *Understand the purpose of seminar*
- *Learn the resources available at the college and outside for pursuing project*
- *Importance of literature review*
- *Learn to document results and arrive at required conclusions*

Course Outcomes: After completion of the course student will be able to

1. Identify engineering problems reviewing available literature.
2. Study the different techniques adopted to solve the problem.
3. Understand the usage of related techniques and software's
4. Investigate the procedure adopted and Interpret the results and conclusions obtained
5. Document the findings as a technical report with proper references.
6.

The seminar must be clearly structured and Power point presentation should include the following:

1. Introduction
2. Literature survey
3. Consolidation of available information
4. Objectives and Methodology
5. Results and Discussions
6. Conclusions
7. References

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Objectives and Methodology
5. Results and Discussions & Summary
6. Conclusions
7. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation

should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.

2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of few research papers from Peer-reviewed or UGC recognized journals.
2. The seminar report should be in the following order: Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and references
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory.

ME100

RESEARCH METHODOLOGY IN MECHANICAL ENGINEERING

Instruction: 3 periods per week Duration of SEE: 3 hours
CIE: 30 marks SEE: 70 marks
Credits: 3

Course Objectives:

- *Learn to focus on research related activities.*
- *Learn methods to devise and develop the various research designs*
- *Learn basic principles of data collection and analysis techniques*
- *Learn the style and format of writing a report for technical papers*

Course Outcomes: *After completion of the course student will be able to*

1. *Motivate the orientation towards research related activities*
2. *Formulate the research problem, analyze research related information*
3. *Identify various sources for literature review and design an experimentation set-up*
4. *Apply the basic principles of data collection and analysis techniques*
5. *Improve the style and format of writing a report for technical / Journal articles*

UNIT – I

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.

Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

UNIT – II

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. **Literature Review**: Need of Review, Guidelines for Review, Record of Research Review.

UNIT – III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

UNIT – IV

Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software.

Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

UNIT – V

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Suggested Reading:

1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011
3. Ratan Khananabis and Suvasis Saha, Research Methodology, Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
5. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
6. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications, Hyderabad, 2012.

SEMESTER - II

ME303

CONTROL OF DYNAMIC SYSTEMS

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Learn to develop mathematical models for first and second order systems.*
- *Understand the importance of transient and steady state analysis of multi degree freedom systems.*
- *Understand the concept of observability and controllability in solve problems in MIMO systems.*
- *Learn to develop stability plots based on time and frequency response techniques.*
- *Learn to draw phase plane plots for non linear systems and determine the stability analysis of linear and non linear systems using Lyapunov analysis.*

Course Outcomes: *After completion of the course student will be able to*

1. *Differentiate between linear, non linear systems & classify features of linear and non-linear systems. Enumerate the merits and demerits of classical and modern control systems.*
2. *Develop mathematical models for various physical systems.*
3. *Determine the transient effects, steady state errors and stability analysis using the frequency and time response plots.*
4. *Determine stability of MIMO systems using State Space variables.*
5. *Sketch phase plane plots for non-linear systems and determine the non linear stability analysis using Lyapunov method.*

UNIT-I

Mathematical Modeling of physical systems, 1st, 2nd order and higher order systems, transient, steady stateanalysis, steady state errors, Performance Indices.

UNIT-II

Poles, zeros, zero and pole placements, Routh‟s criteria, Root locus Technique, Bode plots, Nyquistcriterion, Compensation circuits.

UNIT-III

State space method, state transition matrix, canonical forms, Diagonalisation, solutions of homogeneousand non homogenous equations, zero and pole placement using state space techniques, controllability andobservability, state controllability matrix, state observability matrix.

UNIT-IV

Non-Linear Systems Phase plane analysis: Phase portraits, Singular points characterization. Analysis ofnon-linear systems using phase plane techniques, Existence of limit cycles.

UNIT-V

Stability Analysis Concept of stability, Stability in the sense of Lyapunov and absolute stability, autonomoussystems, the invariance principle, linear systems and linearization, non autonomous systems, linear timevarying systems and linearization.

Suggested Readings:

1. K. Ogata, “Modern Control Engineering”, Pearson India, 3rd Edition.
2. Norman Nise,”Control System Engineering”, Prentice Hall India, Fourth Edition
3. Anand Kumar, “Control System Theory”, Prentice Hall India.
4. M.Vidyasagar, "Nonlinear systems analysis", Second Edition, Prentice Hall, 1993
5. H.Khalil, "Nonlinear Systems", Macmillan Publishing Company, NY, 1992.
6. A. Isidori, “Nonlinear Control Systems” 3rd edition, Springer Verlag, London, 1995.
7. B. Brogliato, R. Lozano, B. Maschke, O. Egeland, "Dissipative Systems Analysis and Control", Springer Verlag, London, 2nd edition, 2007.

ME304

FLUID POWER SYSTEMS

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *The course will develop the students' knowledge and understanding of hydraulic and pneumatic devices and systems.*
- *The students should be able to understand the principles of operation and the design details of hydraulic pumps, motors, valves, actuators, and systems.*
- *The student should be able to analyze both the steady-state and the dynamic performance of individual hydraulic components and systems.*
- *The student should also be able to relate the theory with the practical applications of these principles*

Course Outcomes: *After completion of the course student will be able to*

1. *Differentiate between Hydraulic and Pneumatic systems and Identify various hydraulic and pneumatic elements with their symbols.*
2. *Classify various hydraulic, pneumatic fluids with their properties & applications and Illustrate the working principles of various positive displacement pumps and motors.*
3. *Generate and solve mathematical models for various hydraulic & pneumatic components like valves, pumps and motors.*
4. *Integrate all hydraulic & pneumatic components and solve the corresponding mathematical models for generating various fluidic circuits.*
5. *Apply the concept of fluidics in developing various fluidic circuits.*

UNIT - I

Advantages and Disadvantages of Fluid control, Types of Hydraulic Fluids, physical, chemical and thermalproperties of hydraulic fluids, selection of hydraulic fluid, fluid flow fundamentals. Hydraulic Pumps andMotors: Basic Types and constructions, ideal pump and motor analysis, Performance curves and parameters

UNIT - II

Hydraulic Control Valves- Valve configurations, general valve analysis, critical center, open center, threeway spool valve analysis and Flapper valve analysis, pressure control valves, single and two stage pressurecontrol valves, flow control valves, introduction to electro hydraulic valves.

UNIT - III

Hydraulic Power Elements: Valve controlled motor, valve controlled piston, three way valve controlledpiston, pump controlled motor, pressure transients in power elements.

UNIT - IV

Characteristics of Pneumatics, Applications of Pneumatics, Basic Pneumatic elements, Pneumatic servomechanisms, pneumatic servo, ram equations, load sensitivity, method of stabilization, stabilization usingauxiliary tanks. Some practical aspects of servo testing and design

UNIT - V

Control of pressure and speed in Hydraulic and Pneumatic Systems, Fluidics:proportional amplifier, bistableamplifier, vortex amplifier, turbulence amplifier, impact modulator, Boolean algebra, fluidlogics,manipulation of logic expressions, special circuits and sequential circuits.

Suggested Reading:

1. Herbert E. Merritt, “Hydraulic Control Systems”, John Wiley & Sons, 1967.
2. D McCloy & H R Martin,” The control of fluid power” Longman publications.1980
3. Anthony Esposito, “Fluid power with applications”, Prentice Hall, 7th Edition, 2002.
4. Arthur Akers, Max Gassman, Richard Smith, “Hydraulic Power System Analysis”, Taylor and FrancisGroup, 2006.
5. John Pippenger & Tyler Hicks, “Industrial Hydraulics”, 3rd edition McGraw Hill , 1979
6. A.B. Goodwin, Fluid Power Systems, Macmillan, 1976.

ME 602

ADDITIVE MANUFACTURING TECHNOLOGIES AND APPLICATIONS

(Program Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To know the fundamentals of Additive Manufacturing (AM) and compare it with conventional CNC technology*
- *To understand the working principle, advantages, limitations and applications of various AM Technologies and also various types of data formats and errors.*
- *To know the role of AM in Topology optimization and understand the applications of AM in various fields like Biomedical, Aerospace, Automobile and other domains.*

Course outcomes: After completion of the course student will be able to:

1. Interpret the features of Additive Manufacturing and compare it with
2. conventional CNC Technology
3. Illustrate the working principle, advantages, limitations and applications of various Additive Manufacturing Technologies and Rapid Tooling systems
4. Interpret various types data formats and STL file errors used in AM and identify the role of Topology optimization in AM
5. Analyze the features of different types of software's used in 3D Printing technology
6. Applythe knowledge of various AM technologies for developing new and innovative applications

UNIT – I

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies. Role of AM in Industry 4.0.

UNIT – II

Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies

VatPhotopolymerization AM Systems: Photopolymers, photo polymerization Stereo lithography Apparatus (SLA), Direct Light Processing (DLP) and Continuous Direct Light Processing (CDLP).

Material Jetting AM Systems: Material Jetting, Nano particle jetting and Drop-On-Demand (DOD) material jetting **Binder JettingAM Systems:** Three dimensional Printing (3DP).

Material ExtrusionAM Systems: Fused Deposition Modeling (FDM

UNIT – III

Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies

Powder Bed Fusion AM Systems: Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM).

Direct Energy Deposition (DED) AM Systems: Laser Engineered Net Shaping (LENS) and Electron Beam Additive Manufacturing (EBAM).

Sheet Lamination AM Systems: Laminated Object Manufacturing (LOM) and Ultrasonic Additive Manufacturing (UAM).

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

UNIT – IV

Reengineering in AM: Reengineering Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development

AM Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Slicing Algorithms: Rock Algorithm, Crawford's algorithm, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques, Topology optimization and Additive Manufacturing.

AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab.

UNIT –V

AM Applications: Application – Material Relationship, Application in Design, Engineering Analysis and Planning, Aerospace, Automotive, Jewelry, Coin, GIS, Arts, Architecture. Medical and Bioengineering Applications, Forensic Science and Anthropology, Visualization of Biomolecules.**Cost Estimation in AM:** Cost Model, Build Time Model, Laser Scanning Vat Photopolymerization Example, Life-Cycle Costing.

Suggested Readings:

1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct DigitalManufacturing- Ian Gibson, David W Rosen, Brent Stucker, Springer, Second Edition, 2010.
2. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific.
3. Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.
4. RafiqNoorani,Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
5. NPTEL Course on Rapid Manufacturing

ME 314

MECHANICS OF COMPOSITE MATERIALS
(Program Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To introduce the basics of composite materials, its classification, advantages and applications.*
- *To provide basic knowledge for predicting micromechanical and macro-mechanical properties and strength.*
- *To provide expertise in estimating the properties of composite by considering the various parameters.*
- *To study various fracture modes of composites.*
- *To introduce the procedure for analyzing composite plates and shells.*

Course Outcomes: *After completion of the course student will be able to*

1. *Understand the basics of composites its advantages and applications*
2. *Derive the equations to predict micro and macro-mechanical properties of composites.*
3. *Analysis and evaluation of laminate composites using micro-mechanics and macro-mechanics*
4. *Estimate the strength of orthotropic laminate*
5. *Analytical solution for analysis of plates and shells.*

UNIT-I

Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites carbon fibre composites.

UNIT-II

Micromechanics of Composites: Mechanical properties-Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties-Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

UNIT-III

Macro mechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams.

UNIT-IV

Strength, fracture, fatigue and design: Tensile and compressive strength of unidirectional fibre composites,

Fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and de-lamination failure, fatigue of laminate composites. Effect of variability of fibre strength.

Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials.

UNIT-V

Analysis of plates and shells: Plate equilibrium equations, Bending of composite plates, Levy and Navier solution for plates of composite materials. Analysis of composite cylindrical shells under axially symmetric loads.

Suggested Reading:

1. Jones, R.M., *Mechanics of Composite Materials, Mc Graw Hill Co., 1967.*
2. Calcote, L.R., *The Analysis of Laminated Composite Structures,* Van Nostrand, 1969.
3. Whitney, I.M. Daniel, R.B. Pipes, *Experimental Mechanics of Fibre Reinforced Composite Materials,* Prentice Hall, 1984.
4. Hyer, M.W., *Stress Analysis of Fibre Reinforced Composite Materials,* Mc Graw Hill Co., 1998. 5. Carl. T. Herakovich, *Mechanics of Fibrous Composites,* John Wiley Sons Inc., 1998.

ME 502

FAILURE ANALYSIS & DESIGN
(Program Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the features and basics steps involved in a good design*
- *Know the influence of creativity and systematic design on product design*
- *Understand the basic of fracture mechanics and its influence on the product*
- *Learn various method of fracture analysis for both brittle and ductile materials*
- *Estimate the effect of fatigue on fracture propagation*

Course Outcomes: *After completion of the course student will be able to*

1. *Define, perform and manage steps to create and deliver a technological product that meets or exceeds needs of clients*
2. *Apply basic concepts and methods from design engineering to explore creative solutions to clearly defined real world problems*
3. *Differentiate Brittle &Ductile fracture, modes of fracture and the importance of energy method in brittle materials*
4. *Identify and Determine size and shape of plastic zones subjected to plane stress and plain strain conditions.*
5. *Develop constituent equations for crack propagation from various defects and also find the influence of fatigue conditions on the crack propagation in a component*

UNIT - I

Design Fundamentals: Importance of design- The design process-Considerations of Good Design – Morphology of Design –Organization for design– Computer Aided Engineering –Concurrent Engineering – Product and process cycles –Market Identification – Competition Bench marking. Identification of customer needs- customer requirements-Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.

UNIT- II

Design Methods: Creativity and Problem Solving –Creativity methods-Theory of Inventive Problem Solving(TRIZ)– Conceptual decomposition-Generating design concepts-Axiomatic Design – Evaluation methods-Embodiment Design-Product Architecture-Configuration Design- Parametric Design. Role of models in design-Mathematical Modeling – Simulation – Design for Reliability –Introduction to Robust Design-Failure mode Effect Analysis.

UNIT - III

Fracture Mechanics: Introduction, Modes of fracture failure Griffith Analysis, Energy release rate, Energy release rate of DCB specimen; Stress Intensity Factor: SIF‘s for edge and center line crack, Fracture toughness, Elastic plastic analysis through J-integral method: Relevance and scope, Definition of J-integral, Path independence, stress strain relation, Strain Energy Release Rate Vs J-integral. Failure analysis and determination of stress patterns from plastic Flow observations – Dynamic loading– Fracture types in tension

UNIT – IV

Applications of Fracture Mechanics: Introduction –Through cracks emanating from holes – Corner cracks at holes – Cracks approaching holes-Combined loading-Fatigue crack growth binder- Mixed mode loading-Fracture toughness of weld metals-Service failure analysis

UNIT – V

Fatigue Crack Propagation: Mechanism of fatigue crack initiation, propagation and growth, Fatigue data representation, Factors influencing Fatigue strength, Fatigue life prediction, prevention of fatigue failures, corrosion fatigue. Cumulative fatigue damage

Suggested Reading:

1. Dieter, George E., ―Engineering Design - A Materials and Processing Approach, McGraw Hill, International Editions, Singapore, 2000.
2. Pahl, G, and Beitz, W.,‖ Engineering Design‖, Springer – Verlag, NY. 1984.
3. David Broek, ‖Elementary Engineering Fracture Mechanics ―, Fifthoff and Noerdhoff International Publisher, 1978.
4. Prashant Kumar, ―Elements of Fracture Mechanics‖, Wheeler Publishing, 1999
5. S T. Rolfe and J M Barsom, Fracture and Fatgue control in structure, Prentice Hall
6. KRY Simha, Fracture Mechanics for Modern Engineering Design, University Press

ME 324

ROBOT MOTION PLANNING
(Program Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Refresh the basics of robotic engineering*
- *Learn to use and integrate sensors and actuation in mobile robot systems*
- *Understand various robot path and motion planning algorithms*
- *Learn the basics of object grasping and manipulation*
- *Learn to implement these algorithms in real robots*

Course Outcomes: After completion of the course student will be able to

1. Identify Configuration spaces of mobile vehicles and manipulators,
2. Use Geometric modelling and sensor based map building.
3. Develop Path planning and obstacle avoidance methods and algorithms
4. Perform Object manipulation and grasping
5. Design of user interfaces and simulation and Algorithms for assembly and biological aspects of motion and intelligence.

UNIT-I

Review of robotics basics, transformations, kinematics etc, Concept of configuration space of mobile and arm manipulators**.**

UNIT-II

Sensors and actuators as used in mobile robotics**,** Geometrical modeling and map building

UNIT-III

Path planning and obstacle avoidance**,** Object manipulation and grasping

UNIT-IV

Design of user interface and simulation**,** Algorithms for applications, assembly, etc

UNIT-V

Intelligence in motion planning and optimization

Suggested Readings

1. Robot motion planning algorithms, steve lavelle
2. Robot motion planning, lacoumbe
3. Motion planning algorithms, choset

ME 326

AERIAL ROBOTS
(Programme Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the basic concepts, identify parts and classify aerial robots.*
- *Able to understand fundamentals of aerial robots*
- *Understand and apply knowledge on modelling and dynamics for aerial robot applications*
- *Understand and apply navigation & path planning in aerial robots*
- *Understand system integration for aerial robots*

Course Outcomes: *After completion of the course student will be able to*

1. *Classify aerial robots & Identify the basic components with their functioning.*
2. *Develop dynamic models, derive controllers, and synthesize planners for operating in dynamic conditions.*
3. *Demonstrate the design process of UAVs fixed wing multicopter and flapping wing*
4. *Describe the navigation and guidance of Aerial Robot.*
5. *Apply methods of system integration for aerial robots.*

UNIT I:

Introduction: Fundamentals of Aerial Robot – Classification – Applications – Design considerations

UNIT II:

Sensors And Actuators: Sensors for Aerial robots – Sensor Characteristics – Inertial Sensors – Classification of Sensors – Electric Actuators – DC Motors – Servo motor – Encoders – Motor Drives.

UNIT III:

Modeling And Dynamics :Frame Rotations and Representations – Dynamics of a Multirotor Micro Aerial Vehicle – Dynamics of a Fixed-Wing Unmanned Aerial Vehicle

UNIT IV:

Flight Controls And Motion Planning: PID Control – LQR Control – Linear Model Predictive Control – An Autopilot Solution

UNIT V:

Case Study Of Aerial Robots: Holonomic Vehicle Boundary Value Solver – Dubins Airplane model Boundary Value Solver – Collisionfree Navigation – Structural Inspection Path Planning

Suggested Readings:

1. Kenzo Nonami, Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles, Springer, 2010
2. Yasmina Bestaoui Sebbane, Planning and Decision Making for Aerial Robots, Springer, 2014
3. Roland Siegwart, Introduction to Autonomous Mobile Robots, 2nd Edition, MIT Press, 2011
4. Woo-Kyung Choi, Hong-Tae Jeon, Seong-Joo Kim, "Multiple Sensor Fusion and Motion Control of Snake Robot Based on Soft-Computing", INTECH Open Access Publisher, 2007

ME 316

IMAGE PROCESSING
(Programme Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the fundamentals of image processing and transforms*
- *Learn various methods of Image enhancement*
- *Know various methods of image compression and restoration*
- *Learn video processing and perform 2d motion estimation*
- *Learn various methods of multi object tracking*

Course Outcomes: *After completion of the course student will be able to*

1. *To understand fundamentals and mathematical transforms necessary for image processing.*
2. *To apply various techniques used for image enhancement*
3. *Use appropriate techniques for both image restoration and compression procedures*
4. *Learn video processing techniques and perform 2d motion estimation*
5. *Perform human tracking based on multiple object tracking concepts.*

UNIT I

Fundamentals of Image Processing and Image Transforms; Basic steps of Image ProcessingSystem, Monochrome and color vision models**,** Image acquisition and display, Sampling andQuantization of an image – Basic relationship between pixelsImage Transforms: 2 D- Discrete Fourier Transform, Discrete Cosine Transform (DCT), WaveletTransforms: Continuous Wavelet Transform, Discrete Wavelet Transforms.

UNIT II

Image Processing Techniques Image Enhancement Spatial domain methods: Histogramprocessing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters.Frequency domain methods: Basics of filtering in frequency domain, image smoothing, imagesharpening, Selective filtering. Laplacian of Gaussian (LOG) filters.**Image Segmentation:** Segmentation concepts, Point, Line and Edge Detection, Thresholding, RegionBased segmentation. Hough Transform, boundary detection, chain coding,

UNIT III

Image Compression Image compression fundamentals - Coding Redundancy, Spatial and Tempora redundancy, Compression models: Lossy & Lossless, Huffman coding, Arithmetic coding, LZW coding, Run length coding, Bit plane coding, Transform coding, Predictive coding, Wavelet coding, JPEG standards. **Basic steps of Video Processing** Analog Video, Digital Video. Principles of color video processing,composite versus component video, Time-Varying Image Formation models Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Videosignals, Filtering operations.

UNIT IV

2-D Motion Estimation Optical flow, General Methodologies, Pixel Based Motion Esimation, Block-Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Video coding, Contant dependent video coding and Joint shape and texture coding ,MPEGs and H.26x standards.

UNIT V

Multi-Object Tracking- Classification of multiple interacting objects from video, Region-based Tracking, Contour-based Tracking, Feature-based Tracking, Model-based Tracking, Hybrid Tracking, Particle filter based object tracking, Mean Shift based tracking, Tracking of multiple interacting objects. Human Activity Recognition- Template based activity recognition, Sequential recognition approaches using state models (Hidden Markov Models), Human Recognition Using Gait, HMM Framework for Gait Recognition, Description based approaches, Human interactions, group activities, Applications and challenges.

Suggested Readings

1. Gonzaleze and Woods Digital Image Processing –, 3rd ed., Pearson.
2. Yao Wang, Joem Ostermann and Ya–quin Zhang Video processing and communication –. 1st Ed., PH Int.
3. M. Tekalp, "Digital Video Processing, Prentice Hall International

ME 337

DIGITAL SIGNAL PROCESSING
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To study the DFT and FFT algorithms.*
- *To understand the concept of FIR and IIR filters.*
- *To study the types of filters.*
- *To understand Multi rate signal processing.*
- *To study the architecture of TMS processor*

Course Outcomes: *After completion of the course student will be able to*

1. *Able to find DFT of a given signal through Fast Fourier Transform techniques.*
2. *Able to design FIR and IIR type digital filters*
3. *Able to identify filter structures and evaluate the coefficient quantization effects.*
4. *Able to understand sample rate conversion techniques.*
5. *Able to compare the architectures of DSP and General Purpose Processors.*

UNIT-I

Introduction: Review of Discrete Time Fourier Transform, Concept of frequency in continuous and discrete time signals, DFT and its properties, linear convolution, circular convolution. Computational complexity of direct Computation of DFT, Fast Fourier Transform, DIT and DIF, FFT algorithms for RADIX-2 case, in-place computation, Bit reversal, Finite word length effects in FFT algorithms, Use of FFT in Linear Filtering.

UNIT-II

FIR Filters: FIR digital filter design techniques. Properties of FIR digital filters, design of FIR filters using windows and frequency sampling techniques, linear phase characteristics. Realization diagrams for IIR and FIR filters, finite word length effects.

UNIT-III

IIR Filters: Analog filter design – Butterworth and Chebyshev approximations, IIR digital filter design techniques, impulse invariant technique. Bilinear transform technique. Comparison of FIR and IIR filters, frequency transformations.

UNIT- IV

Multirate signal processing: Introduction, decimation by a factor D, interpolation by a factor I, sampling rate conversion by a rational factor I/D, design of practical sampling rate converter, S/W implementation of sampling rate converter, application of Multirate signal processing.

UNIT-V

DSP Processors: Introduction to Fixed point Digital Signal Processors, TMS 320C54XX processor- architecture, addressing modes, instruction set, Assembly programming, programming issues, Applications of DSP processors.

Suggested Readings:

1. John G.Proakis and Dimitris G. Manolakis, *"Digital Signal Processing principles, Algorithms and Applications"*, 3rd Edition, Prentice-Hall of India Private Limited, NewDelhi, 1997.
2. Alan V. Oppenheim and Ronald W. Schafer,"*Discrete Time Signal Processing*", 3rd edition, Prentice Hall, Upper Saddle River, NJ,2010
3. Sanjit K. Mitra, "*Digital Signal Processing: A Computer-Based Approach*", 4/e,McGraw-Hill, New York,2011
4. Avatar sing and S.Srinivasan, *"Digital Signal Processing implementation using DSP Microprocessors with Examples from TMS320C54XX"*, Thomson Books Icole, 2004.

ME 619

DESIGN OF EXPERIMENTS
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To Understand design and conduct experiments, as well as to analyze and interpret data*
- *To understand the process of designing an experiment including factorial designs with practical cases*
- *An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, manufacturability, and sustainability*
- *To investigate and apply new statistical analyses using Minitab and other software*
- *An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Course Outcomes: *After completion of the course student will be able to*

1. *Gains the knowledge of DOE methodology and its tools*
2. *Plan, Design , and Conduct Experiments with effectively*
3. *Analyse the resulting data to obtain the optimised conclusions*
4. *Understand the process of designing and experimentation with various*
5. *Approaches and Increase the efficiency of experimentations*
6. *Will be trained in statistical modeling and in the choice of experimental designs to use in scientific investigations.*

UNIT-I

Introduction to Design of Experiments: History , Basic Principles of DOE, Steps for Planning, Conducting and Analysing of Experiment, Typical applications of Experimental design, Guidelines for Designing Experiments. Basic Statistical Concepts, Mean median and mode, Measures of Variability, Statistical Distributions: Normal, Log Normal & Weibull distributions, Hypothesis testing.

UNIT-II

Experimental Design, Factorial Experiments: factors, levels, interactions, Two-level, Three-level experimental designs for two factors and three factors Factor effects, Factor interactions, Fractional factorial design, Response Surface Methodology : Central composite designs, Box–Behnken design

UNIT-III

Experimental Design Quality: Using Taguchi's Orthogonal Arrays, Types, selection of standard orthogonal arrays, Signal to Noise Ratio, Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger-the-better type. Signal to Noise ratios for Dynamic problems. Parameter & Tolerance Design and concepts.

UNIT-IV

Analysis & Interpretation Methods: Analysis of variance (ANOVA), Regression analysis, Grey relational analysis from experimental data, case study problems

UNIT-V

Advanced Optimization Techniques: Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

Suggested Readings:

1. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 2003.
2. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.
3. Fundamentals of Quality control and improvement 2nd edition, Amitava Mitra, Pearson Education Asia, 2002.
4. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
5. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
6. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995.
7. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison- Wesley, New York, 1989.

ME 315

ADVANCED SOLID MECHANICS
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To introduce the basic theory of bending in straight and curved beams.*
- *To study the bending behavior of flat and circular plates.*
- *To learn the stresses developed in thick and thin cylinders.*
- *To introduce the significance of thermal stresses in straight and curved beams.*
- *To study the elastic stability behavior of beam-column with different loading and constraint conditions.*

Course Outcomes: *After completion of the course student will be able to*

1. *Analyse straight and curved beam members subjected to tension, compression, bending, torsion and combined stresses*
2. *Evaluate flat /circular plates subjected to bending in single and multi-directions*
3. *Analyse asymmetric bodies subjected to internal and external pressures*
4. *Determine the effects of thermal stresses on beams and discs*
5. *Understand the concept of buckling and determine buckling conditions for long columns under various loading conditions*

UNIT-I

Bending of Beams: Introduction, straight beams and Asymmetrical bending, Euler –Bernoulli hypothesis, shear center, shear stresses in thin walled open sections, bending of curved beams, deflection of thick curved bars.

UNIT-II

Bending of Plates: Behaviour of Flat plates , bending of a plate in one direction, bending of a plate in two perpendicular directions, thermal stresses in plates , bending of circular plates of constant thickness, bending of uniformly loaded plates of constant thickness.

UNIT-III

Asymmetric Bodies: Introduction, Thick-walled cylinder subjected to internal and external pressures, stresses in composite tubes-shrink fit, rotating disks of uniform thickness, disks of variable thickness, rotating shafts and cylinders.

UNIT-IV

Thermal Stresses : Introduction, thermoelastic stress–strain relations, equations of equilibrium, straindisplacement relations, thin circular disk, normal stresses in straight beam due to thermal loading, stresses in curved beams due to thermal loading.

UNIT-V

Elastic Stability : Euler's Buckling load, beam column equations, beam column with concentrated load, continuous lateral loads, beam-Column with end couple, General treatment of column stability problems.

Suggested Readings:

1. L Srinath, " Advanced Mechanics ofSolids ", Tata McGraw-Hill Education, 2009
2. Stephen P. Timoshenko & James M. Gere, " Theory of Elastic Stability", Dover Publications
3. Abdel-Rahman Ragab & Salah Eldin Bayoumi, " Engineering Solid Mechanics", CRC Press
4. Stephen P. Timoshenko & J N Goodier, " Theory of Elasticity", McGraw Hill Publications.
5. Bruhns, Otto T., "Advanced Mechanics of Solids" Springer Verilag, 2003
6. Arthur P. Boresi, Richard J. Schmidt, "Advanced Mechanics of Materials", Wiley International Publications.
7. Allan F Bower, "Advanced Mechanics of Solids", Taylor & Francis, 2014

UNDER ACTUATED ROBOTICS
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the differences between fully and under actuated robot systems*
- *Learn the various methods of walking models*
- *Learn how to model systems with uncertainty*
- *Introduce the concept of Optimal control*
- *Understand the importance of various motion planning algorithms*

Course outcomes: *After completion of the course student will be able to*

1. *Differentiate between fully and under actuated sytems*
2. *Understand the effectiveness of various walking models*
3. *Determine the effects of non linearity in the equations, systems and models*
4. *Apply the concepts of optimal control and other techniques to robot control*
5. *Apply various path and motion control algorithms*

UNIT-I

Fully v/s under actuated systems, non linear dynamics of the simple pendulum, Acrobot and cart-pole controllability, partial feedback linearization (PFL), energy shaping

UNIT-II

Simple walking models- rimless wheels, compass gait, kneed compass gait, feedback control for simple walking models. Simple running models-spring loaded inverted pendulum (SLIP), Raibert hoppers, swimming and flapping flight.

UNIT-III

Function approximation and system identification, model systems with uncertainty, state distribution dynamics and state estimation

UNIT-IV

Introduction to optimal control, double integrator and pendulum examples, dynamic programming and value integration, grid world, quadratic regulator (Hamilton –Jacobi-Bellman sufficiency), min-time control (pontryagin), open loop optimal control, direct and indirect methods., trajectory stabilization, iterative linear quadratic regulator (ILQR).

UNIT-V

Motion planning: Dijkstra‟s algorithm, A-star algorithm, randomized motion planning, rapidly exploring randomized trees, and probabilistic road maps, feedback motion planning-planning with funnels, linear quadratic regulator (LQR) trees

Suggested Reading:

1. Strogatz steven.H, Non linear Dynamics and Chaos: with applications to physics, biology, chemistry and Engineering, Boulder, CO: westview press, 2001
2. Slotine, Jean-Jacques and Weiping Li, Applied Nonlinear control, Upper Saddle River, NJ, Prentice Hall, 1991

3. Fantoni, Isabelle and Rogelio Lozano, Non linear control for under actuated mechanical systems, Newyork, NY, Springer verlag, 2002
4. Bertsekas, Dimitri , Dynamic Programming and Optimal control 3rd edition, vol I and II Nausha, NH, Athena Scientific, 2007
5. Lavalle steven, Planning Algorithms, New york, NY, Cambridge University Press, 2006

ME 321

MODERN CONTROL SYSTEMS
(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- *Understand the basics of linear and non-linear control systems*
- *Learn the concepts of stability in linear and non linear systems*
- *Understand the concept of phase plane plots and their importance*
- *Learn to apply Lyapunov analysis of linear and non linear systems*
- *Understand the basics of optimal control*

Course Outcomes: *After completion of the course student will be able to*

1. *Differentiate between classical and modern control system and their importance in solving real time problems.*
2. *Determine controllability and observability conditions for multi-input and multi-output systems.*
3. *Understand characteristics of non linear systems and Interpret Phase plane plots for various stability conditions.*
4. *Apply the concepts of Liaponov stability conditions for linear and nonlinear systems.*
5. *To apply the comprehensive knowledge of optimal theory for Control Systems*

UNIT–I: Mathematical Preliminaries:
Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen-values, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous-Time State models.

UNIT-II: State Variable Analysis:
Linear Continuous time models for Physical systems– Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties. General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems – Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model.

UNIT-III: Non Linear Systems:
Introduction – Non Linear Systems – Types of Non-Linearities – Saturation – Dead-Zone – Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization of nonlinear systems, Properties of Non-Linear systems – Describing function–describing function analysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.

UNIT-IV: Stability Analysis:
Stability in the sense of Lyapunov, Lyapunov's stability, and Lypanov's instability theorems – Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method Generation of Lyapunov functions – Variable gradient method – Krasooviski's method. State feedback controller design through Pole Assignment – State observers: Full order and Reduced order.

UNIT-V: Optimal Control:
Introduction to optimal control – Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear Quadratic regulator.

Suggested Readings:

1. Modern Control System Theory by M.Gopal – New Age International -1984
2. Control System Engineering, Nagrath and Gopal – New Age International – Fourth Edition
3. Optimal control by Kirck , Dover Publications
4. Advanced Control Theory A. Nagoor Kani, RBA Publications, 1999
5. Modern Control Engineering by Ogata. K – Prentice Hall – 1997

ME 317

PLANAR MULTIBODY DYNAMICS

(Programme Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Learn the fundamentals of planar kinematics & dynamics*
- *Learn to draw FBD for various mechanical systems*
- *Understand the analysis based on body, joint and point formulation*
- *Understand the effect of contact and impact on the dynamic analysis of systems*
- *Use numerical methods to derive forward and inverse dynamics of dynamic systems*

Course Outcomes: *After completion of the course student will be able to*

1. *Understand the importance of kinematics and dynamics in the analysis of mechanical systems*
2. *Draw free body diagrams for mechanical systems under different loading conditions*
3. *Develop dynamic models for mechanical systems based on Joint, point and body coordinate formulation*
4. *Use numerical methods to solve the dynamics effects in mechanical systems*
5. *Apply numerical methods to analyse various mechanisms*

UNIT-I

Multibody Systems: Introduction, Multibody Mechanical Systems,Types of Analyses, **Fundamentals of Planar Kinematics**: Kinematics of a Particle, Rigid Body, Velocity and Acceleration of a Body, Degrees of Freedom, Constraint Equations, Kinematic Joints,**Fundamentals of Planar Dynamics**: Newton's Laws of Motion, Particle Dynamics, Dynamics of a System of Particles, Rigid body Dynamics, Moment of a Force and Torque, Centroidal Equations of Motion, Noncentroidal Equations of Motion Multibody Dynamics, Applied Forces, Reaction ForcesFriction Force, Wheel and Tire, Motor and Driver, Work and Energy

UNIT -II

Vector Kinematics: Types of Vectors, Open-Chain Systems, Closed-Chain Systems, Slider-Crank Mechanism, Four-Bar Mechanism, Six-Bar Quick-Return Mechanism, Six-Bar Dwell Mechanism, Complete Kinematic Analysis Free-Body Diagram, FBD Examples, Two-Body System (Unconstrained), Two-Body System (Constrained), Sliding Pendulum, Slider-Crank Mechanism, Four-Bar Mechanism, Equations of Motion, Force Analysis, Slider-Crank Mechanism, Four-Bar Mechanism, Generalization of Force Analysis,

UNIT-III

Body-Coordinate Formulation: General Procedure, Kinematic Joints, Revolute (Pin) Joint, Translational (Sliding) Joint, Revolute–Revolute Joint, Revolute–Translational Joint, Rigid Joint, Simple Constraints, Circular Disc, Driver Constraints, System Jacobian, Unconstrained Equations of Motion, Constrained Equations of Motion, Reaction Forces and Lagrange Multipliers, Total Energy, Body coordinate simulation examples: Double A-Arm Suspension, MacPherson Suspension, cart, Conveyor Belt and Friction, Rod Impacting Ground Joint-Coordinate Formulations,

Joint coordinate Formulation: Joint Coordinate and Joint Reference Point, Recursive Kinematics, Open-Chain Systems, Closed-Chain Systems, Cut-Joint Constraints, Equations of Motion, Jacobian Matrix, Initial Conditions, Reaction Forces, Driver Constraint,

UNIT-IV

Point-Coordinate Formulation: Classical Method, Primary and Stationary Points, Constraints, Length angle, simple Constraints, Equations of Motion, Force and Torque Distribution, Mass Distribution, Mass Condensation, Two Primary Points, Three Primary Points, Force and Mass Addition.

Contact and Impact: Piecewise Analysis, Momentum, Impact of Particles, Unconstrained Bodies, Constrained Bodies, Impact with Friction, Continuous Analysis, A Body Contacting a Rigid Surface, Two-Body Contact.

UNIT-V

Kinematics and Inverse Dynamics: Kinematic Analysis, Nonlinear Algebraic Equations **Forward Dynamics**: Unconstrained Formulation, Initial Value Problems, Runge–Kutta Algorithm, General Procedure, Constrained Formulation, Constraint Violation Stabilization Method, Coordinate Partitioning Method, Penalty Method,

Joint-Coordinate Method: Momentum Method, Contact and Impact, Combined Analyses, **Complementary Analyses**: Static Analysis, Static Equilibrium, Initial Condition Correction, Redundant Constraints,

Applications: Film-Strip Advancer, Web-Cutter Mechanism, Six-Bar Quick-Return Mechanism, Six-Bar Dwell Mechanism, Windshield Wiper Mechanism, Double A-Arm Suspension, MacPherson Strut Suspension, Half-Car, Mountain Bike, Creeping Robot,

Suggested Readings:

1. Parviz Nikravesh, Planar Multibody Dynamics, Taylor & Francis, 2nd edition
2. Computational dynamics, Shabana A. A., John Wiley & Sons.
3. Dynamics of multibody systems, Roberson R. E., and Richard S., Springer-Verlag.
4. Dynamics of multibody systems, Shabana A. A., Cambridge University press.
5. Flexible multibody dynamics, Bauchau O. A., Vol. 176. Springer.
6. Dynamics and balancing of multibody systems, Chaudhary H., and S K Saha. Springer

AC 035

STRESS MANAGEMENT BY YOGA
(AUDIT COURSE-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *Creating awareness about different types of stress and the role of yoga in the management of stress.*
- *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
- *Prevention of stress related health problems by yoga practice.*

Outcomes: *Students will be able to*

1. *To understand yoga and its benefits.*
2. *Enhance Physical strength and flexibility.*
3. *Learn to relax and focus.*
4. *Relieve physical and mental tension through Asanas*
5. *Improve work performance and efficiency.*

UNIT-I

Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT–II

Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT-III

Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT-IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar

UNIT-V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati-Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Suggested Reading:

1. "Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or Conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3. Nagendra H.R nad Nagaratna R, "Yoga Perspective in Stress Management", Bangalore, Swami Vivekananda Yoga Prakashan

Online Resources:

https://onlinecourses.nptel.ac.in/noc16_ge04/preview
https://freevideolectures.com/course/3539/indian-philosophy/11

AC 036

PERSONALITY DEVELOPMENT THROUGH LIFE ENHANCEMENT SKILLS (AUDIT COURSE-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives :

- *To learn to achieve the highest goal happily*
- *To become a person with stable mind, pleasing personality and determination*
- *To awaken wisdom in students*

Outcomes: *Upon completing this course, students will be able to:*

1. *Develop their personality and achieve their highest goal of life.*
2. *Lead the nation and mankind to peace and prosperity.*
3. *To practice emotional self regulation.*
4. *Develop a positive approach to work and duties.*
5. *Develop a versatile personality.*

UNIT-I

Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT-II

Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

UNIT-III

Introduction to Bhagavad Geetha for Personality Development - Shrimad Bhagawad Geeta: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT-IV

Statements of basic knowledge - Shrimad Bhagawad Geeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT-V

Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 – Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Suggested Reading:

1.. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.

2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

Web resource:

1. NTPEL:http://nptel.ac.in/downloads/109104115/

AC 037

CONSTITUTION OF INDIA
(AUDIT COURSE-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *The history of Indian Constitution and its role in the Indian democracy.*
- *Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*
- *Have knowledge of the various Organs of Governance and Local Administration.*

Outcomes: *Upon completing this course, students will be able to:*

1. *Understand the making of the Indian Constitution and its features.*
2. *Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.*
3. *Have an insight into various Organs of Governance - composition and functions.*
4. *Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.*
5. *Understand Electoral Process, special provisions.*

UNIT-I

History of making of the Indian constitutions: History, Drafting Committee (Composition & Working). **Philosophy of the Indian Constitution**: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights and Duties Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance": Parliament: Composition, Qualifications, Powers and Functions, Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

UNIT-IV

Local Administration - District's Administration head: Role and importance. Municipalities: Introduction, ayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

UNIT-V

Election commission: Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

Suggested Reading:

1. "The Constitution of India", 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3. M. P. Jain, "Indian Constitution Law", 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

Web Resource:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

With effect from academic year 2021-22

AC038

PEDAGOGY STUDIES
(AUDIT COURSE-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in Developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT-I

Introduction and Methodology:

- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions.
- Overview of methodology and Searching.

UNIT-II

- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

UNIT-III

- Evidence on the effectiveness of pedagogical practices
  Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school
- Curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-IV

- Professional development: alignment with classroom practices and followup support
- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes

UNIT-V

- Research gaps and future directions
- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact

Suggested reading:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of
   Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal
   Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.
7. ww.pratham.org/images/resource%20working%20paper%202.pdf.

ME 353

COMPUTATION LABORATORY FOR A&R

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 50 marks *SEE: 00 marks*
Credits: 1.5

Course Objectives:

- *Learn to use Matlab for solving basic problems*
- *Learn to develop simple applications using matlab and simulink*
- *Learn to use python programming and solve simple problems*
- *Learn to use various matlab tool boxes like robotics tool box, Neural nets tool box, global optimization, control tool box for solving engineering problems*

Course Outcomes: *After completion of the course student will be able to*

1. Ability to perform simulations/ experiment and understand the phenomenon
2. Critically evaluate and interpret the results
3. Prepare a well-organized record

List of Experiments:

Using MATLAB software

1. Evaluate the mathematical expressions in Matlab
2. Write scripts to make the following single-index arrays
3. Basic syntax and command-line exercises, Basic array exercises, Relational and logical operations
4. Control of flow: if-blocks , Loop constructs: for and while
5. Problems on generating various kinds of 2D & 3DPlots
6. Solving ordinary differential equations
7. Solving non-linear algebraic equations
8. Applications of Curve fitting and interpolation
9. Introduction to Simulink
10. Modeling of problems related to kinematics and dynamics of robot using MATLAB

Using Python Software

1. Running Python scripts
2. Using Python as a calculator
3. Computing trigonometric functions, arrays, strings, functions, methods, conditional expressions, loops, lists, modules.
4. Solving problems on statistics
5. Working with data: lists, sorting, tuples, sets, files, comprehensions, dictionaries

*Students are advised to do any 10 experiments

ME 352

DRIVES AND CONTROLS LAB

Instruction: 4 periods per week *Duration of SEE: 3 hours*
CIE: 50 marks *SEE: 00 marks*
Credits: 1.5

Course Objectives:

- *Understand the working principles of various sensors*
- *Learn to write embedded programs using KEIL software*
- *Learn to integrate peripheral devices to 8051 micro controller*
- *Understand the working of hydraulic and pneumatic trainer kits*
- *Learn to develop hydraulic and pneumatics circuits for simple applications*

Course Outcomes: *After completion of the course student will be able to*

1. Ability to perform simulations/ experiment and understand the phenomenon
2. Critically evaluate and interpret the results
3. Prepare a well-organized record

Using 8051 Microcontroller

1. LCD interfacing with 8051MC
2. Interfacing of PMW with DC motor using 8051 MC interface
3. 16 ADC and DAC interfacing with 8051 MC
4. Temperature control using 8051 MC interface
5. Traffic Light control using 8051 MC interface.
6. Servo motor Interfacing with 8051MC
7. Basic Experiments using Use Hydraulic, Pneumatic and Electro-pneumatic circuits

ME 371

MINI PROJECT

Instruction: 6 periods per week *CIE: 50 marks*
Credits: 3

Course Objectives:

- *Understand the purpose of doing mini project*
- *Learn the resources available at the college and outside for pursuing project*
- *Importance of literature review*
- *Learn to select appropriate software and procedure*
- *Learn to document results and arrive at required conclusions*

Course Outcomes: *At the end of the course, the student will be able to*

1. *Identify engineering problems reviewing available literature*
2. *Study different techniques used to analyze complex systems.*
3. *Use related techniques and software's for solving the problem*
4. *Interpret the results and arrive at the relevant conclusions.*
5. *Document the findings as a technical report with proper references*

Guidelines

1. Guide allocation will be done at the beginning of the semester. Identification of mini project work will be done with Guides consultation

2. Mini project presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

3. Evaluation of Mini project will be done by the Departmental Committee. Half of the marks are awarded by the Guide and the remaining half of the marks will be awarded by Departmental Committee.

SEMISTER - III

ME 331

INTERNET OF THINGS (iOT)
(Program Elective – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *DiscussfundamentalsofIoTanditsapplicationsandrequisiteinfrastructure*
- *DescribeInternetprinciplesandcommunicationtechnologiesrelevanttoIoT*
- *Discuss hardware and software aspects of design ingan IoT system*
- *Describe concepts of cloud computing and Data Analytics*
- *Discuss business models and manufacturing strategies of IoT products*

Course Outcomes: *At the end of the course, the student will be able to:*

1. *UnderstandthevariousapplicationsofIoTandotherenablingtechnologies.*
2. *Comprehend various protocols and communication technologies used in IoT*
3. *DesignsimpleIoTsystemswithrequisitehardwareandCprogrammingsoftware*
4. *Understand there levance of cloud computing and data analytics to IoT*
5. *Comprehend the business model of IoT from developing a prototype to launching a product.*

UNIT- I

IoT Introduction and Fundamentals, Deciphering the term IoT, Applications, Benefits/Challenges of deploying an IoT, IoT components: Digital Signal Processing, Data transmission, Choice of channel (wired/wireless), back-end data analysis. Packaging and power constraints for IoT implementation

UNIT- II

Signals, Sensors, Actuators, Interfaces Sensors: types, signal types, shape and strength, Actuator, Sensor non-idealities: Sensitivity and offset drift, noise, minimum detectable signal,, nonlinearity Read-out circuits: Instrumentation-amplifier, SNR definition, noise-bandwidthpower trade-off, Circuit component mismatch and mitigation techniques and Interface (calibration, chopping, auto-zeroing etc.) Power/energy considerations, Basic signal processing (filtering, quantization, computation, storage)

UNIT- III

Networking and Cloud Computing in IoT Review of Communication Networks, Challenges in Networking of IoT Nodes, range, bandwidth Machine-to-Machine (M2M) and IoT Technology Fundamentals, Medium Access Control (MAC) Protocols for M2M Communications Standards for the IoT, Basics of 5G Cellular Networks and 5G IoT Communications, Low-Power Wide Area Networks (LPWAN) Wireless communication for IoT: channel models, power budgets, data rates, IoT Security and Privacy, MQTT Protocol, Publisher and Subscriber Model, Cloud computing platform (open source) and local setup of such environment, Embedded software relevant to microcontroller and IoT platforms (enterprise or consumer), user interfaces

UNIT- IV

Data Analysis for IoT applications Statistics relevant to large data Linear regression Basics of clustering, classification

UNIT- V

Thingsboard and Arduino: microcontroller with wireless enabled peripheral – interfacing of sensors, communicating data to a local server, fusion at the server, sending actuator signals from the server, simple audio/speech processing on DSP or Raspberry Pi

Suggested Reading:

1. *Internet of Things* – Converging Technologies for smart environments and Integrated ecosystems, RiverPublishers.
2. *DesigningtheInternetofThings*,AdrianMcEwen(Author),HakimCassimally.WileyIndia Publishers
3. *Fundamentals of embedded software* **:** where C meets assembly by Daneil Wlewies, Pearson.
4. *Internet of things*- Ahandson Approach, Arshdeep Bahga, Universities press.
5. Internet of Things and its Applications by Prof. Satish Jain and Shashi Singh

ME 329

NONLINEAR DYNAMICS AND CHAOS

(Program Elective – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the concept of autonomous and non-autonomous systems*
- *Learn to solve one dimensional and two dimensional bifurcations*
- *Learn to develop chaotic maps*
- *Understand the concept of fractals in dynamic systems*
- *Understand the effect of these non-linear dynamics in mechanical systems*

Course Outcomes: *At the end of the course, the student will be able to:*

1. *Understand the concept of stability related linear and non-linear systems andidentify the basic classes of nonlinear systems.*
2. *Understand the concept of a bifurcation and bifurcation diagrams and be familiar with the most common types of bifurcations*
3. *Specify how and why a dynamical system becomes chaotic*
4. *Develop chaotic solutions for continues systems*
5. *Determine numerical solutions for dynamic systems using various methods*

UNIT-I:

Introduction to dynamical systems: Discrete time systems-continuous time systems-autonomous and nonautonomous systems-phase space and flows-attracting sets-concepts of stability-fixed point-limit cycle

UNIT-II:

Local and global bifurcations- static and dynamic bifurcation- bifurcation of maps. Types of bifurcation- Chaos-period doubling-quasiperiodic and intermittency routs to chaos. Quasiperiodic solutions: Poincare' maps-circle map

UNIT-III

Chaotic solutions of maps, Chaotic solutions of continuous systems, period doubling and intermittency mechanisms.

UNIT-IV:

Fractals and dynamical systems: Fractal dimension-measures of fractal dimension-Tools to identify and analyze motions-Fourier spectra- Poincare' sections and maps- Lyapunov exponents. Computational aspects-Numerical integration-cell mapping-Galerkin-Harmonic Balancing-Shooting method-parameter continuation and path following

UNIT-V

Applications to mechanical systems-gear with backlash, Clutch springs-bearings, buckled beams etc.

Suggested Readings

1. Ali H. Nayfeh and B Balachandran, Applied nonlinear dynamics, John Wiley & Sons
2. Thomson, J M T and Stewart, H B, Nonlinear dynamics and chaos, John Wiley & Sons
3. Francis C.Moon, Chaotic and Fractal dynamics, John Wiley & Sons
4. S.H.Strogatz, Nonlinear dynamics and chaos, Perseus books publishing, LLC, 2000

ME 327

MACHINE LEARNING APPLICATIONS

(Program Elective – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the importance of data preparation & management in Machine learning applications*
- *Learn the basics of various statistical tools required in machine learning*
- *Learn to solve using regression and clustering techniques*
- *Learn to use concept of ANN and CNN for solving problems*
- *Learn to use ML and DL for mechanical applications*

Course Outcomes: *At the end of the course, the student will be able to:*

1. *Distinguish between supervised and unsupervised problem statements*
2. *Compare and contrast various Machine Learning and Deep Learning algorithms*
3. *Apply the concepts of Supervised & Unsupervised Learning to obtain the required results*
4. *Evaluate the importance of different algorithms used for Machine & Deep learning*
5. *Apply the concepts of ML and DL to the real-time data for mechanical applications and arrive at the required results.*

UNIT I

Data Preparation: Introduction, types of data, Data preparation -Data selection, Data Pre-processing-Formatting,cleaning and sampling, Data Transformation-Scaling, Decomposition and Aggregation. **Regression:** Linear regression, Logistic regression, Multiple regression, Stepwise, overfitting, Regularization

UNIT II

Supervised Learning:Gradient Descent, Bias and VarianceSupport Vector Machine: Hyperplanes, Kernels, Regularization, Large margin classification

UNIT III

Unsupervised learning: Clustering, k-means algorithm, Principal Component Analysis, Missing Data, choosing clusters

UNIT IV

Neural Networks: Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, Overfitting, learning network structure. Shallow neural networks, problems with shallow networks, importance of Deep Learning, key concepts in Deep Learning, Practical Considerations of Deep neural networks: hyper parameter tuning, initialisation, regularisation, gradient checking, optimisation algorithms, Convolutional Neural Networks, step by step procedure, Recurrent Neural Networks- step by step procedure, ALEXNET, Autoencoders

UNIT V

Mechanical Applications of Machine Learning: ANOVA Analysis of manufacturing processes like forming, welding, Abrasive machining, Condition Monitoring of rotary and reciprocating equipment, Condition monitoring of wind turbine, bearing fault diagnostics, Automatic car detection,

Suggested Readings:

1. Tom Mitchell, *Machine Learning*, McGraw Hill
2. Ian Good fellow, Yoshua Bengio, and Aaron Courville, Deep Learning
3. Christopher M. Bishop, Pattern Recognition and Machine Learning
4. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning
5. Kevin Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press
6. Richard Sutton and Andrew Barto, *Reinforcement Learning: An Introduction*, MIT Press.
7. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems

ME 318

OPTIMISATION OF ENGINEERING DESIGN
(Program Elective – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Learn to classify and formulate optimization problems*
- *Understand the importance on unconstrained minimization*
- *Learn to use various direct and indirect optimization methods*
- *Learn to optimize various mechanical components with respect parameters like cost, weight*
- *Learn to use optimization for springs and absorbers*

Course Outcomes: *At the end of the course, the student will be able to:*

1. *Understand the definition of parameter optimization.*
2. *Importance of Karush-Kuhn-Tucker Necessary Conditions for Optimality*
3. *Distinguish between various classes of optimization: parameter vs functional, univariate vs. multivariate, linear vs. nonlinear, constrained vs. unconstrained, primal vs. dual, and scalar vs. vector.*
4. *Comprehend the concepts of design variables, objective and constraint functions, local vs. global optima, direct and indirect methods of optimization, penalty functions and Lagrange multipliers*
5. *Apply non-gradient methods, including genetic algorithms and response surface methods, appropriately to engineering design problems.*

UNIT- I

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints, classification of optimization problems. Single and multivariable optimization techniques (structural, size, shape, topology optimisation)

UNIT- II:

Technique of unconstrained minimization. Golden section, Random, Pattern and Gradient search methods, interpolation methods, equality and inequality constraints.Direct methods and indirect methods using penalty function, Lagrange multipliers.

UNIT-III:

EvolutionaryOptimisation Techniques (single and multi) : **Genetic algorithms**: introduction, terminology, features, representation, mutation, crossover, selection mechanism, applications,**Differential Evolution Algorithm**: introduction, terminology, initialisation, mutation, crossover/recombination, selection, examples and applications of NSGA II and NSGA III algorithms, **Artificial Immune Optimisation**: Bioloical Immune systems, immunity, antigens, innate immunity, adaptive immunity, immune network model, negative selection algorithm, clonal selection algorithm, danger theory, Applications.

UNIT-IV:

Swarm Optimisation techniques (single and Multi) **: Particle Swarm Optimisation**: introduction, terminology, fitness function, updation of global best, applications, **Ant Colony Optimisation**: introduction, features, terminology, fitness function, evaluation of fitness function, applications, **Grey Wolf Optimisation**: Wolf behaviour, social behaviour, hunting

behaviour, Algorithm development, encircling prey- its mathematical model, hunting, applications **Spider monkey Optimisation**: introduction, fusion -fision swarm, initialisation, local leader phase, global leader phase, learning of local and global phase, local and global leader decision phase, applications, **Bacterial Foraging Optimisation**: foraging theory, optimal foraging, run/swim and tumble, decision making in foraging, chemotaxis, swarming, reproduction, elimination and dispersion, examples.

UNIT-V:

Engineering applications, structural-design application axial and transverse loaded members for minimum cost, maximum weight. Design of shafts and torsion members, design optimization of springs.

Dynamics applications for two-degree freedom system. vibration absorbers. Application in mechanisms.

Suggested Textbooks:

1. Engineering Optimization -Theory and Practice/ Singerusu S. Rao/ New Age.
2. Optimum Design of Mechanical elements/ Johnson Ray C/ Wiley, John & Sons
3. Genetic Algorithms in search, Optimization and Machine/ Goldberg D. E. Addison/Wesley / NewYork.
4. Optimization for Engineering Design Algorithms and Examples/ Kalyanamoy Deb/Prentice Flail of India.
5. Introduction to Optimum Design/Jasbir S. Arora/ Academic Press/ Everest/ 3rd Edition.
6. P. Y. Papalambros, Principles of optimal design, Cambridge University Press, 2000
7. O. de Weck and K. Willcox, Multidisciplinary System Design Optimization, MIT lecture note, 2003

ME 312

ROTOR DYNAMICS
(Program Elective – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understand the fundamentals of vibrations under free and forced vibrations*
- *Learn to determine mode shapes and critical speeds*
- *Learn to solve multi degree systems using various methods*
- *Learn to determine torsional vibrations in rotary machinery*
- *Understand the effect of rotor placed in fixed rotors, rotor with overhangs and flexible supports*

Course Outcomes: *At the end of the course, the student will be able to:*

1. *Understand the fundamentals of free and damped vibrations*
2. *Importance of Eigen values determination, and critical speeds determination*
3. *Solve multi degree freedom systems using various methods*
4. *Determine the causes and effects of vibrations in torsional vibration systems*
5. *Determination of effects of vibrations for rotating bodies due to various supports*

UNIT-I

Single degree of freedom system – Free vibrations. Damped vibrations and forced vibrations, Two degree of freedom systems – Undamped vibration, absorbers, Forced Damped vibrations, Vibration isolation.

UNIT-II

Close coupled systems – Eigenvalue problem. Orthogonality of mode shapes. Modal analysis Critical speeds.

UNIT-III

Vibrations of multi rotor systems – Matrix method, Influence coefficient methods, Transfer matrix analysis and Holzers method.

UNIT-IV

Torsional vibrations in rotating machinery – Equivalent discrete system, transient response, branched system.

UNIT-V

Out-of-rotors in rigid supports, simply supported rotor with overhangs. Gyroscopic effects. Rotor mounted on fluid film bearings – Transfer matrix analysis of turbine rotor by distributed elements, Dual rotor system analysis. Balancing of rotors.

Suggested Reading:

1. J.S. Rao, *Rotor dynamics*.
2. J.S. Rao, K. Gupta, *Mechanical Vibration*

ME 328

VIRTUAL REALITY/AGUMENTED REALITY SYSTEMS

(Program Elective – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Learn the basics of VR and AR*
- *Learn how to build objects in Unity IDE*
- *Learn to build controllers in Unity IDE*
- *Learn to build environment in Unity IDE*
- *Learn to generate animated walk in Unity IDE*

Course Outcomes: *At the end of the course, the student will be able to:*

1. *Differentiate Virtual and Augmented Realities.*
2. *Understand Virtual reality concepts.*
3. *Develop VR applications using Unity3D.*
4. *Move around the 3D world.*
5. *Run Unity 3D application in VR on a smart phone*

UNIT-I:

Introduction To Virtual Reality : Virtual Reality – Types – Virtual Reality Vs Augmented Reality – Applications – Technical skills required

UNIT-II:

Building Simple Scenes: Introduction to Unity IDE – Objects and Scale – Creating a simple diorama – VR Device integration

UNIT-III:

Gaze Based Control: First person Controller – Third person controller – Navigation in VR application – World space User Interface

UNIT-IV:

Physics & Environment:Physics component – physics materials – Raycast – particle effects

UNIT -V:

Walk-Throughs: Assembling scenes – Adding photos – Animated walkthrough – optimizing for performance – Using all 360 degrees

Suggested Textbooks

1. 1.Tony Parisi, Learning Virtual Reality, O'Reilly Media, 2016
2. Jason Jerald, The VR Book – Human Centered Design for Virtual Reality, Morgan & Claypool, 2015
3. John Williamson, Charles Palmer, Virtual Reality Blueprints: Create compelling VR experiences for mobile and desktop, Packt Publishing, 2018

OE 941

BUSINESS ANALYTICS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *Understanding the basic concepts of business analytics and applications*
- *Study various business analytics methods including predictive, prescriptive and prescriptive analytics*
- *Prepare the students to model business data using various data mining, decision making methods*

Outcomes: *Upon completing this course, students will be able to:*

1. *To understand the basic concepts of business analytics*
2. *Identify the application of business analytics and use tools to analyze business data*
3. *Become familiar with various metrics, measures used in business analytics*
4. *Illustrate various descriptive, predictive and prescriptive methods and techniques*
5. *Model the business data using various business analytical methods and techniques*

UNIT-I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT-II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

UNIT-III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT-IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. **Clustering**: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics**- Linear Programming(LP) and LP model building,

UNIT-V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

Suggested Reading:

1. Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015
3. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2. https://nptel.ac.in/courses/110105089/

OE942

INDUSTRIAL SAFETY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Causes for industrial accidents and preventive steps to be taken.*
- *Fundamental concepts of Maintenance Engineering.*
- *About wear and corrosion along with preventive steps to be taken*
- *The basic concepts and importance of fault tracing.*
- *The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry*

Course Outcomes:

1. *Identify the causes for industrial accidents and suggest preventive measures.*
2. *Identify the basic tools and requirements of different maintenance procedures.*
3. *Apply different techniques to reduce and prevent Wear and corrosion in Industry.*
4. *Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.*
5. *Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc*

UNIT-I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

UNIT–II

Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT–III

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

UNIT–IV

Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

UNIT–V

Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Suggested Reading:

1. H. P. Garg, "Maintenance Engineering", S. Chand and Company
2. Audels, "Pump-hydraulic Compressors", Mcgraw Hill Publication
3. Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
4. Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London

OE 943

OPERATION RESEARCH
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Introduce the concepts of optimization techniques*
- *Formulation of LPP models*
- *Basic concepts of Non-linear programming, Dynamic programming, Game theory are introduced.*

Course Outcomes: *Upon completing this course, students will be able to:*

1. T*o apply the dynamic programming to solve problems of discreet and continuous variables.*
2. *Aapply the concepts of non-linear programming*
3. *Carry out sensitivity analysis*
4. *Model the real world problems and simulate it.*
5. *Apply graph theory, competitive models, and game theory simulations.*

UNIT I

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT II

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT IV

Scheduling and sequencing - single server and multiple server models deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT V

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Suggested Reading::

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

OE 944

COST MANAGEMENT OF ENGINEERING PROJECTS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- Introduce the concepts of cost management, inventory valuation , decision making
- Fundamentals of cost overruns, project execution and technical activities
- Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM

Outcomes:

1. Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
2. Ability to appreciative detailed engineering activities of the project and execution of projects
3. Preparation of project report and network diagram
4. Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
5. Applications of various quantitative techniques for cost management

UNIT I

Introduction and Overview of the Strategic Cost Management Process-Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System- Inventory valuation- Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning- Project execution as conglomeration of technical and non- technical activities- Detailed Engineering activities.

UNIT III

Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT IV

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems- Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector-Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints- Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control;

Flexible Budgets- Performance budgets- Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V

Quantitative techniques for cost management, Linear Programming, PERT/CPM,- Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Reading :

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OE 945

COMPOSITE MATERIALS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To understand the fundamentals of composite materials and the role of matrix and reinforcement.*
- *To know the principles of manufacturing composite*
- *To understand the strength and failure criteria of lamina and laminate.*

Outcomes :

1. *Define a composite, identify the matrix and reinforcement and highlighting the features and application of different composite materials.*
2. *Classify composites and illustrate the mechanical behavior of composites and predict properties using micromechanics principles*
3. *Illustrate the manufacturing of metal matrix composites and outline the properties and applications*
4. *Illustrate the manufacturing of polymer matrix composites and outline the properties and applications.*
5. *Apply various failure criteria to assess the strength of lamina and laminates.*

UNIT-I

Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT-II

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT-III

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT-IV

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT-V

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight

strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Suggested Reading:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. Hand Book of Composite Materials-ed-Lubin.
4. Composite Materials – K.K.Chawla.
5. Composite Materials Science and Applications – Deborah D.L. Chung.
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi

OE 946

WASTE TO ENERGY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To know the various forms of waste*
- *To understand the processes of Biomass Pyrolysis.*
- *To learn the technique of Biomass Combustion*.

Outcomes: *Upon completing this course, students will be able to:*

1. *Understand the concept of conservation of waste.*
2. *Identify the different forms of wastage.*
3. *Chose the best way for conservation to produce energy from waste.*
4. *Explore the ways and means of combustion of biomass.*
5. *Develop a healthy environment for the mankind.*

UNIT-I:

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT-II:

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III:

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV:

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V:

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Reading:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

ME 381

MAJOR PROJECT PHASE I

Instruction: 20 periods per week *Duration of SEE: 3 hours*
Credits: 10 *CIE: 100 marks*

Course Objectives:

- *Understand the purpose of Project work*
- *Learn the resources available at the college and outside for pursuing project*
- *Importance of literature review*
- *Learn to select appropriate software and procedure*
- *Learn to document results and arrive at required conclusions*

Course Outcomes: *At the end of the course, the student will be able to:*

1. *Identify suitable engineering problems reviewing available literature.*
2. *Study different techniques used to analyze complex systems.*
3. *Use related techniques and software's for solving the problem*
4. *Interpret the results (if available) and defend work in front of technically qualified audience*
5. *Document the findings as a technical report with proper references*

Guidelines

1. The Major Project Phase-I Work should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M.E.
3. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The work has to be presented in front of the examiners panel set by Head and Faculty Advisor
6. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

SEMISTER - IV

ME 382

MAJOR PROJECT PHASE II

Instruction: 32 periods per week *SEE: 200 marks*
Credits: 16

Course Objectives:

- *Understand the purpose of doing project work*
- *Learn the resources available at the college and outside for pursuing project*
- *Importance of literature review*
- *Learn to select appropriate software and procedure*
- *Learn to document results and arrive at required conclusions*

Course Outcomes: *At the end of the course, the student will be able to:*

1. *Use different Simulation models /experimental techniques/ software/ computational /analytical tools.*
2. *Design and develop Simulation model/Mathematical model/ experimental set up/ equipment/ testrig.*
3. *Conduct tests and draw logical conclusions from the results after analyzing them.*
4. *Work in either in research environment or in an industrial environment and Conversant with technical report writing.*
5. *Present and defend their work to the evaluation committee.*

Guidelines

1. It is a continuation of Major Project Phase I work started in semester III.
2. The project work should be presented in standard format as provided by the department.
3. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) adopted & Result analysis.
4. The report must bring out the conclusions of the work and future scope for the study and also should be properly referenced.
5. Student has to submit the report in prescribed format and also present a seminar.
6. Student should present a Seminar in front of Internal committee consisting of Head, CBoS, Guide, Subject expert, Faculty Advisor. Further the suggestions of the committee have to be incorporated in the final Report.
7. The final work has to be presented in front of the examiners panel consisting of an approved external examiner and a guide, co-guide etc. as decided by the Head and Faculty advisor.
8. The candidate has to be in regular contact with his guide.