Rajiv Gandhi Institute of Technology

(Govt. Engineering College ,Kottayam)

WHO CAN APPLY?

Degree (B. Tech or BE) in Mechanical / Automobile /Production / Production cum Plant/ Industrial / Mechanical stream Automobile / Mechanical stream Production / Electrical & Electronics / Mechatronics Engineering

Department of Mechanical Engineering

M. Tech
Engineering Design

Intake Seats 9

Course Highlights

The Curriculum includes Courses like Product Design, FEM, CFD , Optimistaion, Electric and Hybrid Vehicle Design, Control System and Vehicle Dynamics, Product Design and Product Testing Lab Sessions

Lab Facilities

Fab Lab | Product Design Lab | Ergonomics Lab | CAD Lab | Advanced Machine Tool Lab | Dynamics Lab

Software Available

Catia V5 , Ansys, Hyperworks, Solid Works, 3D Experience, Jack, MATLAB

About the course

Engineering Design at RIT is an interdisciplinary course with specific focus on form design and functional design, with domain expertise. The curriculum for the program is designed to ensure that the student gets a well-rounded education to meet the requirements of the industry with emphasis on both domain specialization and skill development. The programme gives special thrust to domains such as electric vehicle design, energy harvesting and thermal management of electronic systems .Our design partners in this thrust area includes Enfost Design Bangalore and Nhanz Systems Bangalore. Along with top class design and development facilities we have a strong design group in RIT consisting of a vibrant multi-disciplinary team of Alumni, Students, Faculty and Staff. The department promotes practice based learning, and works with their students to take live industrial problems as mini projects and main projects. Internship is made mandatory to develop student's core competencies to understand the real-life engineering problems and their solution strategies. The Design team has helped to shape the careers of engineering graduates in elite organizations such as Enfost Design, Nhanz Systems, V-Guard, Mercedes-Benz, Tata Advanced Materials, etc. Experience the joy of design with us...

Faculty
with 15+ years of Experience

Industry Tie-Ups

1. MoU with Enfost Design, Bangalore
2. Nhanz Systems Pvt ltd, Bangalore
3. RUBCO Pampady
4. TryCAE Industrial Engineering Pvt Ltd,Trichy

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APJ Abdul Kalam Technological University

Cluster 4: Kottayam

M. Tech Program in Mechanical Engineering (Engineering Design)

Scheme of Instruction and Syllabus: 2020 Admissions

Compiled By

Rajiv Gandhi Institute of Technology, Kottayam

November 2020

SCHEME AND SYLLABI FOR M.TECH DEGREE WITH SPECIALIZATION IN ENGINEERING DESIGN

Credit requirements : 67 credits (22+19+14+12)
Normal Duration : Regular: 4 semesters; External Registration: 6 semesters;
Maximum duration : Regular: 6 semesters; External Registration: 7 semesters.
Courses: Core Courses: Either 4 or 3 credit courses; Elective courses: All of 3 credits

ELIGIBILITY: B.Tech/B.E in Mechanical/Automobile/Production/Production cum Plant/Industrial/Mechanical stream Automobile/Electrical and Electronics/Mechatronics Engineering with 60 % Marks.

Allotment of credits and examination scheme: -

Semester 1: (Credits: 22)

SEMESTER-I

Exam Slot	Course Code:	Name	L- T - P	Internal Marks	End Sem. Exam		Credits (22)
					Marks	**hrs**	
A	04 ME 6601	Applied Mathematics for Engineering	3-0-0	40	60	3	3
B	04 ME 6603	Vibration Analysis & Control	3-1-0	40	60	3	4
C	04 ME 6605	Advanced Mechanics of Solids	3-1-0	40	60	3	3
D	04 ME 6607	Product Design & Development	3-0-0	40	60	3	4
E	04 ME 66XX	Elective1	3-0-0	40	60	3	3
	04 GN 6001	Research Methodology	1-1-0	100	0	0	2
	04 ME 6691	Seminar-I	0-0-2	100	0	0	2
	04 ME 6693	Product Design Lab	0-0-2	100	0	0	1
		Total	23				22

SEMESTER-II

A	04 ME 6602	Finite Element Method	3-1-0	40	60	3	4
B	04 ME 6604	Modeling and Control of Engineering Systems	3-0-0	40	60	3	3
C	04 ME 6606	Design for Manufacturing and Assembly	3-0-0	40	60	3	3
D	04 ME 66XX	Elective 2	3-0-0	40	60	3	3
E	04 ME 66XX	Elective 3	3-0-0	40	60	3	3
	04 ME 6692	Mini Project	0-0-4	100	0	0	2
	04 ME 6694	Product Analysis and Testing Lab	0-0-2	100	0	0	1
		Total	21				19

SUMMER BREAK

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Sem. Exam		Credits (0)
					Marks	**hrs**	
	04 ME 7690	Industrial Training	0-0-4				Pass/ Fail

SEMESTER-III

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Sem. Exam		Credits (14)
					Marks	**hrs**	
A	04ME 764X	Elective 4	3-0-0	40	60	3	3
B	04ME 765X	Elective 5	3-0-0	40	60	3	3
	04 ME 7691	Seminar-II	0-0-2	100	0	0	2
	04 ME 7693	Project (Phase I)	0-0-12	50	0	0	6
		Total	20				14

SEMESTER-IV

Exam Slot	Course No:	Name	L- T - P	Internal Marks	External Evaluation	Credits (12)
					Marks	
	04 ME 7694	Project (Phase II)	0-0-21	70	30	12

ELECTIVE LIST

ELECTIVE GROUP	Course No:	Name
1	04 ME 6609	Mechatronics in Manufacturing Systems
	04 ME 6611	Design of Hydraulic and Pneumatic Systems
	04 ME 6613	Engineering Optimization
	04 ME 6615	Bearing Design and Rotor Dynamics
2	04 ME 6608	Design and Analysis of Energy Systems
	04 ME 6612	Design Automation with IoT
	04 ME 6614	Advanced Fluid Mechanics and Heat transfer
	04 ME 6616	Measurement & Instrumentation Engineering
3	04 ME 6618	Mechanical Behavior of Materials
	04 ME 6620	Experimental Stress Analysis
	04 ME 6622	Engineering Fracture mechanics
	04 ME 6624	Composite Materials and Mechanics
4	04 ME 7601	Micro-Electro Mechanical Systems
	04 ME 7603	Computational Fluid Mechanics
	04 ME 7605	Vehicle Dynamics
	04 ME 7607	Design of Material Handling Equipment
5	04 ME 7609	Rapid Prototyping and Tooling
	04 ME 7611	Electric and Hybrid vehicles
	04 ME 7613	Modal Analysis of Mechanical Systems
	04 ME 7615	Industrial Robotics and Expert Systems

SEMESTER I

04 ME 6601-Syllabus

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Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6601	**Applied Mathematics for Engineering Design**	3-0-0	3	2020

Prerequisite: Under-graduate courses of Mathematics

Course Objectives: The main objectives of this course are

1. To gain knowledge about different types of Partial Differential Equations
3. To understand the basics of calculus of variation
4. To learn the concepts of Fast Fourier Transform.

Syllabus:

Computational methods in engineering, Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE, Tensor analysis, Summation convention – Contra variant and covariant vectors, Calculus of variation, Variation and its properties – Euler's equation – functionals dependent on first and higher order derivatives, Fast Fourier Transform, Variation and its properties – Euler's equation – functionals dependent on first and higher order derivatives

Expected outcome: The student will be able to

1. Understand various numerical methods to solve boundary value problems involving both ODE and PDE, compare the efficiency of different methods.
2. Express tensors using summation convention and classification of these, learn tensor algebra and calculus.
3. Solve problems with moving boundaries using Ritz and Kantrovich methods
4. Understand the computational algorithms that are used to transform a signal to its discrete Fourier transform (DFT) and measure the computational efficiency of such algorithms.

Text Books:

1. Grewal, B.S., Higher Engineering Mathematics, 40th edition, Khanna Publishers, 2007.

References:

1. James, G., Advanced Modern Engineering Mathematics, 3rd edition, PearsonEducation,2004.
2. Grewal, B.S., Numerical methods in Engineering and Science, 7th edition, Khanna Publishers, 2005.
3. Gupta, A.S., Calculus of variations with applications, Prentice-Hall of India, New Delhi, 1997.
4. O'Neil, P.V., Advanced Engineering Mathematics, Thomson Asia Pvt. Ltd., Singapore, 2003.
5. Andrews, L.C. and Philips, R. L. Mathematical Techniques for Engineers and Scientists, Prentice Hall of India, 2006.

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks;(%)**
Module 1 Computational methods in Engineering: Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace's and Poisson equation.	7	9 (15)
Module 2 Liebmann's iteration process– Solution of heat conduction equation by Schmidt explicit formula and Crank-Nicolson implicit scheme – Solution of wave equation	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Tensor Analysis: Summation convention – Contra variant and covariant vectors – contraction of tensors– inner product – quotient law – metric tensor – Christoffel symbols – covariant differentiation – gradient, divergence and curl	7	9 (15)
Module 4 Calculus of variation: Variation and its properties – Euler's equation – functionals dependent on first and higher order derivatives	7	9 (15)
SECOND INTERNAL TEST		
Module 5 functionals dependent on functions of several independent variables – problems with moving boundaries – direct methods – Ritz and Kantorovich methods.	7	12 (20)
Module 6 Fast Fourier Transform: Variation and its properties – Euler's equation – functionals dependent on first and higher order derivatives sampled Fourier series – Approximation of Fourier transform by an N-point DFT – Computational efficiency of FFT	7	12 (20)

04 ME 6603 – Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6603	**Vibration Analysis and Control**	3-1-0	4	2020

Prerequisite: Under-graduate courses in Mathematics and basic Physics

Course Objectives: The main objectives of this course are

1. To formulate a vibratory model of a physical situation and classify it.
2. To learn to apply various vibrational control methods.
3. To be aware of the experimental methods in vibration analysis.

Syllabus:

Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration-Free Vibration of Undamped and Damped- Forced Vibration with Harmonic Excitation System-Multi Degree Freedom System –Influence Coefficients and stiffness coefficients-Transient vibrations Continuous systems Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring Tool-Vibration Analysis Overview - Experimental Methods in Vibration Analysis.

Expected outcome: The student will be able to

1. Formulate a mathematical model for a vibratory system
2. Analyse the vibratory model of m. d. o. f systems.
3. Device vibration control procedures for simple systems.
4. Describe the experimental methods in vibration analysis.

Text Books:

1. Rao, S.S.,” Mechanical Vibrations,” Addison Wesley Longman, 1995.
2. Thomson, W.T. – “Theory of Vibration with Applications”, CBS Publishers and Distributors, New Delhi, 1990.

References:

1. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa, New Delhi, 2000.
2. S. Graham Kelly & Shashidar K. Kudari, “Mechanical Vibrations”, Tata McGraw–Hill Publishing Com. Ltd New Delhi,2007.
3. Grover G K,” Mechanical Vibrations”, Nem Chand and Bros,2009

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks; (%)**
Module 1 Introduction -Sources of Vibration-Mathematical Models- Review of Single Degree Freedom Systems - Types of damping and damping materials Free and forced vibrations, rotating unbalance, base excitation**.**	10	9 (15)

Module 2 Two degree of freedom systems-Normal mode vibration-Principal co-ordinates-Coordinate coupling. Multi Degree Freedom System – Influence Coefficients and stiffness coefficients-Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors	9	9 (15)
FIRST INTERNAL TEST		
Module 3 Multi degree of freedom systems -Numerical Methods -Dunkerley, Rayleigh's, Matrix Iteration Method –Introduction to Continuous System: Vibration of String, Shafts and Beams	9	9 (15)
Module 4 Critical speeds of shafts -whirling of shafts, Response **t**o Arbitrary and non- harmonic excitations – Transient Vibration –Impulse loads Transient vibrations Introduction to Nonlinear Vibrations	9	9 (15)
SECOND INTERNAL TEST		
Module 5 Vibration control: Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber- Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing – Vibration Control by Design Modification- - Active Vibration Control.	10	12 (20)
Module 6 Experimental Methods in Vibration Analysis. -Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. – Vibration Exciters-Mechanical, Hydraulic, Electromagnetic and Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes.	9	12 (20)

04 ME 6605 – Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6605	Advanced Mechanics of Solids	3-1-0	3	2020

Prerequisite: Under-graduate courses in Engineering Mechanics

Course Objectives: The main objectives of this course are

1. To formulate analytical solution for the stress-strain for a general geometry.
2. To learn the basics of a contact stress problem.
3. To introduce the concepts of plasticity.

Syllabus:

Introduction to Three-Dimensional Theory of Elasticity,2-D problem Plane stress , Plane strain and axi-symmetric problem, Methods of solving 2-D problems Shear stress distribution and Shear centre for thin walled open sections , shear centre, torsion of prismatic shaft, theories of failure, and their Applications, Energy Methods and theorem.

Expected outcome: The student will be able to

1. Solve plane stress problems and axi-symmetric problems
2. Compute shear stress distribution in sections and locate the shear centre
3. Solve torsion problems in prismatic shafts and thin walled structures
4. Apply theories of failure according to situations
5. Apply energy methods for calculating deflections

Text Books:

1. S. Timoshenko & J.W. Goodier, “Theory of Elasticity”, McGraw Hill, 2007.

References:

1. Den Hartog, “Advanced Strength of Materials”, McGraw Hill, 1952.
2. Seely and Smith, “Advanced Mechanics of Materials”, John Wiley, 1952.
3. Filonenko & Borodic, “Theory of Elasticity”, Foreign Languages Publishing House, 1965.
4. Fluggue. W, “Handbook of Engineering Mechanics”, McGraw Hill, 1962.
5. L S Sreenath,” Advanced Mechanics of Solids”, McGraw Hill, 2010

COURSE PLAN

MODULES	Contact hours	Sem. Exam Marks (%)
Module 1 Introduction to Three-Dimensional Theory of Elasticity: Plane stress, Plane strain problems and axi symmetric problems, differential Equations of equilibrium, strain-displacement relations in cartesian and polar co-ordinates, Boundary conditions, Compatibility conditions	10	9 (15)
Module 2 Airy’s Stress function, Biharmonic equation, Saint Venant’s principle, applications to Polynomials in rectangular coordinates - cantilever with point load at free end.	9	9 (15)

FIRST INTERNAL TEST		
Module 3 Stress distribution in thick cylinder, shrink fitting, rotating disc, Solid disc and disc with a central hole. Stress concentration problem, Shear centre: Shear stress distribution and Shear centre for thin walled open sections. Computation of shear centre	10	9 (15)
Module 4 Torsion of prismatic shafts, Warping, Stress function method - Membrane analogy, Torsion of bars with elliptical, square and rectangular cross section.	9	9 (15)
SECOND INTERNAL TEST		
Module 5 Theories of Failure, and their Applications, Griffith Theory of Brittle Fracture. Application of Griffith theory. Bending of curved beam	9	12 (20)
Module 6 Energy Methods –Strain energy of linear elastic deformation Energy Theorems, Principal of virtual work. Use of energy theories for calculating deflections, twists	9	12 (20)

04 ME 6607 - Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6607	**Product Design & Development**	3-0-0	4	2020

Prerequisite: An under-graduate course in Design & Engineering

Course Objectives: The main objectives of this course are

1. To encourage students to develop environment friendly products for satisfying societal needs.
2. To equip with practical knowledge in design and development of new products.
3. To familiarize concepts and tools related to product design, development and quality assessment.

Syllabus:

Importance of Engineering design, Steps in Product design, designing for customer needs and satisfaction, designing for societal needs, Creative thinking for product development, Industrial design, Cost evaluation, Design for reliability, Quality aspects of design, use of Quality tools.

Note: Assignment shall preferably be based on a product design and development

Expected outcome: The student will be able to

1. Describe the types of design, the design process and the different phases of product development.
2. Create product design specifications.
3. Do cost evaluation and activity-based costing.
4. Apply creative process techniques in synthesizing information, problem-solving and critical thinking
5. Incorporate the aspect of reliability in product design

Reference books

1. George E. Dieter, Linda C. Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9
2. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development “, 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9
3. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint 2004, Pearson Education, ISBN 9788177588217
4. Fundamentals of Quality control and improvement 4th edition, Amitava Mitra, Wiley, 2016.
5. Clive L. Dym, Patrick Little, “Engineering Design: A Project-based Introduction”, 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
6. Patrick D. T. O’Connor, “Practical reliability Engineering “, 4 th Edition, 2006, Wiley India Pvt Ltd.

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COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks; (%)**
Module 1 Need for developing products – the importance of engineering design – types of design –the design process – relevance of product life-cycle issues in design –designing to codes and standards- societal considerations in engineering design-generic product development process – various phases of product development-planning for products –establishing markets-market segments- relevance of market research.	7	9 (15)
Module 2 Identifying customer needs –voice of customer – Concept generation – testing of concepts – customer populations- hierarchy of human needs - need gathering methods – affinity diagrams – needs importance-establishing engineering characteristics-competitive benchmarking- - product design specification.	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing – functional decomposition – physical decomposition – functional representation –morphological methods- Decision making – Psychology of colors – Visual balancing	7	9 (15)
Module 4 Industrial design – human factors design –user friendly design – design for manufacturability - design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost –overhead costs – activity-based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Design for reliability- basic concept of reliability- failure distributions-MTTF-MTBF-reliability-of-systems-redundancy -derating-maintainability-availability-reliability testing.	6	12 (20)
Module 6 Quality Aspects of Design -Objectives and functions-Targets- Dimensions of Quality - quality function deployment- house of quality – GD&T - Measures and Matrices-Design of Experiments –design process - Identification of control factors, noise factors, and performance metrics – Quality tools – Case studies.	8	12 (20)

04 ME 6609 – Syllabus

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6609	**Mechatronics in Manufacturing Systems**	3-0-0	3	2020

Prerequisite: Knowledge in undergraduate level basics of electronics and mechanical engineering.

Course Objectives: The objectives of the course are

1. To introduce the integrated field of mechatronics.
2. To impart knowledge about different components of a mechatronic system.
3. To familiarize typical practical common application of mechatronics.

Syllabus:

Introduction to Mechatronics - Systems- Need for Mechatronics- Performance Terminology – Potentiometers - LVDT – Capacitance sensors- Actuators – Mechanical - Electrical - Fluid Power – Piezoelectric- PLC. Designing - Possible design solutions-Traditional and Mechatronics design concepts

Expected outcome: At the end of the course, the student will be able to

1. Explain the function of basic mechatronics systems and components
2. Development of Programmable Logic controller programming and implementation of real-life system
3. Devise simple mechatronics systems for practical applications

Text Books:

1. Bolton. W, “Mechatronics” , Pearson education, second edition, fifth Indian Reprint,2003.
2. Smaili. A and Mrad. F , "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008

References:

1. Devadas Shetty and Richard A. Kolk, “Mechatronics systems design”, PWS Publishing company, 2007.
2. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
3. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applicatlions” Tata McGraw-Hill Publishing company Limited, 2003.
4. Michael B. Histand and Davis G. Alciatore,” Introduction to Mechatronics and Measurement systems”. McGraw Hill International edition, 1999.
5. Bradley D.A, Dawson. D, Buru N.C and Loader A.J, “Mechatronics” Nelson Thornes ltd, Eswar press, Indian print, 2004.
6. Lawrence J.Kamm, “Understanding Electro-Mechanical Engineering – An Introduction to Mechatronics”, Prentice Hall of India Pvt Ltd, 2000.

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
Module 1 Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems – Control Systems.	7	9 (15)
Module 2 Sensors and transducers: Introduction - Performance Terminology – Potentiometers - LVDT – Capacitance sensors - Strain gauges - Eddy current sensor - Hall effect sensor – Temperature sensors - Light sensors - Selection of sensors - Signal processing.	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Actuators: Mechanical - Electrical - Fluid Power - Piezoelectric –Magneto strictive- Shape memory alloy - applications - selection of actuators.	7	9 (15)
Module 4 Programmable Logical Controllers: Introduction - Basic structure - Input and output processing - Programming -Mnemonics- Timers, counters and internal relays - Data handling - Selection of PLC.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Designing - Possible design solutions-Traditional and Mechatronics design concepts	7	12 (20)
Module 6 Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine - Engine Management system - Automatic car park barrier - Data acquisition Case studies	7	12 (20)

04 ME 6611 – Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6611	Design of Hydraulic and Pneumatic Systems	3-0-0	3	2020

Prerequisite: Knowledge in undergraduate level basics of mechanical engineering

Course Objectives: The objectives of the course are

1. To know about the basic elements of hydraulic and pneumatic system.
2. To do the sizing and system design of typical hydraulic pneumatic systems.
3. To know the maintenance practices of hydro pneumatic systems

Syllabus:

Hydraulic Power Generators – Selection and specification of pumps, Pressure - direction and flow control valves - relief valves, Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits-Pneumatic fundamentals - control elements, position and pressure sensing – logic circuits, Pneumatic equipment- selection of components - design calculations

Expected outcome: At the end of the course, the student will be able to

1. Describe basic elements and functions of hydraulic and pneumatic systems
2. Describe the maintenance practices of hydro-pneumatic systems
3. Describe the maintenance practices of hydro-pneumatic systems
4. Conduct system design of hydraulic and pneumatic systems

Text Books:

1. Andrew Parr, “Hydraulic and Pneumatics” (HB), Jaico Publishing House, 1999.

References:

1. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
2. Dudley, A. Pease and John J. Pippenger, “Basic fluid power”, Prentice Hall,1987.
3. Bolton. W., “Pneumatic and Hydraulic Systems “, Butterworth –Heinemann, 1997.
4. K. Shanmuga Sundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy" S. Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009.

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
Module 1 Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators –election, specification and characteristics.	7	9 (15)
Module 2 Control and regulation elements: Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Hydraulic circuits: Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits- industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components – safety and emergency mandrels.	7	9 (15)

Module 4 Pneumatic systems: Pneumatic fundamentals - control elements, position and pressure sensing – logic circuits - switching circuits - fringe conditions modules and these integration	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Circuits: sequential circuits - cascade methods - mapping methods - step counter method, compound circuit design - combination circuit design.	7	12 (20)
Module 6 Selection and sizing: Pneumatic equipment- selection of components - design calculations – application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing -PLC, Low cost automation - Robotic circuits.	7	12 (20)

04 ME 6613 - Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6613	**Engineering Optimization**	3-0-0	3	2020

Prerequisite: Knowledge in undergraduate level engineering mathematics

Course Objectives: The objectives of the course are

1. To introduce the concept of optimization for optimum engineering design
2. To discuss about the formulation and classification of optimization problems
3. To instil the methods of solving various types of optimization problems

Syllabus:

Statement of engineering optimization problems, formulation of optimization problems, classification of optimization problems and methods of optimization, linear optimization problem, unconstrained non-linear optimization problem, constrained nonlinear optimization problems, multi-objective and multistage optimization problem. Evolutionary algorithms for solving optimization problems, Design of experiment-based optimization.

Expected outcome: At the end of the course, the student will be able to

1. Formulate and classify engineering optimization problems
2. Solve linear optimization problems of engineering interest.
3. Understand the theory of unconstrained nonlinear optimization problems and to find the solution.
4. Apply the theoretical background of constrained nonlinear optimization to solve constrained nonlinear optimization problems
5. Understand the methods of solving multi-objective optimization problems
6. Apply the knowledge of evolutionary algorithms for solving engineering optimization problems.

Reference books

1. S. S. Rao, Engineering Optimization: Theory and practice, New Age international publishers, 3rd edition, 2013.
2. A. D Belegunndu and T.R. Chandrupatla, Optimization concepts and applications in engineering, Cambridge university press, 3rd Edition, 2019
3. K. Deb., Optimization for Engineering Design: Algorithms and Examples, PHI, 2nd Edition, 2012.
4. J.S Arora, Introduction to optimum design, Academic Press, 4th Edition, 2017

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
Module 1 Introduction to optimization, Engineering applications of optimization, Statement of an optimization problem- Design vector, Design constraints and constraint functions - Classification of optimization problems, Optimization Methods - Direct and indirect search methods, deterministic and stochastic methods- Maximization and minimization- Local and global optimization-Formulation of optimization problems as mathematical programming problems-Numerical example problems involving design, manufacturing and thermal systems.	6	9 (15)
Module 2 Linear optimization problems- Simplex method of solving linear optimization problems, Simplex tableau, Artificial variable methods- Two phase and Big-M methods. concept of duality, concept of degeneracy, sensitivity or post optimality analysis, Integer linear programming – Cutting plane method, Branch and bound method	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Unconstrained nonlinear optimization- Convexity and concavity of functions of single and multi-variables. Mathematical theory of unconstrained optimization, necessary and sufficient conditions. Single variable optimization – direct root methods -Newton-Raphson and secant methods, Elimination methods- Fibonacci and Golden section methods, Multi-variable optimization- Direct search methods - random search methods, pattern search methods-Indirect search methods- Steepest Decent, Newton, Levenberg-Marquardt and conjugate gradient methods.	8	9 (15)
Module 4 Constrained nonlinear optimization- Mathematical theory of constrained optimization, necessary and sufficient conditions for extrema. Equality Constraints-Lagrange multipliers and Lagrangian optimization, Inequality constraints- Kuhn-Tucker conditions, Direct search methods- random search method and methods of feasible directions. Indirect method-Transformation techniques, Penalty function method.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Multi-objective optimization problem- Concept of Pareto-optimality. Min-Max Pareto solution, Weighted sum approach – Goal programming-Multistage optimization-Dynamic programming.	7	12 (20)
Module 6 Evolutionary algorithm for optimization- genetic algorithms, simulated annealing, particle swam optimization and ant colony optimization. Neural Network based optimization. Design of experiment-based optimization-Response surface methods-Implementing optimization algorithm using commercial software packages: Matlab/Mathcad/Minitab/design expert.	7	12 (20)

04 ME 6615 - Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6615	**Bearing Design and Rotor Dynamics**	**3-0-0**	**3**	**2020**

Prerequisite: Nil

Course Objectives: The main objectives of this course are

1. To gain knowledge about different types of bearings
2. To systematically to do the ideal bearing selection according to the situations

Syllabus:

Selection criteria-Dry and Boundary Lubrication, Design and performance analysis of Thrust and Journal bearings, Contact Stresses in Rolling bearings- Centrifugal stresses, Hydrodynamic Lubrication equation for dynamic loadings, Rotor vibration and Rotor critical speeds- support stiffness on critical speeds.

Expected outcome: The student will be able to

1. Explain different types of bearings and applications
2. Design and performance analysis of Thrust and Journal bearings
3. Compute the contact stress in roller bearings
4. Computation and measurements of journal bearing coefficient

Text Books:

1. S. K. Basu, S. N. Sengupta & B. B. Ahuja," Fundamentals of Tribology", Prentice–Hall of India Pvt Ltd , New Delhi, 2005.

References:

1. Neale, M.J. "Tribology Hand Book", Butterworth Heinemann, United Kingdom 2001.
2. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – "Principles of Tribology ", Macmillian – 1984.
4. Williams J.A. "Engineering Tribology", Oxford Univ. Press, 1994.
5. S.K. Basu, S.N. Sengupta & B.B. Ahuja," Fundamentals of Tribology", Prentice–Hall of India Pvt Ltd , New Delhi, 2005.
6. G.W. Stachowiak & A. W. Batchelor, Engineering Tribology, Butterworth-Heinemann, UK, 2005.Kachanov. L.M., "Foundations of Theory of Plasticity", North-Holland Publishing Co., 1971.

COURSE PLAN

MODULES	Contact hours	Sem. Exam Marks; (%)
Module 1 Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic bearings- Electro Magnetic Bearings-Dry Bearings-Rolling Element bearings- Bearings for Precision Applications-Foil Bearings-Special Bearings-Selection of plain Bearing materials –Metallic and Non-metallic bearings.	7	9 (15)

Module 2 Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Design based on Charts & Tables and Experimental Curves-Design of Foil Bearings-Air Bearings- Design of Hydrostatic Bearings-Thrust and Journal bearings- Stiffness consideration - flow regulators and pump design.	7	9 (15)
Module 4 Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication- Fatigue life calculations- Bearing operating temperature- Lubrication-Selection of lubricants- Internal clearance – Shaft and housing fit- -Mounting Arrangements-Materials for rolling bearings-Manufacturing methods- Ceramic bearings-Rolling bearing cages-bearing seals selection.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads, alternating and impulse loads in journal bearings – Journal centre Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions.	7	12 (20)
Module 6 Rotor vibration and Rotor critical speeds- support stiffness on critical speeds-Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients -Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip- Design configurations of stable journal bearings.	7	12 (20)

04 GN 6001 – **Syllabus**

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 GN 6001	**Research Methodology**	3-0-0	3	2020

Prerequisite: Nil

Course Objectives: The objectives of the course are

1. To learn the basic steps in research
2. To impart knowledge about carrying out sampling-based studies.
3. To learn to prepare technical presentation and reports

Syllabus:

Introduction to the Concepts of Research Methodology, Research Proposals, Research Design, Data Collection and Analysis, Quantitative Techniques and Mathematical Modeling, Report writing

Expected outcome: At the end of the course, the student will be able to

1. Choose, formulate and apply research tools and techniques appropriate to the respective research method and process they meet in their research / actual work environment
2. Develop and use appropriate sampling and data collection techniques of the qualitative and quantitative domain for executing research work
3. Apply and interpret the statistical tools / methods in the data analysis and draw conclusions
4. Interpret the results of the experiments conducted and present reports

Text Books:

1. Research Methodology: Methods and techniques: C. R. Kothari.

References:

1. Research Methodology: Pannerselvam
2. Management Research Methodology: K. N. Krishnaswami, AppaIyer and M Mathirajan, Pearson Education, Delhi, 2010
3. Research Methodology: Ranjit Kumar, Pearson Education, Delhi, 2009.
4. Hand Book of Research Methodology: M N Borse, SreeNivas Publications, Jaipur, 2004
5. Business Research Methods: William G Zikmund, South – Western Ltd, 2003
6. Research Methods in Social Science: P K Majumdar, Viva Books Pvt Ltd, New Delhi, 2005
7. Analyzing Quantitative Data: Norman Blaikie, SAGE Publications , London, 2003
8. SPSS for Windows: Pearson Education, New Delhi, 2007Kachanov.L.M., “Foundations of Theory of Plasticity”, North-Holland Publishing Co., 1971.

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks (%)**
Module 1 Introduction to Research Methodology: Concepts of Research, Meaning and Objectives of Research, Research Process, Types of Research, Type of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical	5	15

Module 2 Criteria of Good Research, Research Problem, Selection of a problem, Techniques involved in definition of a problem, Research Proposals – Types, contents, Ethical aspects, IPR issues like patenting, copyrights	5	15
FIRST INTERNAL TEST		
Module 3 Research Design: Meaning, Need and Types of research design, Literature Survey and Review, Identifying gap areas from literature review, Research Design Process, Sampling fundamentals, Measurement and scaling techniques, Data Collection –concept, types and methods, Design of Experiments.	5	15
Module 4 Quantitative Techniques: Probability distributions, Fundamentals of Statistical analysis, Data Analysis with Statistical Packages, Multivariate methods, Concepts of correlation and regression - Fundamentals of time series analysis and spectral analysis.	5	15
SECOND INTERNAL TEST		
Module 5 Report Writing: Principles of Thesis Writing, Guidelines for writing reports & papers, Methods of giving references and appendices, Reproduction of published material, Plagiarism, Citation and acknowledgement.	4	20
Module 6 Documentation and presentation tools – LaTeX, Office with basic presentations skills, Use of Internet and advanced search techniques.	4	20

04 ME 6691- Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6691	**SEMINAR I**	0-0-2	2	2020

Prerequisite: Nil

Course Objectives: The objectives of the course are

1. To improve written and oral presentation skills and to develop confidence in making public technical presentations
2. To introduce a new relevant topic and share it to the peer group

Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses being undergone in the first semester of the M.Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student's paper, presentation and his/her participation in the seminar.

Goals: This course is designed to improve written and oral presentation skills and to develop confidence in making public presentations, to provide feedback on the quality and appropriateness of the work experience, and to promote discussions on design problems or new developments or ethical and safety issues in the workplace.

Expected outcome: At the end of the course, the student will be able to

1. Present advanced topics related to Engineering Design based on recent journal papers
2. Report effectively the topic of seminar as a bound volume

04 ME 6693 – Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6693	**Product Design Lab**	0-0-2	1	2020

Prerequisite: Nil

Course Objectives: The objectives of the course are

1. To create digital Mock-up of components/systems using various 3D modelling packages
2. To enable students to do simulation studies using software

Syllabus

Part A

Computer Aided Engineering Design

Computer aided modelling and drafting: Part creation, surface generation, solid modelling of machine parts and rendering of parts, assembly of parts. Parametric modelling of standard parts, – library creation – catalogue making – customisation using various software like visual basic, Kinematic simulation of mechanisms. Ergonomic Analysis of systems. Routing of Electrical and Mechanical Electrical Harness routing, 3 D printing of parts.

Software: Students must be trained in 3D Modelling Software such as CatiaV5, NX, Creo, Solid Works etc, as part of the Lab exercise.

Part B

Solving design problems using software

Modular programming practice in MATLAB/Python. Applications of passing function as an argument in MATLAB\Python. Plotting tools in MATLAB/Python. Programming of mathematical algorithms for: the solution of a system of linear equations, eigenvalue decomposition of a matrix. Simulation of optimization algorithms. Simulation of electro-mechanical systems.

Expected outcome: At the end of the course, the student will be able to

1) Design the digital mock-up of a product/system.
2) Do mathematical simulation studies using software.

No	List of Exercises	Course Outcomes	No of Hours
1	Modelling of brackets/machine components	**CO 1**	2
2	Modelling of Assembly of machine components	**CO 1**	2
3	Surface Modelling of parts and rendering	**CO 1**	2
4	Parametric modelling of standard parts & Creation of library/catalogues	**CO 1**	2
5	Kinematic simulation of simple mechanisms	**CO 1**	2
6	Ergonomic Analysis of products	**CO 1**	2
7	Routing of Electrical Harness	**CO 1**	2
8	Customisation of CAD software using macros	**CO 1**	2
9	3D printing of parts	**CO 1**	2
10	Laser cutting and engraving of parts	**CO 1**	2
11	Modular programming practice using software	**CO 2**	1
12	Programming of mathematical algorithms for: the solution of a system of linear equations	**CO 2**	1
13	Programming of mathematical algorithms for: the solution of a system of linear equations	**CO 2**	1
14	Eigenvalue decomposition of a matrix using software	**CO 2**	1
15	Simulation of optimisation algorithms	**CO 2**	1
16	Simulation of electro-mechanical systems	**CO 2**	1

SEMESTER II

04 ME 6602 – **Syllabus**

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6602	**Finite Element Method**	3-1-0	3	2020

Pre requisite: Basic understanding of Advanced Mechanics of solids

Course Objectives: The main objectives of this course are

1. To impart the basic concepts of finite element method
2. To focus on the practical aspects of applying the Finite Element Method to various problems in engineering and science
3. To enhance the students understanding by writing simple computer programme and use of commercial package

Syllabus:

Basic concepts of FEM – a general procedure for finite element analysis, brief history of finite element method, Truss structures: The direct stiffness method – Nodal equilibrium equation, element transformation and direct assembly of global stiffness matrix, Method of weighted residuals – introduction, method of weighted residuals, the Galerikin finite element method, Applications in solid mechanics, modal analysis and modelling using Matlab and Commercial software

Expected outcome: The student will be able to

1. Define mathematical model and create finite element model.
2. Write simple computer programme for finite element analysis
3. Use commercial software for finite element analysis

Text Books:

1. David V Hutton, “Fundamentals of finite element analysis”, McGraw Hill.

References:

1. Daryl L. Logan, “First course in finite element method”, Cengage Learning, Singapore.
2. J. N. Reddy, “An introduction to the finite element method”, McGraw Hill
3. C. Zienkiwiez, “The finite element method”, McGraw Hill, New York.
4. K. H. Huebner, “The finite element method of engineers”, John Wiley & Sons, New York.
5. Robert D Cook,”Fnite Element modelling for stress Analysis”, Wiley

COURSE PLAN

MODULES	Contact hours	Sem. Exam Marks; (%)
Module 1 Basic concepts of FEM –brief history of finite element method. Mathematical Modelling of field problems in Engineering, Governing Equations – Discrete and continuous models, discretization-convergence behaviour, Boundary, Initial and Eigen Value problems. Various steps of FEM-Need for studying FEM	8	9 (15)

Module 2 Linear spring as a finite element, elastic bar, spar/link/truss element. assembly of global stiffness matrix, boundary conditions, constraint forces, element strain and stress, Plane truss- Element formulation-Co ordinate transformation- Local and global co-ordinates- Stress calculations.	10	9 (15)
FIRST INTERNAL TEST		
Module 3 Interpolation functions-Shape functions- Lagrange interpolation- 1D linear and quadratic element. Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices, Strong and week form-one dimensional stress and Heat conduction	9	9 (15)
Module 4 Variational methods: Functionals, Principle of stationary potential energy-Rayleigh Ritz method. FE formulation of- B matrix- Element matrices for bar element- Consistent nodal loads.Weighted residual method: Galerkin FE formulation. Axially loaded bar- Heat flow in a bar.Weighted residual method: Galerkin FE formulation. Axially loaded bar- Heat flow in a bar	9	9 (15)
SECOND INTERNAL TEST		
Module 5 Polynomial forms- one dimensional elements, triangular elements, rectangular elements, Higher order elements- Quadratic and cubic elements-Pascal's triangle. Iso parametric elements, Natural coordinates, Quadrilateral elements- Serendipity elements- isoperimetric formulations	10	12 (20)
Module 6 Numerical integration: Gaussian quadrature. Finite element formulation of beam and frame element. Introduction to Modal analysis, non-linear analysis and coupled analysis. Introduction to FEM modelling using computer programme and Commercial software	10	12 (20)

04 ME 6604 - Syllabus

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Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6604	**Modelling and Control of Engineering Systems**	3-0-0	3	2020

Prerequisite: Under graduate level knowledge in Mathematics

Course Objectives: The main objectives of this course are

1. To introduce the mathematical model of engineering systems
2. To introduce methods for analyzing the time response, the frequency response and the stability of systems.
3. To design control systems with compensating techniques.
4. To design the state feedback controller and observers

Syllabus:

Introduction to linear systems - Modeling of engineering systems - Free, forced and transient response of first and second order systems - Solution of differential equation using Laplace Transforms - Time domain and Frequency domain analysis - State space representation - System characteristics from state space representation - Controller and Observer design.

Expected outcome: The student will be able to

1. Classify different types of system and identify a set of algebraic equations to represent a system
2. Understand time response of first and second order control systems for different standard test signals
3. Formulate the analysis in frequency domain to explain the nature of stability of the system
4. Apply root locus technique and bode plot for designing different compensators
5. Design the controllers and observers in state space

Reference books

1. Woods Robert L. and Lawrence Kent L., “Modelling and Simulation of Dynamic Systems”, Prentice Hall, 1997.
2. Ashish Tiwari, “Modern Control Design with MATLAB and SIMULINK”, John Wiley, 2002.
3. Kuo, B. C., Automatic Control Systems, Prentice Hall,2012
4. Nagrath I J and Gopal M, Control Systems Engineering, New Age India Pvt Limited, 2009
5. Ogata K., Modern Control Engineering, Prentice Hall of India, New Delhi, 2010.

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks; (%)**
Module 1 Introduction to control, classification of dynamic systems -Modelling of engineering systems, Transfer Function - mechanical, electrical, fluid and thermal systems, Poles and Zeros. Standard Inputs, Free and Forced Response	6	9 (15)

Module 2 Time domain analysis-Time response of first and second order systems, specifications in time domain. Response with Proportional (P), Integral (I), Derivative (D) and PID controllers Concept of stability, Routh's stability criterion. Root locus method of analysis. Effect of adding Poles and Zeros.	8	9 (15)
FIRST INTERNAL TEST		
Module 3 Frequency domain analysis - Frequency Response, Bode Plots, Relative Stability – Gain and Phase Margins.	7	9 (15)
Module 4 Design of Lag, Lead and lag-lead compensators using Root locus and Bode plot	7	9 (15)
SECOND INTERNAL TEST		
Module 5 State-Space Representation of Control Systems, Eigenvalues and Eigenvectors, State-Space Representation of Dynamic Systems. Solving State Equations, Controllability and Observability.	7	12 (20)
Module 6 State feedback design - Pole Placement technique, State observer - Asymptotic observers for state measurement-open loop observer-closed loop observer formulae for observer gain - implementation of the observer - full order and reduced order observers.	7	12 (20)

04 ME 6606 – **Syllabus**

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6606	**Design for Manufacturing and Assembly**	3-0-0	3	2020

Prerequisite: An under graduate course in Design & Engineering

Course Objectives: The main objectives of this course are

1. To understand tools and technique used in design for manufacture & assembly considering different products as case-studies.
2. To learn advanced tools and techniques for dimensioning and tolerancing.
3. To encourage students to develop environmentally friendly products that satisfy societal needs.

Syllabus:

Design for manufacturing, Tolerance analysis and related tools, Design for machining, Life cycle Assessment, Design for dis-assembly, DFE- Methods and needs, Design for recyclability & energy efficiency.

Expected outcome: The student will be able to

1. Develop new quality products that are environmentally friendly & reliable
2. Use advanced tools & techniques related to dimensioning and tolerancing.
3. Do case-studies on different products that helps them to apply those techniques in real-life situations.

Reference Books:

1. Boothroyd G., Dewhurst P., and Knight W., "*Product Design for Manufacture and Assembly*", Second Edition, Marcel Dekker, New York, 2002.
2. Harry Peck, "*Designing for Manufacture*", Pitman Publications, 1983.
3. Spotts M. F., "*Dimensioning and Tolerance for Quantity Production*", Prentice Hall, 1983.
4. Boothroyd G., "*Design for Assembly: The Road to Higher Productivity*", Assembly Engineering, 1982.
5. Creveling C. M., "*Tolerance Design - A Hand Book for Developing Optimal Specifications*", Prentice Hall, 1997.

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks; (%)**
Module 1 DFM approach, DFM guidelines, Standardization. Group technology, Value engineering, development and evaluation of alternative solutions, Poke – Yoke principles.	7	9 (15)
Module 2 Tolerance analysis – process capability, process capability metrics, cost aspects, geometric tolerances, cumulative effect of tolerances, Interchangeable and selective assembly. Control of axial play – secondary machining operations, laminated shims.	7	9 (15)

FIRST INTERNAL TEST		
Module 3 Datum systems-grouped datum systems – geometric analysis and applications. True position theory – true position tolerancing, zero true position tolerance, functional gauges, paper layout gauging, compound assembly.	7	9 (15)
Module 4 Form design of castings and weldments – Redesign of castings – redesigning cast members using weldments. Tolerance charting technique, centrality analysis – computer aided tolerance charting.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Design for machining. Design features to facilitate machining – functional and manufacturing datum features, redesign for manufacture. Environmental objectives – Global issues – Regional and local issues– Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Techniques to reduce environmental impact	8	12 (20)
Module 6 Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.	6	12 (20)

04 ME 6608 – Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6608	**Design and Analysis of Energy systems**	**3-0-0**	**3**	**2020**

Prerequisite: Basic Mechanical Engineering

Course Objectives: The main objectives of this course are

1.To understand an engineering system design fundamental
2. To learn the design principles of various heat exchanger equipment
3. To do the system design of a pumping system
4. To model and simulate a thermal system

Syllabus:

Engineering design fundamentals - Designing a workable system, Heat exchanger design calculations - Evaporators and condensers temperature concentration pressure characteristics of binary solutions - Pump characteristics - Manufacturer's specifications - Relations among performance characteristics- Basics of Second law analysis in heat and fluid flow - Applications in thermal design

Expected outcome: The student will be able to

1. Design Heat Exchangers
2. Apply thermodynamic laws in thermal design
3. Do the simulation Gas Turbine systems
4. Mathematical modelling of large systems

Text Books:

1. Y. Jaluria: Design and Optimization of Thermal Systems, McGraw Hill, 1998.

References:

1. A. Bejan: Thermal Design and Optimization, John Wiley, 1995.
2. W.F. Stoeker: Design of Thermal Systems, 3e, McGraw Hill, 1989.
3. B.K. Hodge: Analysis and Design of Energy Systems, Prentice Hall, 1990.
4. R.F. Boehm: Design Analysis of Thermal systems, John Wiley, 1987.
5. Jones J. B. and Dugan R. E.: Engineering Thermodynamics, Prentice Hall of India, 1998.
6. Yunus A. Cengel: Thermodynamics: An Engineering approach, McGraw Hill, 1994.

W.J. Gajda and W.E. Biles: Engineering Modeling and Computation, Houghton Mifflin, 1980.

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks; (%)**
Module 1 Engineering design fundamentals - Designing a workable system - Economic evaluation - Fitting data and solving equations - Design optimization - Knowledge based system design.	7	9 (15)
Module 2 Heat exchanger design calculations - Evaporators and condensers temperature concentration pressure characteristics of binary solutions - Rectifiers - Cooling towers -Pressure drop and pumping power.	7	9 (15)
FIRST INTERNAL TEST		

Module 3 Pump characteristics - Manufacturer's specifications - Relations among performance characteristics - Pump system operation - Cavitation prevention - Other system considerations, Fans and nozzles.	7	9 (15)
Module 4 Basics of Second law analysis in heat and fluid flow - Applications in thermal design - Modelling and simulation principles	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Hardy-Cross method - Multi-variable, Newton- Raphson simulation method - Simulation of a gas turbine system	7	12 (20)
Module 6 Simulation using differential equations - Mathematical modelling of thermodynamic properties – Steady state simulation of large systems.	7	12 (20)

04 ME 6612 - **Syllabus**

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Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6612	**Design Automation with IoT**	**3-0-0**	**3**	**2020**

Prerequisite: Basic knowledge in Electronics

Course Objectives: The main objectives of this course are

1. To introduce students to the field of IoT
2. To familiarise students' different types of sensors used in automation
3. To provide awareness about the applications of IoT

Syllabus:

Introduction to IoT & Cyber-Physical Systems, Communication and networking technologies in IoT, sensors and characteristics, actuators-different types including MEMS, applications of IoT

Expected outcome: The student will be able to

1. Identify different networks that can be used in IoT
2. Select sensors that can be used for IoT application
3. Apply in simple industrial automation applications

References:

1. Adrian McEwan and Hakim Cassimally, "Designing the internet of things", Wiley, 2013
2. Vijay Madisetti and Arshdeep Bahga,"Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014.
3. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.
4. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',YoleDéveloppement Copyrights ,2014
5. Jacob Fraden, (2010), Handbook of Modern Sensors, 5th Edition, Springer.
6. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David
7. Boyle, "From Machine-to-Machine to the Internet of Things -Introduction to a New Ageo Intelligence" Elsevier

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks; (%)**
Module 1 Introduction to IoT & Cyber-Physical Systems, IoT Enabling Technologies – Physical End points, Network Services, Cloud. Different Levels of IoT Applications.	7	9 (15)
Module 2 Communication and networking technologies in IoT: Communication models, AdHoc. Industrial & Automotive Networks, Vehicular networks	7	9 (15)

FIRST INTERNAL TEST		
Module 3 Thermo resistive Sensors- Thermistors, Resistance Temperature Sensors, and Silicon Resistive Sensors, Thermo electric sensors, PN junction temperature sensors, thermos mechanical sensors and actuators. Quantum effects of optical radiation, quantum based optical sensors, photoelectric sensors, optical actuators.	7	9 (15)
Module 4 Electric and magnetic sensors and actuators-Capacitive Position, Proximity, and Displacement Sensors, Capacitive Actuators, Inductive Sensors, Hall Effect Sensor, Voltage and Current Sensors, Radiation sensors – ionization sensors, microwave sensors, antennas as sensors and actuators.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Mechanical Sensors and Actuators- force sensors, pressure sensors, Acoustic actuators, ultrasonic sensors and actuators. MEMS and Smart sensors- pressure sensors, thermal and piezo electric actuation, wireless sensors and actuators and issues associated with their use.	6	12 (20)
Module 6 IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Management of critical assets, and proactive maintenance. Applications HCI and IoT world -Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges.	8	12 (20)

04 ME 6614 - **Syllabus**

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Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6614	**Advanced Fluid Flow and Heat Transfer**	3-0-0	3	2020

Prerequisite: Basic Mechanical Engineering

Course Objectives: The main objectives of this course are

1. To provide knowledge regarding fluid-flow phenomena like potential flow, viscous flow, boundary-layer flows, etc. in various applications.
2. To enhance the understanding of fluid mechanics, including the equations of motion in differential form and turbulence.
3. To undertake sustained learning in fluid mechanics to extend their knowledge in heat transfer problems

Syllabus:

Lagrangian and Eulerian approaches, Angular deformation and rotation, Reynolds transport theorem, Potential flows, Viscous flows and Navier-Stoke's equation, Boundary layer theory, Turbulent flows, Convective heat transfer

Expected outcome: The student will be able to

1. Understand the basic approaches in fluid mechanics and use Reynolds transport theorem.
2. Understand the potential flow approach and apply the concept in fluid flow problems.
3. Use Navier-Stoke's equation in various fluid flow problems.
4. Understand the concept of boundary layer and apply boundary layer equations.
5. Understand the basics of turbulent flow and turbulence modeling.
6. Apply the knowledge of fluid mechanics in convective heat transfer.

Reference books

1. S. K. Som Gauthan Biswas and Suman Chakraborthy, Introduction to Fluid Mechanics and Fluid Machines, Mc Graw Hill, 2012.
2. John. M. Cimbala and Yunus A. Cengel, Fluid Mechanics: Fundamentals and Applications, Mc Graw Hill, 2019.
3. Frank Incropera and David P. Dewitt, Fundamentals of Heat and Mass Transfer, Wiley student edition, 2007
4. S. P. Venkateshan, Heat Transfer, Ane Books Pvt. Ltd., 2016.

COURSE PLAN

MODULES	Contact hours	Sem. Exam Marks; (%)
Module 1 Lagrangian and Eulerian Approach, Types of fluid flow- Streamlines, Streakline and Pathline- Acceleration of fluid flow- Deformation and Conservation of mass of fluid element- Angular deformation of a fluid element- vorticity- stream function and velocity potential- Euler's equation and Bernoulli's equation- Reynolds Transport Theorem- Application of RTT: Conservation of mass and linear momentum.	7	9 (15)

Module 2 Potential flow: Uniform flow, source flow, sink flow, source and sink pair, doublet, plane source in a uniform flow- source and sink pair in a uniform flow- doublet in a uniform flow- Flow past a cylinder with circulation- Magnus effect- Kutta-Juokowsky's law- Concept of lift and drag.	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Incompressible viscous flow- Navier-Stoke's equation and significance (derivation not necessary)- Navier-Stoke's equation for steady incompressible flows with negligible body forces- Fully developed flow between two parallel plates - Couette flow- Hagen-Poiseuille flow- Hagen-Poissuille equations for velocity and discharge through a pipe- friction factor for laminar flow- Flow between two rotating cylinders	7	9 (15)
Module 4 Introduction to Boundary layer- Scaling and order of magnitude analysis- Flow over a fat plate: Blasius equation- Momentum integral method for boundary layer analysis- Approximate solution of the momentum integral equation- Displacement and Momentum thickness- Illustrative examples- Boundary layer separation	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Turbulent Flow: Introduction to turbulent flow, Governing equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Fully developed Turbulent pipe flow for moderate Reynold's number, Prandtl mixing hypothesis, Turbulence modeling.	6	12 (20)
Module 6 Convective heat transfer- Dimensional analysis- Solutions to free and forced convection in laminar and turbulent- internal and external flows- Reynolds and Colburn analogies- Free and forced convection correlations.	8	12 (20)

04 ME 6616 - **Syllabus**

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6616	**Measurement of Mechanical and Electrical Systems**	3-0-0	3	2020

Prerequisite: Basic knowledge in Mechanics and Electronics

Course Objectives: The main objective of this course is

1. To learn various mechanical & Electrical measurement techniques for different parameters

Syllabus

Generalized measuring system and functional elements, Instrumentation and control, LVDT, ADC, DAC**:** Measurement of temperature by intrusive (Thermocouples, Thermistors and Resistance Temperature Detector) and non-intrusive (pyrometers) techniques, Measurement of force, torque, power and acceleration, Measurement of gas concentration, level and noise

Expected outcome: The student will be able to

1. Analyse the statistical data obtained through measurement
2. Conditioning the electronic data obtained through measurements
3. Acquire data inputs using sensors from a system
4. Select the correct transducers for measurement of temperature, pressure etc of fluids
5. Select the correct transducers for measurement of force, torque & power etc

Reference Text Books: -

1. Measurement Systems: Application and Design- E.O. Doebelin- McGraw Hill
2. Mechanical Measurements - S. P. Venkateshan- Ane Books India
3. Principles of Measurement systems – John P. Bentley – Pearson Education
4. Experimental Methods for Engineers- J. P. Holman, Tata-McGraw Hill
5. Introduction to instrumentation and measurements- Robert B. Northrop-CRC press

COURSE PLAN		
MODULES	**Contact hours**	**Sem Exam Marks; %**
Module 1 Introduction to measurement and measurement System: Generalized measurement system and functional elements, Static and dynamic performance characteristics of measurement devices, Errors in measurements, Statistical analysis of data, Regression analysis, Chi-Square Testing, correlation, estimation of uncertainty and presentation of data, elementary principles of design of experiments.	7	9 (15)
Module 2 Signal conditioning and signal processing elements of measurement systems: Effects of noise and interference on measurement circuits, Noise sources and coupling mechanisms, Methods of reducing effects of noise and interference - Signal Conditioning Elements- Analogue signal conditioning, Deflection	7	9 (15)

bridges, Amplifiers, A.C. carrier systems, Current transmitters, Oscillators and resonators - Signal Processing Elements- Analogue-to-digital (A/D) conversion, Successive-Approximation ADCs, Tracking or servo ADCS, Signal processing calculations- Digital signal processing- Digital Filters and the *z*-Transform, Simple DSP Algorithms		
FIRST INTERNAL TEST		
Module 3 Measurement of temperature, pressure and flow velocity: Measurement of temperature by intrusive (Thermocouples, Thermistors and Resistance Temperature Detector) and non-intrusive (pyrometers) techniques. Measurement of pressure - manometers, elastic type pressure gauges (Bourdon tube, diaphragm, and bellows), strain gauges – capacitive type pressure gauge – piezoelectric pressure sensor, Measurement of vacuum – McLeod gauge, thermal conductivity gauges, Ionization gauge - Testing and calibration of pressure gauges – dead weight tester. Measurement of flow velocity- intrusive and nonintrusive types- Pitot and Pitot static tube, Hot wire Anemometer - Ultrasonic and laser Doppler velocity meter, particle image velocimetry.	7	9 (15)
Module 4 Measurement of gas composition, liquid level and noise: Measurement of gas composition- Sampling systems, sampling probe, molecular beam sampling probe - separation methods - gas chromatography, flame ionization detector, Spectroscopic techniques, non-separation methods- Non Dispersive infrared analyzer, Luminescence-based detectors- Principles of liquid level measurement- buoyancy force, differential pressure, capacitor and resistance level indicators, Measurement of noise-sound level meters.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Measurement of force, torque, power and acceleration: force measurement by mechanical balancing, force to displacement transformation and force to pressure transformation- strain gauges, piezoelectric transducer, Load cells for force measurement - Torque and power measurement – dynamometers - measurement of angular velocity – Tachometers, mechanical and fiber optic gyroscopes - Measurement of linear acceleration- Accelerometers – theoretical consideration of a seismic mass accelerometer, piezoelectric and fiber optic accelerometers-Laser Doppler Vibrometer	7	12 (20)
Module 6 Data acquisition, presentation and communication systems: Typical data acquisition system, Time division multiplexing, Parallel digital signals, Serial digital signals, Error detection and correction, Frequency shift keying, Communication systems for measurement, Data acquisition cards for PCs – data presentation elements - choice of data presentation elements, Pointer–scale indicators, Digital display principles, Light-emitting diode (LED) displays, Cathode ray tube (CRT) displays, Liquid crystal displays (LCDs), Electroluminescence (EL) displays, Chart recorders, Paperless recorders, Laser printers	7	12 (20)

04 ME 6618 – **Syllabus**

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6618	**Mechanical Behaviour of Materials**	3-0-0	3	2020

Prerequisite: Nil

Course Objectives: The main objectives of this course are

1. To learn the mechanical behaviour of various material under different loading conditions
2. To systematically specify and justify suitable material(s) for a given application, including the use of relevant material selection methodologies

Syllabus:

Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, Motivation for selection, cost basis and service requirements – Selection for mechanical properties, Modern metallic materials, Non-metallic materials.

Expected outcome: The student will be able to

1. Understand the effect of temperature, strain and strain rate on plastic behaviour
2. Calculate Stress intensity factor and fracture toughness
3. Select the ideal material for different applications
4. Classify different types of steels
5. Use Advanced ceramics depending on the application

Text Books:

1. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill, 2000.

References:

1. George E. Dieter, Mechanical Metallurgy, McGraw Hill, 1988
2. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (34d edition), Butterworth-Heiremann, 1997.
3. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4thEdition) Jaico, 1999.
4. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999..W, "Handbook of Engineering Mechanics", McGraw Hill, 1962.

COURSE PLAN

MODULES	Contact hours	Sem. Exam Marks; (%)
Module 1 Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening	7	9 (15)
Module 2 Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity –. Griffith's theory, – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps.	7	9 (15)
FIRST INTERNAL TEST		

Module 3 Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law. - Safe life, Stress life, strain-life and fail - safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non-metallic materials – Failure analysis, sources of failure, procedure of failure analysis.	7	9 (15)
Module 4 Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallic, Ni and Tialuminides – smart materials, shape memory alloys – Metallic glass and nanocrystalline materials.	7	12 (20)
Module 6 Polymeric materials – Formation of polymer structure – Production techniques of fibres, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processing and applications.	7	12 (20)

04 ME 6620 - **Syllabus**

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Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6620	**Experimental Stress Analysis**	**3-0-0**	**3**	**2020**

Prerequisite: Advanced Mechanics of Solids

Course Objectives: The main objectives of this course are

1. To provide knowledge regarding the theory and application of strain gauges for stress analysis.
2. To provide knowledge on the theory of photo-elasticity and its various applications.
3. To create an awareness on Moire fringe method, Brittle coating technique and Holography for stress analysis.
4. To give an understanding about different Non-destructive testing methods.

Syllabus:

Principal stresses and strains – Three-dimensional stress – strain relationships, Transverse sensitivity – Selection and mounting of strain gauges – Strain gauge rosettes, Theory of photoelasticity - Stress-optic law - Plain Polariscope& Circular Polariscope –Moire fringe method and Brittle coating technique for stress analysis.

Expected outcome: The student will be able to

1. Understand the basic approaches in solid mechanics and use in the application of strain gauges for stress analysis.
2. Calculate stress and strain using strain gauges.
3. Apply the principles of photoelasticity to measure strain
4. Understand the basics of different Non-destructive testing methods.

Text Books:

1.Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi, 1996.

References:

1. Dalley and Riley, “Experimental stress Analysis”, McGraw Hill, 1991.
2. Dove and Adams, “Experimental Stress Analysis and Motion measurement”, Prentice Hall, 1965.
3. Hetenyi, “Handbook of Experimental stress Analysis”, John Wiley, 1960.
4. Perry and Lissener, “Strain gauge Primer”, McGraw Hill, 1962.
5. McGonnagle, “Non-destructive Testing”, McGraw Hill, 1961.
6. American Society for Metals, “Metals Hand Book – Vol.7”, 1984. “Handbook of Engineering Mechanics”, McGraw Hill, 1962

COURSE PLAN

MODULES	Contact hours	Sem. Exam Marks; (%)
Module 1 Introduction: –Principal stresses and strains – Three-dimensional stress – strain relationships – Plane stress and Plane strain conditions. Strain gauges – Types – Mechanical, Optical and Electrical strain gauges – Electrical resistance strain gauges – Gauge factor – Strain gauge circuitry – Temperature compensation – Bridge balancing and calibration of D.C and A.C bridges.	7	9 (15)

Module 2 Application of strain gauges: - Transverse sensitivity – Selection and mounting of strain gauges – Strain gauge rosettes – Analysis of strain gauge data and stress calculations – Recording equipment for static and dynamic strains – Strain gauge transducers – Introduction to semiconductor strain gauges - Residual stresses - Beneficial and harmful effects – Principle of residual stress measurement methods.	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Photoelasticity: Theory of photoelasticity - Stress-optic law - Plain Polariscope& Circular Polariscope – Isoclinic & Isochromatic fringes – Partial fringe value and compensation techniques – Tardy's Method	7	9 (15)
Module 4 Photoelastic model materials and their desired properties - use of photo elastic coatings. Applications of Photoelasicity for two dimensional models - Separation of Principal stresses – Scaling models to prototype. Introduction to 3D Photoelasticity.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Other Stress analysis techniques - Moire fringe method and Brittle coating technique for stress analysis. Introduction to Holography in stress analysis. Non-destructive testing – Types – Dye penetrate methods,	6	12 (20)
Module 6 Radiography, X-ray and Gamma ray - X-ray fluoroscopy – Penetrameter - Magnetic particle method. Introduction to lasers in NDT – Ultrasonic flaw detection	8	12 (20)

04 ME 6622 – **Syllabus**

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6622	**Engineering fracture Mechanics**	3-0-0	3	2020

Prerequisite: Advanced Mechanics of Solids

Course Objectives: The main objectives of this course are

1. To understand the basics of fracture mechanics
2. To understand the crack initiation and propagation concepts

Syllabus:

The geometry of stress and strain, elastic deformation, Two dimensional elastic fields – Analytical solutions yielding near a crack front, Griffith analysis – stable and unstable crack growth –Dynamic energy balance, Empirical relation describing crack growth law – life calculations for a given load amplitude, Crack Initiation under large scale yielding thickness as a design parameter.

Expected outcome: The student will be able to

1. Describe theory, concepts and principles of fracture mechanics
2. Solve problems involving fractures using analytical and computational tools
3. Predict the life of mechanical parts using the concepts of fracture mechanics

Text Books:

1. Preshant Kumar, “Elements of Fracture Mechanics”, Wheeler Publishing, 1999.

References:

1. David Broek,” Elementary Engineering Fracture Mechanics “, Fifth off and Noerdhoff International Publisher, 1978.
2. Kare Hellan, “Introduction of Fracture Mechanics”, McGraw-Hill Book Company,1985.
3. John M. Barson and Stanely T. Rolfe Fatigue and fracture control in structures Prentice hall Inc. Englewood cliffs. 1977Prager W., “Introduction to Plasticity”, Oxford University Press, 1959.
4. Kachanov.L.M., “Foundations of Theory of Plasticity”, North-Holland Publishing Co., 1971.

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks; (%)**
Module 1 The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis – Airy’s function – field equation for stress intensity factor.	7	9 (15)
Module 2 Two dimensional elastic fields – Analytical solutions yielding near a crack front.	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Irwin’s approximation - plastic zone size – Dugdaale model determination of integral and its relation to crack opening displacement.	7	9 (15)

Module 4 Griffith analysis – stable and unstable crack growth –Dynamic energy balance –crack arrest mechanism –K1c test methods - R curves - determination of collapse load.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Empirical relation describing crack growth law – life calculations for a given load amplitude – effects of changing the load spectrum -- rain flow method– external factors affecting the K1c values.- leak before break analysis.	7	12 (20)
Module 6 Crack Initiation under large scale yielding thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields – numerical methods.	7	12 (20)

04 ME 6624 - **Syllabus**

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Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6624	**Composite Materials and Mechanics**	3-0-0	3	2020

Prerequisite: Nil

Course Objectives: The main objectives of this course are

1. To impart knowledge about different types of composites
2. To know the formulation of constitutive relations
3. To gain knowledge about the different properties of composites.

Syllabus: Lamina constitutive relations**,** Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law

Expected outcome: The student will be able to

1. Describe the general characteristics and applications of composite materials
2. Apply constitutive equations of composite materials and understand mechanical behaviour at micro and macro levels
3. Determine stresses and strains relation in composites materials.
4. Analyze the properties of a composite material based on given data

Reference books

1. Issac M. Daniel and OriIshai, "Engineering Mechanics of Composite Materials",Oxford University Press-2006, First Indian Edition – 2007.
2. Mallick, P.K., Fiber –"Reinforced Composites: Materials, Manufacturing and Design",
3. Maneel Dekker Inc, 1993.
4. Halpin, J.C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.
5. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
6. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.
7. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures".
8. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill,1994,Second Edition - CRC press in progress.
9. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 1998.

COURSE PLAN

MODULES	Contact hours	Sem. Exam Marks; (%)
Module 1 General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina –Isotropic limit case	7	9 (15)

Module 2 Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina – Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding – Compression Moulding –Pultrusion – Filament Winding – Other Manufacturing Processes.	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations –Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina. Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates	7	9 (15)
Module 4 Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies.	6	12 (20)
Module 6 Modification of Hooke's Law due to thermal properties - Modification of Laminate Constitutive Equations. Orthotropic Lamina - special Laminate Configurations –Unidirectional, Off-axis, Symmetric Balanced Laminates - Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates.	8	12 (20)

04 ME 6692 – Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6692	**Mini Project**	0-0-2	2	2020

Prerequisite: Nil

Course Objectives: The objectives of the course is/are

1. To prepare students for final year project

Syllabus

The aim of the mini project is to prepare the students for the final year project. The topic for the mini project should be simple as compared to the main project, but should cover all the aspects of a complete project

Expected outcome: At the end of the course, the student will be able to

1. Practice acquired knowledge related to Engineering Design for project development.
2. Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach
3. Apply practical tools/techniques in order to solve actual problems related to Industry
4. Communicate and report effectively project related activities and findings

04 ME 6694 – Syllabus

Course No.	Course Name	L-T-P	Credits	Year of Introduction
04 ME 6694	**Product Analysis and Testing Lab**	0-0-2	1	2020

Prerequisite: Nil

Course Objectives: The objectives of the course are

1. To Practice the modelling of mechanical system/components using application software
2. To Practice the modelling of control systems
3. To gain practical knowledge about vibrational systems
4. To acquire expertise in experimental stress analysis

Syllabus

Part A

Computer Aided Engineering Simulation: -

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ ABAQUS /Hyper mesh etc., Exercises shall include analysis of i) Machine elements under Static loads, thermal Analysis of mechanical systems/iii) Vibration Analysis, Machine elements under Dynamic loads, Electro Mechanical Coupled problems, Non-linear contact problems, flow analysis using CFD tools

Part B

Simulation of Control Systems: -

Stability analysis of a system by plotting Root locus and Bode plot using MATLAB software. State space model for classical transfer function using MATLAB, Real Time Liquid Level Control Using P, PI and PID Controllers, Speed and position control using DC servo motor.

Part C

Experimental System Analysis: -

Whirling of shafts, Free vibration analysis, forced vibration analysis, Torsional vibration analysis, balancing of revolving masses, Vibration signature analysis of different existing machines such as Lathe, Grinder, Compressors, Blower etc, Vibration analysis of roller bearings, vibration analysis using FFT analyser, Machine Condition Monitoring

Part D

Experimental Stress Analysis: -

Stress Analysis using strain gauge, photo elastic and holographic methods

Note: Should do at least 15 exercises from the four parts of the syllabus

Expected outcome: At the end of the course, the student will be able to

1. Analyse structural, thermal and coupled problems
2. Design control system using simulation software.
3. Do the condition monitoring of mechanical systems
4. Validate stress analysis results obtained through simulation

No	List of Exercises	Course Outcomes	No of Hours
1	Analysis of a cantilever Beam	CO 1	2
2	Analysis of a plane stress situation	CO 1	2
3	Analysis involving plane strain condition	CO 1	2
4	Heat transfer analysis	CO 1	2
5	Analysis of a thermo mechanical coupled problem	CO 1	2
6	Analysis of an electro mechanical coupling problem	CO 1	2
7	Electromagnetic field simulation	CO 1	2
8	Two-dimensional flow analysis	CO 1	2
9	Three-dimensional flow analysis	CO 1	2
10	Stability analysis of a system by plotting Root locus and Bode plot using software	CO 2	1
11	State space model for classical transfer function using software	CO 2	1
12	Real Time Liquid Level Control Using P, PI and PID Controllers		
13	Condition monitoring of machinery with FFT analysis	CO 3	1
14	Vibration level estimation of machinery	CO 3	1
15	Condition monitoring of bearings	CO 3	1
16	Natural frequency estimation based on bump testing	CO 3	2
17	Conduct stress measurement on a 3-point bending polycarbonate beam using photoelasticity.	CO 4	2
18	Conduct strain measurement on an axially loaded member using moire fringe method.	CO 4	2
19	Conduct strain measurement of cantilever beam using a strain gauge.	CO 4	2
20	Conduct strain measurement of cantilever beam using three strain gauges in rectangular rosette	CO 4	2
21	Conduct Strain measurement using holography method	CO 4	2

SUMMER BREAK

04 ME 7690-Syllabus

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7690	Industrial Training	0-0-4	4	2020

Prerequisite: Nil

Course Objectives: The objective is

1. To gain knowledge in industrial practices and thereby make students industry ready

Syllabus:

The student shall undergo an industrial training for a minimum period of 12 weeks in an industry/ company approved by the institution and under the guidance of a staff member in the concerned field. The candidate is also required to identify, define, formulate and offer an acceptable solution for a problem observed in the organization. At the end of the training he/she has to submit a report on the work being carried out.

Expected outcome: The student will be able to

1. Present the functional aspects and technical aspects of the organization related to the Engineering Design domain
2. Identify, define, formulate and offer an acceptable solution for a problem observed in the organization
3. Communicate and report effectively training related activities and findings

SEMESTER III

04 ME 7601- **Syllabus**

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7601	**Micro Electro Mechanical Systems**	3-0-0	3	2020

Prerequisite: Nil

Course Objectives: The objectives of the course is/are

1. To introduce the new field –micro electro mechanical systems
2. To know the application of micro electro mechanical systems

Syllabus

Materials-substrates, Additive materials. Fabrication techniques-Standard IC packages-ceramic, plastic and metal packages. Packaging process, Piezo resistivity, Piezoelectricity, Capacitive Techniques, Techniques for sensing-Physics of pressure sensing-Pressure sensor specifications, -Silicon based devises-Optical devises-capacitive devises-Magnetic devices.

Expected outcome: The student will be able to

1. Describe the systems, components and properties of Micro Electro Mechanical Systems
2. Select MEMS sensors for the mechanical system design.
3. Create pressure sensor (MEMS type) specifications required for a situation

Text Books:

1. Nadim Maluf and Kirt Williams,' An introduction to Micro electro mechanical System Engineering,Artech House, Inc. Boston.2003.

References:

1. Stephen Beeby, Graham Ensell, Michael Kraft and Neil White,' MEMS Mechanical sensors' Artech House, Inc. Boston 2003

COURSE PLAN		
MODULES	**Contact hours**	**Sem Exam Marks; %**
Module 1 Introduction, Materials-substrates, Additive materials. Fabrication techniques- Deposition, Lithography, etching, Surface micro machining, Thick film screen-printing and electroplating.	7	9 (15)
Module 2 Introduction, Standard IC packages-ceramic, plastic and metal packages. Packaging process-Electrical interconnects, Methods of die attachment, sealing techniques. MEMS mechanical sensor packaging.	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Piezo resistivity, Piezoelectricity, Capacitive Techniques, Optical techniques, Resonant techniques. Actuation techniques	7	9 (15)
Module 4 Smart Sensors. MEMS Simulation and Design Tools-Behavioral model ling simulation tools and Finite element simulation tools	7	9 (15)
SECOND INTERNAL TEST		

Module 5 Introduction-Techniques for sensing-Physics of pressure sensing-Pressure sensor specifications-Dynamic pressure sensing. Pressure sensor types-MEMS technology pressure sensors-Micro machined silicon diaphragms.	7	12 (20)
Module 6 Introduction-Silicon based devises-Optical devises-capacitive devises-Magnetic Devices-Atomic force microscope and scanning probes- micro machined accelerometer-Micro machined Gyroscope-Future inertial micro machined sensors.	7	12 (20)

04 ME 7603 – **Syllabus**

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7603	**Computational Fluid Mechanics**	3-0-0	3	2020

Prerequisite: Basic Mechanical Engineering and under graduate courses in Mathematics

Course Objectives: The objectives of the course are to give the student:

1. An introduction of numerical approach in fluid mechanics and heat transfer
2. Foundation for different discretization scheme using Taylor series expansion and develop skills to check consistency, stability and errors of those scheme
3. Basics of point-by-point and line-by-line method, explicit, implicit, Crank-Nicholson and ADI schemes used in heat conduction problems
4. Fundamentals of finite volume method for diffusion and convection-diffusion problems

Syllabus:

Governing equations of fluid mechanics and heat transfer; classifications of PDE Experimental, theoretical and numerical approaches. Discretization- Taylor's series approach. Errors, consistency, stability and convergence analysis. Steady 1D and 2D heat conduction problems; point-by-point and line-by-line method; Dirichlet, Neumann, and Robins boundary conditions; tri-diagonal matrix algorithm; transient heat conduction problems -explicit, implicit, Crank-Nicholson and ADI schemes. Finite volume method for diffusion and convection-diffusion problems; upwind, hybrid, power-law and QUICK schemes stream function-vorticity formulation; SIMPLE algorithm

Expected outcome: The student will be able to

1. Apply the computational methods to solve heat transfer and fluid flow problems numerically.
2. Do numerical analysis like consistency, stability and errors of different finite difference scheme.
3. Conduct CFD analysis for a physical problem

Text Books:

1. Anderson, D, A, Tannehill, J C, and R H Pletcher, R H, Computational Fluid Mechanics and Heat Transfer, Second Edition, Taylor & Francis, 1995
2. Muraleedhar, K and T Sundararaja T(eds.) Computational Fluid flow and Heat Transfer, Second Edition, Narosa Publishing House, 2003.
4. Versteeg, H K and W Malalasekera, W, An Introduction to Computational Fluid Dynamics: The Finite Volume method, Addison Wesley-Longman, 1995
4. Patankar, S, V, Numerical Heat Transfer and Fluid Flow, Hemisphere, 1980.

References:

1. Klaus A. Hoffmann, Steve T Chiang, Computational Fluid Dynamics, Fourth Edition, Volume 1, Engineering Education System, 2000.
2. Hornbeck, R W, Numerical Marching Techniques for Fluid Flows with Heat Transfer, NASA, SP -297, 1973.
3. Computational Fluid Dynamics: The Basics with Applications – John D Anderson, Jr, McGraw-Hill, 1995
4. Computational Methods for Fluid Dynamics - Joel H. Ferziger and Milovan Peric. Springer

COURSE PLAN		
MODULES	**Contact hours**	**Sem Exam Marks; %**
Module 1 Governing equations of fluid mechanics and heat transfer; fundamental equations – continuity equation, momentum equation and energy equation; non-dimensional form of equations; averaged equations for turbulent flows; boundary layer equations for steady incompressible flows.	7	9 (15)
Module 2 Physical and mathematical classifications of partial differential equations. Comparison of experimental, theoretical and numerical approaches; applications of CFD. Discretization-converting derivatives to their finite difference forms-Taylor's series approach, polynomial fitting approach; forward, backward and central differencing Schemes. Discretization error, truncation error, round off error.	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Consistency and numerical stability analysis of different schemes-case studies; iterative convergence, condition for convergence, rate of convergence; under and over relaxations, termination of iteration.	7	9 (15)
Module 4 Steady one–dimensional conduction in Cartesian and cylindrical coordinates; handling of boundary conditions; two-dimensional steady state conduction problems; point-by-point and line-by-line method of solution; dealing with Dirichlet, Neumann, and Robins type boundary conditions; tri-diagonal matrix algorithm; transient heat conduction problems -explicit, implicit, Crank-Nicholson and ADI schemes; stability criterion of these schemes.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Finite volume method for diffusion and convection-diffusion problems; steady one-dimensional convection and diffusion; upwind, hybrid, power-law and QUICK schemes; false diffusion	7	12 (20)
Module 6 Properties of discretization schemes; conservativeness, boundedness, transportiveness. Computation of the flow field using stream function-vorticity formulation. Solution algorithm for pressure-velocity coupling in steady flows-SIMPLE algorithm	7	12 (20)

04 ME 7605 – **Syllabus**

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7605	**Vehicle Dynamics**	3-0-0	3	2020

Prerequisite: Engineering Mechanics

Course Objective: The objectives of the course is/are

1. To provide an overview of important concepts of road vehicle dynamics.

Syllabus:

Introduction to Vehicle Dynamics, Longitudinal Dynamics, Tire Mechanics, Tire Model, Lateral Dynamics, Subjective and Objective Evaluation of Vehicle Handling, Vertical Dynamics, Noise, Vibration and Harshness.

Expected outcome: The student will be able to

1. Analyze road vehicles for their longitudinal dynamic response during acceleration and braking.
2. Analyze road vehicles for their lateral dynamic response during cornering.
3. Analyze road vehicles for their vertical dynamic response to analyze ride, pitch and roll.

Reference books

1. Wong, Jo Yung. Theory of ground vehicles. John Wiley & Sons, 2001.
2. R. Rajamani, Vehicle Dynamics and Control.
3. R. N. Jazar, Vehicle Dynamics: Theory and Application
4.. Gillespie, Thomas D. Fundamentals of vehicle dynamics, 1992.

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks; (%)**
Module 1 Introduction to Vehicle Dynamics, Longitudinal Dynamics, Vehicle Load Distribution – Acceleration and Braking - Brake Force Distribution Braking Efficiency and Braking Distance - Longitudinal dynamics of a Tractor-Semi Trailer	7	9 (15)
Module 2 Tire Mechanics – An Introduction, Mechanical Properties of Rubber - Slip, Grip and Rolling Resistance - Tire Construction and Force Development - Contact Patch and Contact Pressure Distribution	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Tire Model, Lateral Force Generation - Ply Steer and Conicity - Tire Models – Magic Formula - Classification of Tire Models and Combined Slip	6	9 (15)

Module 4 Lateral Dynamics-Bicycle Model - Stability and Steering Conditions - Understeer Gradient and State space Approach - Handling Response of a Vehicle - Mimuro Plot for Lateral Transient Response - Parameters affecting vehicle handling characteristics	8	9 (15)
SECOND INTERNAL TEST		
Module 5 Subjective and Objective Evaluation of Vehicle Handling, Rollover prevention	7	12 (20)
Module 6 Vertical Dynamics - quarter car model, Noise, Vibration and Harshness – Random Processes	7	12 (20)

04 ME 7607 – **Syllabus**

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7607	**Design of Material handling Equipment**	3-0-0	3	2020

Prerequisite: Engineering Mechanics

Course Objectives: The objectives of the course is/are

1. To know different types of material handling equipment
2. To design material handling equipment like hoists, conveyors elevators etc

Syllabus

Types, selection and applications-Design of hoisting elements: Welded and roller chains, Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes, Types - description - design and applications of Belt conveyors, apron conveyors, Bucket elevators: design - loading and bucket arrangements - Cage elevators.

Expected outcome: The student will be able to

1. Select the correct type of material handling equipment for the situation
2. Design the components of material handling systems
3. Design material handling systems like hoists, conveyors elevators etc

Text Books:

1. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
2. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.

References:

1. Alexandrov, M., Materials Handling Equipment, MIR Publishers, 1981.
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
3. P.S.G. Tech., “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2003.
4. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers, Bangalore, 1983.

COURSE PLAN		
MODULES	**Contact hours**	**Sem Exam Marks; %**
Module 1 Hoists **T**ypes, selection and applications-Design of hoisting elements: Welded and roller chains - Hemp and wire ropes	7	9 (15)
Module 2 Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Lifting magnets -Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.	7	9 (15)

Module 4 Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Conveyors: Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors	7	12 (20)
Module 6 Elevators**:** Bucket elevators: design - loading and bucket arrangements - Cage elevators – shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift, trucks.	7	12 (20)

04 ME 7609 – **Syllabus**

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7609	**Rapid Prototyping and Tooling**	3-0-0	3	2020

Prerequisite: Nil

Course Objectives: The objectives of the course is/are

1. To know different types of rapid prototyping processes.
2. To know how to do the rapid prototyping of 3D models.

Syllabus

Need - Development of RP systems – RP process chain -Stereolithography Apparatus, Fused deposition Modelling, Laminated object manufacturing, – Data Processing for Rapid Prototyping: CAD model preparation, Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronics industries.

Expected outcome: The student will be able to

1. Describe the different types of rapid prototyping process
2. Design the prototype for rapid prototyping
3. Do the rapid prototyping of any model

Text Books:

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
2. Rapid Tooling: Technologies and Industrial Applications, Peter D. Hilton, Hilton/Jacobs, Paul F. Jacobs, CRC press, 2000

References:

1. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
2. Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou W. Liou, Frank W.Liou, CRC Press, 2007.
3. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006.

COURSE PLAN		
MODULES	**Contact hours**	**Sem Exam Marks; %**
Module 1 Introduction: Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development - Benefits- Applications – Digital prototyping - Virtual prototyping.	7	9 (15)
Module 2 Liquid based and solid based rapid prototyping systems: Stereolithography Apparatus, Fused deposition Modelling, Laminated object manufacturing, three-dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies	7	9 (15)
FIRST INTERNAL TEST		

Module 3 Powder based rapid prototyping systems: Selective Laser Sintering, Direct Metal Laser Sintering, Three-Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies	7	9 (15)
Module 4 Reverse engineering and cad tooling: Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Geometric modelling techniques: Wire frame, surface and solid modelling – data formats – Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation	7	12 (20)
Module 6 Rapid Tooling: Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect –Fabrication processes, Applications. Case studies - automotive, aerospace and electronics industries.	7	12 (20)

04 ME 7611 – Syllabus

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7611	**Electric and hybrid vehicles**	3-0-0	3	2020

Prerequisite: Basic Electrical and Electronics Engineering

Course Objectives: The objectives of the course is/are

1. To impart knowledge about electric vehicles.

Syllabus

Introduction to Hybrid Electric Vehicles and Electric Vehicle, Types of EVs, Hybrid Electric Drive-train, Electric Drives Energy Consumption, Architecture of Hybrid Electric Drive Trains, Configuration and control of motors, Energy Storage System, Battery & fuel cell based energy storage and its analysis, Hybridization of different energy storage devices, Reverse engineering and cad tooling, Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping. Connected Mobility and Autonomous Mobility, EVs in infrastructure system

Expected outcome: The student will be able to

1. Understand the basics of hybrid electric vehicle
2. Understand about drives and control
3. Select battery and apply the concept of battery management system
4. Design battery charger for an EV
5. Describe the latest trends in E–vehicle networking

References:

1. Emadi A (Ed) Miller J Ehsani M," Vehicular Electric Power system", Boca Raton, CRC Press 2003
2. Husain I," Electric and Hybrid Vehicles", Boca Raton, CRC Press 2003
3. Larminie, James and John Lowry," Electric Vehicle Technology Explained", John Wiley and sons,2012
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
5. Dominique Paret, "Multiplexed Networks for Embedded Systems: CAN, LIN, Flex Ray, Safe-by-Wire", Wiley,2007.

COURSE PLAN

MODULES	Contact hours	Sem Exam Marks; %
Module 1 Review of Conventional Vehicle. Introduction to Hybrid Electric Vehicles and Electric Vehicles. Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving.	7	9 (15)
Module 2 Electric Drives Energy Consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor	7	9 (15)

FIRST INTERNAL TEST		
Module 3 Energy Storage System: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles: - Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system.	7	9 (15)
Module 4 Reverse engineering and cad tooling: Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Connected Mobility and Autonomous Mobility- case study E-mobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. Connectors- Types of EV charging connector, North American EV Plug Standards, DC Fast Charge CCS (Combined Charging System), Tesla, European EV Plug Standards	7	12 (20)
Module 6 Vehicular Communications: Intelligent Transportation Systems: IEEE 802.11p-ITS-IVC: Inter Vehicle Communications- Mobile Wireless Communications and Networks- Architecture Layers Communication Regime.V2V, V2I-VANET-WAVE; DSRC. Information In The Vehicle Network Routing-Physical Layer Technologies-Medium Access For Vehicular Communications- Security Applications And Case Studies.	7	12 (20)

04 ME 7613 - Syllabus

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7613	**Modal Analysis of Mechanical Systems**	3-0-0	3	2020

Prerequisite: A course on Vibration Analysis and Control

Course Objectives: The objectives of the course is/are

1. To understand the theoretical procedure for conducting the modal analysis
2. To know the extraction of modal parameters

Syllabus:

Introduction to Modal Testing – Applications of Modal Testing – Philosophy of Modal Testing –Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data, – Basic Measurement System – Structure preparation – Excitation of the Structure, SDOF Modal Analysis-I – Peak amplitude– SDOF Modal Analysis-II – Circle Fit Method, Derivation of mathematical models.

Expected outcomes: The student will be able to

1. Set up the system for modal analysis of specimens
2. Conduct the modal analysis of specimens
3. Interpret the results obtained from experimental modal analysis

Text Books:

1. Ewins D J, "Modal Testing: Theory and Practice ", John Wiley & Sons Inc., 1988.

References:

1. Nuno Manuel Mendes Maia et al," Theoretical and Experimental Modal Analysis", Wiley John& sons, 1997.

COURSE PLAN		
MODULES	**Contact hours**	**Sem Exam Marks; %**
Module 1 Overview: Introduction to Modal Testing – Applications of Modal Testing – Philosophy of Modal Testing – Summary of Theory – Summary of Measurement Methods – Summary of Analysis – Review of Test Procedure	7	9 (15)
Module 2 Theoretical Basis: Introduction – Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data for SDOP System – Undamped Multi-degree of freedom (MDOF) system	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Proportional Damping – Hysteretic Damping – General Case –Viscous Damping – General Case – Characteristics and presentation of MDOF – FRF Data – Complete and incomplete models - Non-sinusoidal vibration and FRF- Properties – Analysis of Weakly Nonlinear Structures.	7	9 (15)

Module 4 Basic Measurement System – Structure preparation – Excitation of the Structure – Transducers and Amplifiers – Analyzers – Digital Signal Processing –Use of Different Excitation types – Calibration – Mass Cancellation – Rotational Mobility Measurement – Measurement on Nonlinear structures – Multi pointe excitation methods.	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Modal Parameter extraction methods**:** Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak amplitude– SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III –Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Nonlinear systems.	7	12 (20)
Module 6 Derivation of Mathematical Models- Introduction – Modal Models – Display of Modal Model – Response Models – Spatial Models – Mobility Skeletons and System Models.	7	12 (20)

04 ME 7615 -Syllabus

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7615	**Industrial Robotics and Expert Systems**	3-0-0	3	2020

Prerequisite: Basic knowledge in Mechanics and Electronics

Course Objectives: The objectives of the course is/are

1. To understand the basic kinematics of robotics
2. To impart knowledge about robotic drives, control and programming
3. To impart an idea about artificial intelligence and expert systems

Syllabus

Robot anatomy – Work volume –Precision movement – End effectors – Sensors. Robot Kinematics, Controlling the Robot motion – Position and velocity sensing devices, Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces, Robot work cell design and control, Methods of Robot Programming

Expected outcome: The student will be able to

1. Do the direct and reverse kinematics
2. Select the sensors, drivers and controllers
3. Design the work cells for robots
4. Do the programming of robots

Text Book

1. K.S. Fu, R.C. Gonzalez and C.S.G. Lee, “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 1987.rewal, B.S., Higher Engineering Mathematics, 40th edition, Khanna

References:

1. Yoram Koren,” Robotics for Engineers’ McGraw-Hill, 1987.
2. Kozyrey, Yu. “Industrial Robots”, MIR Publishers Moscow, 1985.
3. Richard. D, K lafter, Thomas, A, Chmielewski, Michael Negin, “Robotics Engineering – An Integrated Approach”, Prentice-Hall of India Pvt. Ltd., 1984.
4. Deb, S.R.” Robotics Technology and Flexible Automation”, Tata Mc Graw-Hill,1994.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey,” Industrial Robotics Technology, Programming and Applications”, McGraw-Hill, Int. 1986.
6. Timothy Jordanides et al,” Expert Systems and Robotics “, Springer –Verlag, New York, May 1991.

COURSE PLAN		
MODULES	**Contact hours**	**Sem Exam Marks; %**
Module 1 Introduction: Definition need and scope of Industrial robots – Robot anatomy – Work volume –Precision movement – End effectors – Sensors	7	9 (15)
Module 2 Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects	7	9 (15)
FIRST INTERNAL TEST		
Module 3 Robot drives and control: Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.	7	9 (15)
Module 4 Robot sensors**:** Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system	7	9 (15)
SECOND INTERNAL TEST		
Module 5 Robot work cell design and control – Safety in Robotics – Robot cell layouts –Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots	7	12 (20)
Module 6 Robot Programming, Artificial Intelligence and Expert systems Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics– Goals of artificial intelligence – AI techniques – problem representation in AI –Problem reduction and solution techniques - Application of AI and KBES in Robots	7	12 (20)

04 ME 7691 - Syllabus

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7691	**SEMINAR II**	0-0-2	2	2020

Prerequisite: Nil

Course Objectives: The objectives of the course are

1. To improve written and oral presentation skills and to develop confidence in making public technical presentations
2. To introduce a new relevant topic and share it to the peer group

Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses being undergone in the first semester of the M. Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student's paper, presentation and his/her participation in the seminar.

Goals: This course is designed to improve written and oral presentation skills and to develop confidence in making public presentations, to provide feedback on the quality and appropriateness of the work experience, and to promote discussions on design problems or new developments or ethical and safety issues in the workplace.

Expected outcome: At the end of the course, the student will be able to

1. Identify new directions in Engineering Design domain related to the core/elective courses
2. Demonstrate oral presentation skills
3. Demonstrate public engagement skills
4. Prepare comprehensive report based on literature survey on a technical topic

04 ME 7693 – **Syllabus**

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7693	**Project (Phase I)**	0-0-12	6	2020

Prerequisite: Nil

Course Objectives: The objectives of the course is/are

1. To identify a real-time mechanical design problem and prepare a mathematical model for the same.

The thesis (Phase I) shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject of specialization or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed.

In Phase I of the thesis it is expected that the student should decide a topic of thesis, which is useful in the field or practical life. It is expected that students should refer national and international journals, proceedings of national and international seminars. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work/experimentation carried out on the thesis topic.

Student should submit Phase I thesis report in two copies covering the content discussed above and highlighting the features of work to be carried out in part I of the thesis. Student should follow standard practice of thesis writing. The candidate will deliver a talk on the topic and the assessment will be made on the basic of the term work and talks there on by a panel of internal examiners one of which will be the internal guide. These examiners should give suggestions in writing to the student to be incorporated in thesis work Phase II.

Expected outcome: At the end of the course,

1. Identify a real-time mechanical design problem and prepare a mathematical model for the same.
2. Communicate and report effectively project related activities and findings as a bound volume

SEMESTER IV

04 ME 7694 – **Syllabus**

Course No	Course Name	L-T-P	Credits	Year of Introduction
04 ME 7694	**Project (Phase II)**	0-0-21	12	2020

Prerequisite: Nil

Course Objectives: The objectives of the course is/are

1. To find out a technical feasible solution for the mathematical model formulated in the Phase-I of project

Syllabus

In the fourth semester the student has continue thesis work and present the report. At the end of successfully finishing the work he/she has to submit a detailed report and has to present for a viva–voce. The work carried out should lead to a publication in a National / International Journal or Conference. They should have submitted the paper before M. Tech. evaluation and specific weightage should be given to accepted papers in reputed journals or conferences.

Expected outcome: At the end of the course students will be able to

1. Apply practical tools/techniques in order to solve a practical design problem
2. Communicate and report effectively project related activities and findings as a bound volume
3. Publish the work done related to the project in a National / International Conference or Journal