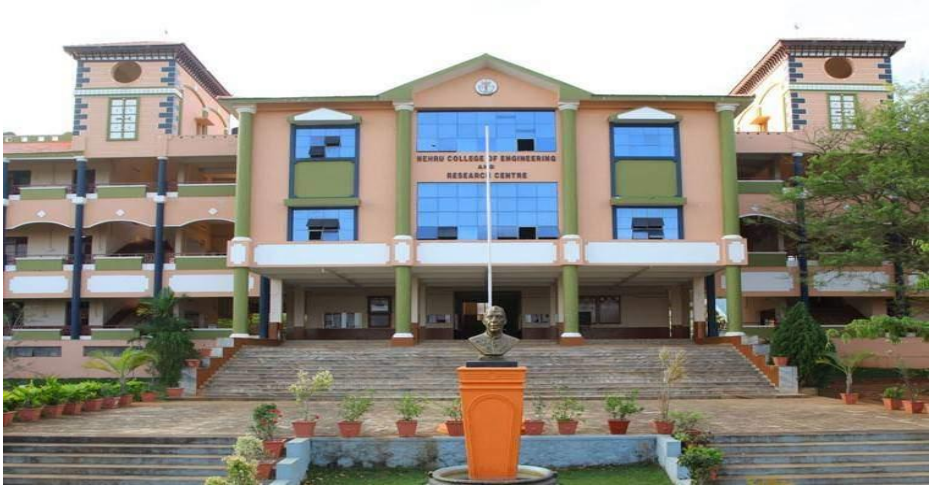
NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE
(NAAC Accredited)
(Approved by AICTE, Affiliated to APJ Abdul Kalam Technological University, Kerala)

DEPARTMENT OF MECHANICAL ENGINEERING

SYLLABUS BOOK FOR STUDENTS



VISION OF THE INSTITUTION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION OF THE INSTITUTION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values.

We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

ABOUT DEPARTMENT

- Established in: 2002
- Course offered : B.Tech in Mechanical Engineering
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to the University of Dr. A P J Abdul Kalam Technological University.

DEPARTMENT VISION

Producing internationally competitive Mechanical Engineers with social responsibility & sustainable employability through viable strategies as well as competent exposure oriented quality education.

DEPARTMENT MISSION

1. Imparting high impact education by providing conductive teaching learning environment.
2. Fostering effective modes of continuous learning process with moral & ethical values.
3. Enhancing leadership qualities with social commitment, professional attitude, unity, team spirit & communication skill.
4. Introducing the present scenario in research & development through collaborative efforts blended with industry & institution.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: Graduates shall have strong practical & technical exposures in the field of Mechanical Engineering & will contribute to the society through innovation & enterprise.

PEO2: Graduates will have the demonstrated ability to analyze, formulate & solve design engineering / thermal engineering / materials & manufacturing / design issues & real life problems.

PEO3: Graduates will be capable of pursuing Mechanical Engineering profession with good communication skills, leadership qualities, team spirit & communication skills.

PEO4: Graduates will sustain an appetite for continuous learning by pursuing higher education & research in the allied areas of technology.

PROGRAM OUTCOMES (POS)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and

norms of the engineering practice.

9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1: Students will be able to apply principles of engineering, basic sciences & analytics including multi variant calculus & higher order partial differential equations..

PSO2: Students will be able to perform modeling, analyzing, designing & simulating physical systems, components & processes.

PSO3: Students will be able to work professionally on mechanical systems, thermal systems & production systems.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Curriculum for

B.Tech Degree-ME

Semesters III to VIII

2016

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY CET

CAMPUS, THIRUVANANTHAPURAM – 695016 KERALA,

INDIA

Phone +91 471 2598122, 2598422
Fax +91 471 2598522 Web: ktu.edu.in Email: university@ktu.edu.in

SEMESTER - 3

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MA201	Linear Algebra & Complex Analysis	3-1-0	4	A
ME201	Mechanics of Solids	3-1-0	4	B
ME203	Mechanics of Fluids	3-1-0	4	C
ME205	Thermodynamics	3-1-0	4	D
ME210	Metallurgy and Materials Engineering	3-0-0	3	E
HS200/ HS210	Business Economics/Life Skills	3-0-0/ 2-0-2	3	F
ME231	Computer Aided Machine Drawing Lab	0-0-3	1	S
CE230	Material Testing Lab	0-0-3	1	T

Total Credits = 24 Hours: 28/29

Cumulative Credits= 71

SEMESTER - 4

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MA202	Probability Distributions, Transforms and Numerical Methods	3-1-0	4	A
ME202	Advanced Mechanics of Solids	3-1-0	4	B
ME204	Thermal Engineering	3-1-0	4	C
ME206	Fluid Machinery	2-1-0	3	D
ME220	Manufacturing Technology	3-0-0	3	E
HS210/ HS200	Life Skills/Business Economics	2-0-2/ 3-0-0	3	F
ME232	Thermal Engineering Lab	0-0-3	1	S
ME230	Fluid Mechanics & Machines Lab	0-0-3	1	T

Total Credits = 23 Hours 28/27 Cumulative Credits= 94

SEMESTER - 5

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
ME301	Mechanics of Machinery	3-1-0	4	A
ME303	Machine Tools & Digital Manufacturing	3-0-0	3	B
ME305	Computer Programming & Numerical Methods	2-0-1	3	C
EE311	Electrical Drives & Control for Automation	3-0-0	3	D
HS300	Principles of Management	3-0-0	3	E
	Elective 1	3-0-0	3	F
ME341	Design Project	0-1-2	2	S
EE335	Electrical and Electronics Lab	0-0-3	1	T
ME331	Manufacturing Technology Lab I	0-0-3	1	U

Total Credits = 23 Hours: 28

Cumulative Credits= 117

Elective 1:-

1. ME361 Advanced Fluid Mechanics
2. ME363 Composite Materials and Mechanics
3. ME365 Advanced Metal Casting
4. ME367 Non-Destructive Testing
5. ME369 Tribology
6. ME371 Nuclear Engineering
7. ME373 Human Relations Management

SEMESTER – 6

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
ME302	Heat & Mass Transfer	3-1-0	4	A
ME304	Dynamics of Machinery	2-1-0	3	B
ME306	Advanced Manufacturing Technology	3-0-0	3	C
ME308	Computer Aided Design and Analysis	3-0-0	3	D
ME312	Metrology and Instrumentation	3-0-0	3	E
	Elective 2	3-0-0	3	F
ME332	Computer Aided Design & Analysis Lab	0-0-3	1	S
ME334	Manufacturing Technology Lab II	0-0-3	1	T
ME352	Comprehensive Exam	0-1-1	2	U

Total Credits = 23 Hours: 27

Cumulative Credits= 140

Elective 2:-

1. ME362 Control System Engineering
2. ME364 Turbo Machinery
3. ME366 Advanced Metal Joining Technology
4. ME368 Marketing Management
5. ME372 Operations Research
6. ME374 Theory of Vibration
7. ME376 Maintenance Engineering

SEMESTER - 7

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
ME401	Design of Machine Elements I	3-1-0	4	A
ME403	Advanced Energy Engineering	3-0-0	3	B
ME405	Refrigeration and Air Conditioning	2-1-0	3	C
ME407	Mechatronics	3-0-0	3	D
ME409	Compressible Fluid Flow	2-1-0	3	E
	Elective 3	3-0-0	3	F
ME451	Seminar & Project Preliminary	0-1-4	2	S
ME431	Mechanical Engineering Lab	0-0-3	1	T

Total Credits = 22 Hours: 27

Cumulative Credits= 162

Elective 3:-

1. ME461 Aerospace Engineering
2. ME463 Automobile Engineering
3. ME465 Industrial Hydraulics
4. IE306 Supply Chain and Logistics Management
5. ME467 Cryogenic Engineering
6. ME469 Finite Element Analysis
7. ME471 Optimization Techniques

SEMESTER – 8

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
ME402	Design of Machine Elements II	3-0-0	3	A
ME404	Industrial Engineering	3-0-0	3	B
	Elective 4	3-0-0	3	C
	Elective 5 (Non Departmental)	3-0-0	3	D
ME492	Project		6	

Total Credits = 18 Hours: 30
Cumulative Credits= 180

1	ME462	Propulsion Engineering
2	ME464	Robotics and Automation
3	ME466	Computational Fluid Dynamics
4	ME468	Nanotechnology
5	ME472	Failure Analysis and Design
6	ME474	Micro and Nano Manufacturing
7	ME476	Material Handling & Facilities Planning

LIST OF NON DEPARTMENTAL COURSES

1. AE482 INDUSTRIAL INSTRUMENTATION
2. AE484 INSTRUMENTATION SYSTEM DESIGN
3. AO482 FLIGHT AGAINST GRAVITY
4. AU484 MICROPROCESSOR AND EMBEDDED SYSTEMS
5. AU486 NOISE, VIBRATION AND HARSHNESS
6. BM482 BIOMEDICAL INSTRUMENTATION
7. BM484 MEDICAL IMAGING & IMAGE PROCESSING TECHNIQUES
8. BT362 SUSTAINABLE ENERGY PROCESSES
9. BT461 DESIGN OF BIOLOGICAL WASTE WATER TREATMENT SYSTEMS
10. CE482 ENVIRONMENTAL IMPACT ASSESSMENT
11. CE484 APPLIED EARTH SYSTEMS
12. CE486 GEO INFORMATICS FOR INFRASTRUCTURE MANAGEMENT
13. CE488 DISASTER MANAGEMENT
14. CE494 ENVIRONMENTAL HEALTH AND SAFETY
15. CH482 PROCESS UTILITIES AND PIPE LINE DESIGN

16. CH484 FUEL CELL TECHNOLOGY
17. CS482 DATA STRUCTURES
18. CS484 COMPUTER GRAPHICS
19. CS486 OBJECT ORIENTED PROGRAMMING
20. CS488 C # AND .NET PROGRAMMING
21. EC482 BIOMEDICAL ENGINEERING
22. EE482 ENERGY MANAGEMENT AND AUDITING
23. EE484 CONTROL SYSTEMS
24. EE486 SOFT COMPUTING
25. EE488 INDUSTRIAL AUTOMATION
26. EE494 INSTRUMENTATION SYSTEMS
27. FS482 RESPONSIBLE ENGINEERING
28. FT482 FOOD PROCESS ENGINEERING
29. FT484 FOOD STORAGE ENGINEERING
30. IC482 BIOMEDICAL SIGNAL PROCESSING
32. IE482 FINANCIAL MANAGEMENT
33. IE484 INTRODUCTION TO BUSINESS ANALYTICS
34. IE486 DESIGN AND ANALYSIS OF EXPERIMENTS
35. IE488 TOTAL QUALITY MANAGEMENT
36. IT482 INFORMATION STORAGE MANAGEMENT
37. MA482 APPLIED LINEAR ALGEBRA
38. MA484 OPERATIONS RESEARCH
39. MA486 ADVANCED NUMERICAL COMPUTATIONS
40. MA488 CRYPTOGRAPHY
41. ME471 OPTIMIZATION TECHNIQUES
42. ME482 ENERGY CONSERVATION AND MANAGEMENT
43. ME484 FINITE ELEMENT ANALYSIS
44. MP469 INDUSTRIAL PSYCHOLOGY & ORGANIZATIONAL BEHAVIOUR
45. MP482 PRODUCT DEVELOPMENT AND DESIGN
46. MP484 PROJECT MANAGEMENT
47. MR482 MECHATRONICS
48. MT482 INDUSTRIAL SAFETY
49. SB482 DREDGERS AND HARBOUR CRAFTS

General Guidelines

1. Non departmental electives are courses offered by a department for students of other departments.
2. Students of a department cannot choose a course offered by his/her department. The college shall ensure this.
3. Also, the college should ensure that a student does not choose a course having contents in courses which he/she has studied in previous semester or is studying in the 8th Semester.
4. Each department should offer minimum one Non departmental elective.
5. Maximum number of students in a batch for non departmental elective shall be in the range 50-60 and minimum number around {Total students/(1.5*No of batches)}.
6. The syllabus of ND electives is available in KTU website.

Non-Departmental Elective Courses which are NOT eligible for Mechanical Engineering	COURSES NOT ELIGIBLE	COURSES CONDITIONALLY ELIGIBLE
	ME482, ME484, ME471, EE482, MR482 EE484	(ME362), EE488 (ME464), MA484 (ME372)

SEMESTER 3

Course No.	Course Name	L-T-P - Credits	Year of Introduction
MA201	LINEAR ALGEBRA AND COMPLEX ANALYSIS	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

COURSE OBJECTIVES

- To equip the students with methods of solving a general system of linear equations.
- To familiarize them with the concept of Eigen values and diagonalization of a matrix which have many applications in Engineering.
- To understand the basic theory of functions of a complex variable and conformal Transformations**.**

Syllabus

Analyticity of complex functions-Complex differentiation-Conformal mappings-Complex integration-System of linear equations-Eigen value problem

Expected outcome .

At the end of the course students will be able to
(i) solve any given system of linear equations
(ii) find the Eigen values of a matrix and how to diagonalize a matrix
(iii) identify analytic functions and Harmonic functions.
(iv)evaluate real definite Integrals as application of Residue Theorem
(v) identify conformal mappings(vi) find regions that are mapped under certain Transformations

Text Book:

Erwin Kreyszig: Advanced Engineering Mathematics, 10th ed. Wiley

References:

1.Dennis g Zill&Patric D Shanahan-A first Course in Complex Analysis with Applications-Jones&Bartlet Publishers
2.B. S. Grewal. Higher Engineering Mathematics, Khanna Publishers, New Delhi.
3.Lipschutz, Linear Algebra,3e **(** Schaums **Series)**McGraw Hill Education India 2005
4.Complex variables introduction and applications-second edition-Mark.J.Owitz-Cambridge Publication

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Complex differentiation Text 1[13.3,13.4] Limit, continuity and derivative of complex functions	3	
	Analytic Functions	2	
	Cauchy–Riemann Equation(Proof of sufficient condition of analyticity & C R Equations in polar form not required)-Laplace's Equation	2	
	Harmonic functions, Harmonic Conjugate	2	15%
II	Conformal mapping: Text 1[17.1-17.4] Geometry of Analytic functions Conformal Mapping,	1	
	Mapping $w = z^2$ conformality of $w = e^z$.	2	15%

	The mapping $w = z + \frac{1}{z}$ Properties of $w = \frac{1}{z}$ Circles and straight lines, extended complex plane, fixed points Special linear fractional Transformations, Cross Ratio, Cross Ratio property-Mapping of disks and half planes Conformal mapping by $w = \sin z$ & $w = \cos z$ (Assignment: Application of analytic functions in Engineering)	1 3 3	
FIRST INTERNAL EXAMINATION			
III	Complex Integration. Text 1[14.1-14.4] [15.4&16.1] Definition Complex Line Integrals, First Evaluation Method, Second Evaluation Method Cauchy's Integral Theorem(without proof), Independence of path(without proof), Cauchy's Integral Theorem for Multiply Connected Domains (without proof) Cauchy's Integral Formula- Derivatives of Analytic Functions(without proof)Application of derivative of Analytical Functions Taylor and Maclaurin series(without proof), Power series as Taylor series, Practical methods(without proof) Laurent's series (without proof)	2 2 2 2 2	15%
IV	Residue Integration Text 1 [16.2-16.4] Singularities, Zeros, Poles, Essential singularity, Zeros of analytic functions Residue Integration Method, Formulas for Residues, Several singularities inside the contour Residue Theorem. Evaluation of Real Integrals (i) Integrals of rational functions of $\sin\theta$ and $\cos\theta$ (ii)Integrals of the type $\int_{-\infty}^{\infty} f(x)dx$ (Type I, Integrals from 0 to ∞) (Assignment : Application of Complex integration in Engineering)	2 4 3	15%
SECOND INTERNAL EXAMINATION			
	Linear system of Equations Text 1(7.3-7.5) Linear systems of Equations, Coefficient Matrix, Augmented Matrix	 1	20%

V	Gauss Elimination and back-substitution, Elementary row operations, Row equivalent systems, Gauss elimination-Three possible cases, Row Echelon form and Information from it.	5	
	Linear independence-rank of a matrix Vector Space-Dimension-basis-vector space $\mathbf{R^3}$	2	
	Solution of linear systems, Fundamental theorem of non-homogeneous linear systems(Without proof)-Homogeneous linear systems (Theory only	1	
VI	Matrix Eigen value Problem Text 1.(8.1,8.3 &8.4) Determination of Eigen values and Eigen vectors-Eigen space	3	20%
	Symmetric, Skew Symmetric and Orthogonal matrices –simple properties (without proof)	2	
	Basis of Eigen vectors- Similar matrices Diagonalization of a matrix-Quadratic forms- Principal axis theorem(without proof) (Assignment-Some applications of Eigen values(8.2))	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks : 100 Exam Duration: 3 hours

The question paper will consist of 3 parts.

Part A will have 3 questions of 15 marks each uniformly covering modules I and II. Each question may have two sub questions.

Part B will have 3 questions of 15 marks each uniformly covering modules III and IV. Each question may have two sub questions.

Part C will have 3 questions of 20 marks each uniformly covering modules V and VI. Each question may have three sub questions.

Any two questions from each part have to be answered.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME201	MECHANICS OF SOLIDS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To acquaint with the basic concepts of stress and deformation in solids.
2. To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.

Syllabus

Analysis of deformable bodies : stress, strain, material behaviour, deformation in axially loaded bars, biaxial and triaxial deformation. Torsion of elastic circular members, design of shafts. Axial force, shear force and bending moment in beams. Stresses in beams: flexure and shear stress formulae, design of beams. Deflection of beams. Transformation equations for plane state of stress and strain, principal planes and stresses, Mohr's circle. Compound stresses: combined axial, flexural and shear loads – eccentric loading. Buckling: Euler's theory and Rankine's formula for columns.

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

1. Understand basic concepts of stress and strain in solids.
2. Determine the stresses in simple structural members such as shafts, beams, columns etc. and apply these results in simple design problems.
3. Determine principal planes and stresses, and apply the results to combined loading case.

Text Books:

1. Rattan, Strength of Materials, 2e McGraw Hill Education India, 2011
2. S.Jose, Sudhi Mary Kurian, Mechanics of Solids, Pentagon, 2015

References Books:

1. S. H. Crandal, N. C. Dhal, T. J. Lardner, An introduction to the Mechanics of Solids, McGraw Hill, 1999
2. R. C. Hibbeler, Mechanics of Materials, Pearson Education,2008
3. I.H. Shames, J. H. Pitarresi, Introduction to Solid Mechanics, Prentice Hall of India, 2006
4. James M.Gere, Stephen Timoshenko, Mechanics of Materials, CBS Publishers & Distributors, New Delhi,2012
5. F. Beer, E. R. Johnston, J. T. DeWolf, Mechanics of Materials, Tata McGraw Hill, 2011
6. A. Pytel, F. L. Singer, Strength of Materials, Harper & Row Publishers, New York,1998
7. E. P. Popov, T. A. Balan, Engineering Mechanics of Solids, Pearson Education, 2012
8. R. K. Bansal, Mechanics of solids, Laxmi Publications, 2004
9. P. N. Singh, P. K. Jha, Elementary Mechanics of Solids, Wiley Eastern Limited, 2012

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction to analysis of deformable bodies – internal forces – method of sections – assumptions and limitations. Stress – stresses due to normal, shear and bearing loads – strength design of simple members. Definition of linear and shear strains.	3	15%
	Material behavior – uniaxial tension test – stress-strain diagrams concepts of orthotropy, anisotropy and inelastic behavior – Hooke's law for linearly elastic isotropic material under axial and shear deformation	3	
	Deformation in axially loaded bars – thermal effects – statically indeterminate problems – principle of superposition - elastic strain energy for uniaxial stress.	4	
II	Definition of stress and strain at a point (introduction to stress and strain tensors and its components only) – Poisson's ratio – biaxial and triaxial deformations – Bulk modulus - Relations between elastic	4	15%
	Torsion: Shafts - torsion theory of elastic circular bars – assumptions and limitations – polar modulus - torsional rigidity – economic cross-sections – statically indeterminate problems – shaft design for torsional load.	4	
FIRST INTERNAL EXAM			
III	Beams- classification - diagrammatic conventions for supports and loading - axial force, shear force and bending moment in a beam	2	15%
	Shear force and bending moment diagrams by direct approach	3	
	Differential equations between load, shear force and bending moment. Shear force and bending moment diagrams by summation approach – elastic curve – point of inflection.	5	
IV	Stresses in beams: Pure bending – flexure formula for beams assumptions and limitations – section modulus - flexural rigidity - economic sections – beam of uniform strength.	4	15%
	Shearing stress formula for beams – assumptions and limitations – design for flexure and shear.	4	
SECOND INTERNAL EXAM			
V	Deflection of beams: Moment-curvature relation – assumptions and limitations - double integration method – Macaulay's method - superposition techniques – moment area method and conjugate beam ideas for simple cases.	6	20%
	Transformation of stress and strains: Plane state of stress - equations of transformation - principal planes and stresses.	4	
	Mohr's circles of stress – plane state of strain – analogy between stress and strain transformation – strain rosettes	3	

VI	Compound stresses: Combined axial, flexural and shear loads – eccentric loading under tension/compression - combined bending and twisting loads.	4	20%
	Theory of columns: Buckling theory –Euler's formula for long columns – assumptions and limitations – effect of end conditions - slenderness ratio – Rankin's formula for intermediate columns.	3	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME203	MECHANICS OF FLUIDS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To study the mechanics of fluid motion.
2. To establish fundamental knowledge of basic fluid mechanics and address specific topics relevant to simple applications involving fluids
3. To familiarize students with the relevance of fluid dynamics to many engineering systems

Syllabus

Fluid Properties, Kinematics of fluid flow, Fluid Statics, Dynamics of fluid flow, Flow through pipes, Concept of Boundary Layer, Dimensional Analysis and Hydraulic similitude

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

1. Calculate pressure variations in accelerating fluids using Euler's and Bernoulli's equations
2. Become conversant with the concepts of flow measurements and flow through pipes
3. Apply the momentum and energy equations to fluid flow problems.
4. Evaluate head loss in pipes and conduits.
5. Use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity

Text Books:

1. Balachandran.P, Engineering Fluid Mechanics, PHI,2012
2. A S Saleem, Fluid Mechanics, Fathima Books,2016

References Books:

1. Cengel, Fluid Mechanics**,** McGraw Hill Education India 2014
2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005
3. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002
4. Streeter V. L., E. B. Wylie and K. W. Bedford, Fluid Mechanics, Tata McGraw Hill, Delhi, 2010.
5. Joseph Karz, Introductory Fluid Mechanics, Cambridge University press,2010
6. Fox R. W. and A. T. McDonald, Introduction to Fluid dynamics, 5/e, John Wiley and Sons, 2009.
7. Shames I. H, Mechanics of Fluids, McGraw Hill, 1992.
8. White F.M., Fluid Mechanics, 6/e, Tata McGraw Hill, 2008

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure.	8	15%
II	Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines flow nets, uses and limitations,	8	15%
FIRST INTERNAL EXAM			
III	Dynamics of Fluid flow: Fluid Dynamics: Energies in flowing fluid, head, pressure, dynamic, static and total head, Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Navier-Stokes equations (without proof) in rectangular and cylindrical co-ordinates, Bernoulli's equation and its applications: Venturi and Orifice meters, Notches and Weirs (description only for notches and weirs). Hydraulic coefficients, Velocity measurements: Pitot tube and Pitot-static tube.	10	15%
IV	Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen Poiseuille equation. Turbulent flow: Darcy- Weisbach equation, Chezy's equation Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission, Water hammer, Cavitation.	12	15%
SECOND INTERNAL EXAM			
V	Concept of Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control.	10	20%

VI	Dimensional Analysis and Hydraulic similitude: Dimensional analysis, Buckingham's theorem, important dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynold, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME205	THERMODYNAMICS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To understand basic thermodynamic principles and laws
2. To develop the skills to analyze and design thermodynamic systems

Syllabus

Basic concepts, zeroth law of thermodynamics and thermometry, energy, first law of thermodynamics, second law of thermodynamics, entropy, irreversibility and availability, third law of thermodynamics pure substances, equations of state, properties of gas mixtures, Introduction to ideal binary solutions, general thermodynamic relationships, combustion thermodynamics

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

1. Understand the laws of thermodynamics and their significance
2. Apply the principles of thermodynamics for the analysis of thermal systems

Text Books

1. P.K.Nag, Engineering Thermodynamics, McGraw Hill,2013
2. E.Rathakrishnan Fundamentals of Engineering Thermodynamics, PHI,2005

References Books:

1 Y. A. Cengel and M. A.Boles,Thermodynamics an Engineering Approach,McGraw Hill, 2011
2 G.VanWylen, R.Sonntag and C.Borgnakke, Fundamentals of Classical Thermodynamics, John Wiley & Sons,2012
3. Holman J.P, Thermodynamics, McGraw Hill, 2004
4. M.Achuthan, Engineering Thermodynamics, PHI,2004

Steam Tables/Data book

5. R.S.Khurmi, Steam table with Mollier chart, S.Chand,2008

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Role of Thermodynamics in Engineering and Science -- Applications of Thermodynamics Basic Concepts - Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe, Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function. (Review only- self study) Zeroth Law of Thermodynamics, Measurement of Temperature- Thermometry, reference Points, Temperature Scales, Ideal gas temperature scale, Comparison of thermometers-Gas Thermometers, Thermocouple, Resistance thermometer Energy - Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity.	7	15%
II	Joule's Experiment- First law of Thermodynamics - First law applied to Non flow Process- Enthalpy- specific heats- PMM1, First law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE, Transient flow –Filling and Emptying Process. (Problems), Limitations of the First Law.	8	15%
FIRST INTERNAL EXAM			
III	Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump - Performance factors, Kelvin-Planck and Clausius Statements, Equivalence of two statements, Reversibility, Irreversible Process, Causes of Irreversibility, Corollaries of second law, PMM2, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale. Clausius Inequality, Entropy- Causes of Entropy Change, Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications, Entropy generation in open and closed system, Entropy and Disorder, Reversible adiabatic process- isentropic Process	10	15%
IV	Available Energy, Availability and Irreversibility- Useful work, Dead state, Availability function, Availability and irreversibility in open and closed systems - Gouy-Stodola theorem , Third law of thermodynamics. Pure Substances, Phase Transformations, Triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface, Saturation pressure and Temperature, T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables.	10	15%
SECOND INTERNAL EXAM			

V	The ideal Gas Equation, Characteristic and Universal Gas constants, Deviations from ideal Gas Model: Equation of state of real substances- Vander Waals Equation of State, Berthelot, Dieterici, and Redlich-Kwong equations of state , Virial Expansion, Compressibility factor, Law of corresponding state, Compressibility charts Mixtures of ideal Gases – Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure, Amagat's Laws of additive volumes, Gibbs-Dalton's law -Equivalent Gas constant and Molecular Weight, Properties of gas mixtures: Internal Energy, Enthalpy, specific heats and Entropy, Introduction to real gas mixtures- Kay's rule. *Introduction to ideal binary solutions, Definition of solution, ideal binary solutions and their characteristics, Deviation from ideality, Raoult's Law, Phase diagram, Lever rule(*in this section numerical problems not)	11	20%
VI	General Thermodynamic Relations – Combined First and Second law equations – Helmholtz and Gibb's functions - Maxwell's Relations, Tds Equations. The Clapeyron Equation, equations for internal energy, enthalpy and entropy, specific heats, Throttling process, Joule Thomson Coefficient, inversion curve. #Introduction to thermodynamics of chemically reacting systems, Combustion, Thermochemistry – Theoretical and Actual combustion processes- Definition and significance of equivalence ratio, enthalpy of formation , enthalpy of combustion and heating value (#in this section numerical problems not included)	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
Approved steam tables permitted
The question paper should consist of three parts **Part A**
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME210	**METALLURGY AND MATERIALS ENGINEERING**	**3-0-0-3**	**2016**

Prerequisite: nil

Course Objectives:

1. To provide fundamental science relevant to materials
2. To provide physical concepts of atomic radius, atomic structure, chemical bonds, crystalline and non-crystalline materials and defects of crystal structures, grain size, strengthening mechanisms, heat treatment of metals with mechanical properties and changes in structure
3. To enable students to be more aware of the behavior of materials in engineering applications and select the materials for various engineering applications.
4. To understand the causes behind metal failure and deformation
5. To determine properties of unknown materials and develop an awareness to apply this knowledge in material design.

Syllabus:-Chemical bonds – crystallography- imperfections- crystallization- diffusion- phase diagrams-heat treatment – strengthening mechanisms- hot and cold working – alloying- ferrous and non ferrous alloys- fatigue-creep- basics, need, properties and applications of modern engineering materials.

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

1. Identify the crystal structures of metallic materials.
2. Analyze the binary phase diagrams of alloys Fe-Fe_3C, etc.
3. Correlate the microstructure with properties, processing and performance of metals.
4. Recognize the failure of metals with structural change.
5. Select materials for design and construction.
6. Apply core concepts in materials science to solve engineering problems.

Text Books

1. Raghavan V, Material Science and Engineering, Prentice Hall,2004
2. Jose S and Mathew E V, Metallurgy and Materials Science, Pentagon, 2011

Reference

1 Anderson J.C. *et.al*., Material Science for Engineers,Chapman and Hall,1990
2 Clark and Varney, Physical metallurgy for Engineers, Van Nostrand,1964
3. Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning,2009
4. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009
5. Callister William. D., Material Science and Engineering, John Wiley,2014
6. Dieter George E, Mechanical Metallurgy,Tata McGraw Hill,1976
7. Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998
8. Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008
9. Van Vlack -Elements of Material Science - Addison Wesley,1989
10. http://nptel.ac.in/courses/113106032/1
11. http://www.myopencourses.com/subject/principles-of-physical-metallurgy-2
12. http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-

solid-state-chemistry-fall-2010/syllabus/ 13. http://www.msm.cam.ac.uk/teaching/partIA.php			
Course Plan			
Module	**Contents**	**Hours**	**Semester Exam. Marks**
I	Earlier and present development of atomic structure; attributes of ionization energy and conductivity, electronegativity and alloying; correlation of atomic radius to strength; electron configurations; electronic repulsion Primary bonds: - characteristics of covalent, ionic and metallic bond: attributes of bond energy, cohesive force, density, directional and non-directional and ductility. properties based on atomic bonding:- attributes of deeper energy well and shallow energy well to melting temperature, coefficient of thermal expansion - attributes of modulus of elasticity in metal cutting process -Secondary bonds:- classification- hydrogen bond and anomalous behavior of ice float on water, application- atomic mass unit and specific heat, application. *(brief review only, no University questions and internal assessment from these portions).*	2	**15%**
	Crystallography:- Crystal, space lattice, unit cell- BCC, FCC, HCP structures - short and long range order - effects of crystalline and amorphous structure on mechanical properties.	1	
	Coordination number and radius ratio; theoretical density; simple problems - Polymorphism and allotropy.	1	
	Miller Indices: - crystal plane and direction *(brief review)* - Attributes of miller indices for slip system, brittleness of BCC, HCP and ductility of FCC - Modes of plastic deformation: - Slip and twinning.	1	
	Schmid's law, equation, critical resolved shear stress, correlation of slip system with plastic deformation in metals and applications.	1	
II	Mechanism of crystallization: Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity.	1	**15%**
	Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch theory, simple problems	1	
	Classification of crystal imperfections: - types of dislocation – effect of point defects on mechanical properties - forest of dislocation, role of surface defects on crack initiation.	1	

	Burgers vector –dislocation source, significance of Frank Read source in metals deformation - Correlation of dislocation density with strength and nano concept, applications.	1	
	Significance high and low angle grain boundaries on dislocation – driving force for grain growth and applications during heat treatment.	1	
	Polishing and etching to determine the microstructure and grain size.	1	
	Fundamentals and crystal structure determination by X – ray diffraction, simple problems –SEM and TEM.	1	
	Diffusion in solids, Fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.	1	
	FIRST INTERNAL EXAMINATION		
III	Phase diagrams: - Limitations of pure metals and need of alloying - classification of alloys, solid solutions, Hume Rothery`s rule - equilibrium diagram of common types of binary systems: five types.	2	**15%**
	Coring - lever rule and Gibb`s phase rule - Reactions: - monotectic, eutectic, eutectoid, peritectic, peritectoid.	1	
	Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties changes in austenite, ledeburite, ferrite, cementite, special features of martensite transformation, bainite, spheroidite etc.	1	
	Heat treatment: - Definition and necessity – TTT for a eutectoid iron–carbon alloy, CCT diagram, applications - annealing, normalizing, hardening, spheroidizing.	1	
	Tempering:- austermpering, martempering and ausforming - Comparative study on ductility and strength with structure of pearlite, bainite, spherodite, martensite, tempered martensite and ausforming.	1	
	Hardenability, Jominy end quench test, applications- Surface hardening methods:- no change in surface composition methods :- Flame, induction, laser and electron beam hardening processes- change in surface composition methods :carburizing and Nitriding; applications.	2	

	Types of Strengthening mechanisms: - work hardening, equation - precipitation strengthening and over ageing- dispersion hardening.	1	
	Cold working: Detailed discussion on strain hardening; recovery; re-rystallization, effect of stored energy; re-crystallization temperature - hot working Bauschinger effect and attributes in metal forming.	1	**15%**
	Alloy steels:- Effects of alloying elements on steel: dislocation movement, polymorphic transformation temperature, alpha and beta stabilizers, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties	1	
IV	Nickel steels, Chromium steels etc. - Enhancement of steel properties by adding alloying elements: - Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead.	1	
	High speed steels:- Mo and W types, effect of different alloying elements in HSS	1	
	Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, microstructure, properties and applications.	1	**15%**
	Principal Non ferrous Alloys: - Aluminum, Copper, Magnesium, Nickel, study of composition, properties, applications, reference shall be made to the phase diagrams whenever necessary.	1	
	SECOND INTERNAL EXAMINATION		
	Fatigue: - Stress cycles – Primary and secondary stress raisers - Characteristics of fatigue failure, fatigue tests, S-N curve.	1	
	Factors affecting fatigue strength: stress concentration, size effect, surface roughness, change in surface properties, surface residual stress.	1	
V	Ways to improve fatigue life – effect of temperature on fatigue, thermal fatigue and its applications in metal cutting	1	**20%**
	Fracture: – Brittle and ductile fracture – Griffith theory of brittle fracture – Stress concentration, stress raiser – Effect of plastic deformation on crack propagation.	1	
	transgranular, intergranular fracture - Effect of impact loading on ductile material and its application in forging, applications - Mechanism of fatigue failure.	1	

	Structural features of fatigue: - crack initiation, growth, propagation - Fracture toughness (definition only) - Ductile to brittle transition temperature (DBTT) in steels and structural changes during DBTT, applications.	1	
V1	Creep: - Creep curves – creep tests - Structural change:- deformation by slip, sub-grain formation, grain boundary Sliding	1	**20%**
	Mechanism of creep deformation - threshold for creep, prevention against creep - Super plasticity: need and applications	1	
	Composites:- Need of development of composites - geometrical and spatial Characteristics of particles – classification - fiber phase: - characteristics, classifications - matrix phase:- functions – only need and characteristics of PMC, MMC, and CMC – applications of composites: aircraft applications, aerospace equipment and instrument structure, industrial applications of composites, marine applications, composites in the sporting goods industry, composite biomaterials..	2	
	Modern engineering materials: - only fundamentals, need, properties and applications of, intermetallics, maraging steel, super alloys, Titanium – introduction to nuclear materials, smart materials and bio materials.	2	
	Ceramics:-coordination number and radius ratios- AX, A_mX_p, $A_mB_mX_p$ type structures – applications.	1	

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts **Part A**

4 questions uniformly covering modules I and II. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
HS200	Business Economics	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To familiarize the prospective engineers with elementary Principles of Economics and Business Economics.
- To acquaint the students with tools and techniques that are useful in their profession in Business Decision Making which will enhance their employability;
- To apply business analysis to the "firm" under different market conditions;
- To apply economic models to examine current economic scenario and evaluate policy options for addressing economic issues
- To gain understanding of some Macroeconomic concepts to improve their ability to understand the business climate;
- To prepare and analyse various business tools like balance sheet, cost benefit analysis and rate of returns at an elementary level

Syllabus

Business Economics - basic concepts, tools and analysis, scarcity and choices , resource allocation, marginal analysis, opportunity costs and production possibility curve. Fundamentals of microeconomics - Demand and Supply Analysis, equilibrium, elasticity, production and production function, cost analysis, break-even analysis and markets. Basics of macroeconomics - the circular flow models, national income analysis, inflation, trade cycles, money and credit, and monetary policy. Business decisions - investment analysis, Capital Budgeting decisions, forecasting techniques and elementary Balance Sheet and taxation, business financing, international investments

Expected outcome .

A student who has undergone this course would be able to

i. make investment decisions based on capital budgeting methods in alignment with microeconomic and macroeconomic theories.

ii. able to analyse the profitability of the firm, economy of operation, determination of price under various market situations with good grasp on the effect of trade cycles in business.

iii. gain knowledge on Monetary theory, measures by RBI in controlling interest rate and emerging concepts like Bit Coin.

iv. gain knowledge of elementary accounting concepts used for preparing balance sheet and interpretation of balance sheet

Text Books

1. Geetika, Piyali Ghosh and Chodhury, *Managerial Economics*, Tata McGraw Hill, 2015
2. Gregory Mankiw, *Principles of Macroeconomics*, Cengage Learning, 2006.
3. M.Kasi Reddy and S.Saraswathi, *Economics and Financial Accounting*. Prentice Hall of India. New Delhi.

References:

1. Dornbusch, Fischer and Startz, *Macroeconomics*, McGraw Hill, 11th edition, 2010.
2. Khan M Y, *Indian Financial System*, Tata McGraw Hill, 7th edition, 2011.
3. Samuelson, *Managerial Economics*, 6th edition, Wiley
4. Snyder C and Nicholson W, *Fundamentals of Microeconomics*, Cengage Learning (India), 2010.
5. Truett, Managerial Economics: Analysis, Problems, Cases, 8th Edition, Wiley
6. Welch, *Economics: Theory and Practice* 7th Edition, Wiley
7. Uma Kapila, *Indian Economy Since Independence, 26th Edition: A Comprehensive and Critical Analysis of India's Economy*, 1947-2015
8. C Rangarajan, *Indian Economy, Essays on monetary and finance*, UBS Publishers'Distributors, 1998
9. A.Ramachandra Aryasri, *Managerial Economics and Financial Analysis,* Tata McGraw-Hill, New Delhi.
10. Dominick Salvatore, *Managerial Economics in Global Economy,* Thomas Western College Publishing, Singapore.
11. I.M .Pandey, *Financial Management*, Vikas Publishing House. New Delhi.
12. Dominick Salvatore, *Theory and Problems of Micro Economic Theory.* Tata Mac Graw-Hill, New Delhi.
13. T.N.Hajela.*Money, Banking and Public Finance.* Anne Books. New Delhi.
14. G.S.Gupta. *Macro Economics-Theory and Applications.* Tata Mac Graw- Hill, New Delhi.
15. Yogesh, Maheswari, *Management Economics* , PHI learning, NewDelhi, 2012
16. Timothy Taylor , *Principles of Economics*, 3rdedition, TEXTBOOK MEDIA.
17. Varshney and Maheshwari. *Managerial Economics.* Sultan Chand. New Delhi

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Business Economics** and its role in managerial decision making-meaning-scope-relevance-economic problems-scarcity Vs choice (2 Hrs)-Basic concepts in economics-scarcity, choice, resource allocation- Trade-off-opportunity cost-marginal analysis- marginal utility theory, Law of diminishing marginal utility -production possibility curve (2 Hrs)	4	15%
II	**Basics of Micro Economics I** Demand and Supply analysis-equillibrium-elasticity (demand and supply) (3 Hrs.) -Production concepts-average product-marginal product-law of variable proportions- Production function-Cobb Douglas function-problems (3 Hrs.)	6	15%
FIRST INTERNAL EXAMINATION			
III	**Basics of Micro Economics II** Concept of costs-marginal, average, fixed, variable costs-cost curves-shut down point-long run and short run (3 Hrs.)- Break Even Analysis-Problem-Markets-Perfect Competition, Monopoly and Monopolistic Competition, Oligopoly-Cartel and collusion (3 Hrs.).	6	15%
IV	**Basics of Macro Economics** - Circular flow of income-two sector and multi-sector models- National Income Concepts-Measurement methods-problems-Inflation, deflation (4 Hrs.)-Trade cycles-Money-stock and flow concept-Quantity theory of money-Fischer's Equation and Cambridge Equation -velocity of circulation of money-credit control methods-SLR, CRR, Open Market Operations-Repo and Reverse Repo rate-emerging concepts in money-bit coin (4 Hrs.).	8	15%

SECOND INTERNAL EXAMINATION			
V	**Business Decisions I**-Investment analysis-Capital Budgeting-NPV, IRR, Profitability Index, ARR, Payback Period (5 Hrs.)- Business decisions under certainty-uncertainty-selection of alternatives-risk and sensitivity- cost benefit analysis-resource management (4 Hrs.).	9	20%
VI	**Business Decisions II** Balance sheet preparation-principles and interpretation-forecasting techniques (7 Hrs.)-business financing-sources of capital- Capital and money markets-international financing-FDI, FPI, FII-Basic Principles of taxation-direct tax, indirect tax-GST (2 hrs.).	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100, Time: 3 hours

The question paper shall consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME231	COMPUTER AIDED MACHINE DRAWING LAB	0-0-3-1	2016

Course Objectives:

1. To introduce students to the basics and standards of engineering drawing related to machines and components.
2. To teach students technical skills regarding assembly, production and part drawings.
3. To familiarize students with various limits, fits and tolerances.
4. To help students gain knowledge about standard CAD packages on modeling and drafting.

Syllabus

Introduction to Machine Drawing, Drawing Standards, Fits, Tolerances, Production drawings. Introduction to CAD, assembly drawings, etc.

Expected outcome

At the end of the course students will be able to

1. Acquire the knowledge of various standards and specifications about standard machine components.
2. Make drawings of assemblies with the help of part drawings given.
3. Ability to select, configure and synthesize mechanical components into assemblies.
4. Apply the knowledge of fits and tolerances for various applications.
5. Able to model components of their choice using CAD software.
6. Get exposure to advanced CAD packages.

Text Books:

1. N. D. Bhatt and V.M. Panchal, Machine Drawing, Charotar Publishing House,2014
2. K C John, Machine Drawing, PHI,2009
3. P I Vargheese and K C John, Machine Drawing, VIP Publishers ,2011
4. K.L.Narayana, P.Kannaiah & K. Venkata Reddy,Machine Drawing, New Age Publishers,2009
5. Ajeet Singh, Machine Drawing Includes AutoCAD, Tata McGraw-hill,2012
6. P S Gill, Machine Drawing, Kataria & Sons,2009

Course Plan		
Module	**Contents**	**Hours**
0	Introduction Principles of drawing, free hand sketching, manual drawing, CAD drawing etc.	01
I	Drawing standards**:** 2 exercises Code of practice for Engineering Drawing, BIS specifications – lines, types of lines, dimensioning, sectional views, Welding symbols, riveted joints, keys, fasteners –bolts, nuts, screws, keys etc.	05
II	Fits ,Tolerances and Surface Roughness**:** 2 exercises Limits, Fits – Tolerances of individual dimensions – Specification of Fits – basic principles of geometric & dimensional tolerances. Preparation of production drawings and reading of part and assembly drawings, surface roughness, indication of surface roughness, etc.	06
FIRST INTERNAL EXAM		
III	Introduction to drafting package: Introduction, input, output devices, introduction to drafting software like Auto CAD, basic commands and development of simple 2D and 3D drawings. Drawing, Editing, Dimensioning, Plotting Commands, Layering Concepts, Matching, Detailing, Detailed drawings.	06
IV	Assembly drawings(2D)**:** 10 exercises Preparation of assembled views. (Manually): Shaft couplings – Connecting rod - Machine Vice – Stuffing box – Plummer block. (Using software package, 2D Drawing) :– Universal joint - Screw jack – Lathe Tailstock – Rams Bottom Safety Valve – Steam stop valve. Preparation of Bill of materials and tolerance data sheet.	24
SECOND INTERNAL EXAM		
Note: 50% of assembly drawings (Module IV) must be done manually and remaining 50% of assembly drawings must be done using any 2D drafting package.		
FINAL INTERNAL EXAM		

Examination scheme

(1) End semester examination shall be for 30 marks and of 2 hours duration.

(2) End semester exam shall be based on Module IV. It shall be conducted as a CAD examination

(3) 50 marks are allotted for internal evaluation: first internal exam 25 marks, second internal exam 25 marks and class exercises 20 marks.

(4) The first internal exam will be based on modules I and II and the second internal exam will be a based on Module IV alone. (Both will be conducted as manual drawing examinations)

Course No.	Course Name	L-T-P-Credits	Year of Introductio
CE230	MATERIAL TESTING LAB	0-0-3-1	2016

Course Objectives:

1. To provide knowledge on mechanical behaviour of materials
2. To acquaint with the experimental methods to determine the mechanical properties of materials.

Syllabus

List of experiments:

1. Tension test on mild steel/ tor-steel/ high strength steel and cast iron using Universal Testing Machine and extensometers.
2. Tests on springs (Open and closed coiled)
3. Torsion pendulum (mild steel, aluminium and brass wires)
4. Hardness test (Brinell, Vickers and Rockwell)
5. Impact test (Izod and Charpy)
6. Torsion test on mild steel rods.
7. Shear test on mild steel rods.
8. Fatigue test – Study of testing machine.
9. Bending test on wooden beams.
10. Strut test (Column buckling experiment)
11. Verification of Clerk Maxwell's law of reciprocal deflection and determination of Young's modulus of steel.
12. Photo elastic methods for stress measurements.
13. Jominy hardenability test
14. Measurement using strain gauges
15. Determination of moment of inertia of rotating bodies

Note: A minimum of 10 experiments are mandatory.

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

1. Acquire the knowledge on mechanical behaviour of materials
2. Conduct experiments determine the mechanical properties of materials.

References Books:

1. G E Dieter. Mechanical Metallurgy, McGraw Hill,2013
2. Dally J W, Railey W P, Experimental Stress analysis , McGarw Hill,1991
3. Baldev Raj, Jayakumar T, Thavasimuthu M., Practical Non destructive testing, Narosa Book Distributors,2015

SEMESTER 4

Course No.	Course Name	L-T-P - Credits	Year of Introduction
MA202	Probability distributions, Transforms and Numerical Methods	3-1-0-4	2016

Prerequisite: Nil

Course Objectives

- To introduce the concept of random variables, probability distributions, specific discrete and continuous distributions with practical application in various Engineering and social life situations.
- To know Laplace and Fourier transforms which has wide application in all Engineering courses.
- To enable the students to solve various engineering problems using numerical methods.

Syllabus

Discrete random variables and Discrete Probability Distribution.
Continuous Random variables and Continuous Probability Distribution.
Fourier transforms.
Laplace Transforms.
Numerical methods-solution of Algebraic and transcendental Equations, Interpolation.
Numerical solution of system of Equations. Numerical Integration, Numerical solution of ordinary differential equation of First order.

Expected outcome .

After the completion of the course student is expected to have concept of
(i) Discrete and continuous probability density functions and special probability distributions.
(ii) Laplace and Fourier transforms and apply them in their Engineering branch
(iii) numerical methods and their applications in solving Engineering problems.

Text Books:

1. Miller and Freund's "Probability and statistics for Engineers"-Pearson-Eighth Edition.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2015.

References:

1. V. Sundarapandian, "Probability, Statistics and Queuing theory", PHI Learning, 2009.
2. C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics"-Sixth Edition.
3. Jay L. Devore, "Probability and Statistics for Engineering and Science"-Eight Edition.
4. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers"-Sixth Edition-Mc Graw Hill.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Discrete Probability Distributions.** (Relevant topics in section 4.1,4,2,4.4,4.6 Text1) Discrete Random Variables, Probability distribution function, Cumulative distribution function. Mean and Variance of Discrete Probability Distribution. Binomial Distribution-Mean and variance. Poisson Approximation to the Binomial Distribution. Poisson distribution-Mean and variance.	2 2 2 2	15%

II	**Continuous Probability Distributions.** (Relevant topics in section 5.1,5.2,5.5,5.7 Text1) Continuous Random Variable, Probability density function, Cumulative density function, Mean and variance. Normal Distribution, Mean and variance (without proof). Uniform Distribution.Mean and variance. Exponential Distribution, Mean and variance.	 2 4 2 2	 15%
FIRST INTERNAL EXAMINATION			
III	**Fourier Integrals and transforms. (**Relevant topics in section 11.7, 11.8, 11.9 Text2) Fourier Integrals. Fourier integral theorem (without proof). Fourier Transform and inverse transform. Fourier Sine & Cosine Transform, inverse transform.	 3 3 3	15%
IV	**Laplace transforms. (**Relevant topics in section 6.1,6.2,6.3,6.5,6.6 Text2**)** Laplace Transforms, linearity, first shifting Theorem. Transform of derivative and Integral, Inverse Laplace transform, Solution of ordinary differential equation using Laplace transform. Unit step function, second shifting theorem. Convolution Theorem (without proof). Differentiation and Integration of transforms.	 3 4 2 2 2	15%
SECOND INTERNAL EXAMINATION			
V	**Numerical Techniques**.(Relevant topics in section.19.1,19.2,19.3 Text2) Solution Of equations by Iteration, Newton- Raphson Method. Interpolation of Unequal intervals-Lagrange's Interpolation formula. Interpolation of Equal intervals-Newton's forward difference formula, Newton's Backward difference formula.	 2 2 3	20%
VI	**Numerical Techniques**. (Relevant topics in section 19.5,20.1,20.3, 21.1 Text2) Solution to linear System- Gauss Elimination, Gauss Seidal Iteration Method. Numeric Integration-Trapezoidal Rule, Simpson's 1/3 Rule. Numerical solution of firstorder ODE-Euler method, Runge-Kutta Method (fourth order).	 3 3 3	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks : 100 Exam Duration: 3 hours The question paper will consist of 3 parts.
Part A will have 3 questions of 15 marks each uniformly covering modules I and II. Each question may have two sub questions.

Part B will have 3 questions of 15 marks each uniformly covering modules III and IV. Each question may have two sub questions.

Part C will have 3 questions of 20 marks each uniformly covering modules V and VI. Each question may have three sub questions.

Any two questions from each part have to be answered

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME202	ADVANCED MECHANICS OF SOLIDS	3-1-0-4	2016

Prerequisite: ME201 Mechanics of solids

Course Objectives: The main objectives of the course are

1. To impart concepts of stress and strain analyses in a solid.
2. To study the methodologies in theory of elasticity at a basic level.
3. To acquaint with the solution of advanced bending problems.
4. To get familiar with energy methods for solving structural mechanics problems.

Syllabus

Introduction, concepts of stress, equations of equilibrium, strain components, strain-displacement relations, compatibility conditions, constitutive relations, boundary conditions, 2D problems in elasticity, Airy's stress function method, unsymmetrical bending of straight beams, bending of curved beams, shear center, energy methods in elasticity, torsion of non-circular solid shafts, torsion of thin walled tubes.

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

1. Apply concepts of stress and strain analyses in solids.
2. Use the procedures in theory of elasticity at a basic level.
3. Solve general bending problems.
4. Apply energy methods in structural mechanics problems.

Text Books:

1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill,2008
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill,2008
3. S. Jose, Advanced Mechanics of Materials, Pentagon Educational Services,2013
4. L. Govindaraju ,TG Sitharaman, Applied elasticity for Engineers, NPTEL
5. U. Saravanan, Advanced Solid Mechanics, NPTEL
6. S. Anil Lal, Advanced Mechanics of Solids, Siva Publications and Distributions, 2017

References Books:

1. S. P. Timoshenko, J. N. Goodier, Theory of elasticity, McGraw Hill,1970
2. R.J. Atkin, and N. Fox, An introduction the theory of elasticity, Longman,1980
3. J. P. Den Hartog, Advanced Strength of Materials, McGraw Hill,1987
4. C. K. Wang, Applied Elasticity, McGraw Hill,1983
5. www.solidmechanics.org/contents.htm - Free web book on Applied Mechanics of Solids by A.F. Bower.

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction to stress analysis in elastic solids - stress at a point – stress tensor – stress components in rectangular and polar coordinate systems - Cauchy's equations – stress transformation – principal stresses and planes - hydrostatic and deviatoric stress components, octahedral shear stress - equations of equilibrium	6	15%
	Displacement field – engineering strain - strain tensor *(basics only)* – analogy between stress and strain tensors - strain-displacement relations *(small-strain only)* – compatibility conditions	4	
II	Constitutive equations – generalized Hooke's law – equations for linear elastic isotropic solids - relation among elastic constants – Boundary conditions – St. Venant's principle for end effects – uniqueness theorem	4	15%
	2-D problems in elasticity - Plane stress and plane strain problems – stress compatibility equation - Airy's stress function and equation – polynomial method of solution – solution for bending of a cantilever with an end load	4	
FIRST INTERNAL EXAM			
III	Equations in polar coordinates (2D) – equilibrium equations, strain-displacement relations, Airy's equation, stress function and stress components *(only short derivations for examination)*	3	15%
	Application of stress function to Lame's problem and stress concentration problem of a small hole in a large plate *(only stress distribution)*	3	
	Axisymmetric problems – governing equations – application to thick cylinders,~~,~~ rotating discs.	4	
IV	Unsymmetrical bending of straight beams *(problems having c/s with one axis of symmetry only)* – curved beams *(rectangular c/s only)* - shear center of thin walled open sections *(c/s with one axis of symmetry only)*	6	15%
	Strain energy of deformation – special cases of a body subjected to concentrated loads, moment or torque - reciprocal relation – strain energy of a bar subjected to axial force, shear force, bending moment and torque	3	
SECOND INTERNAL EXAM			
V	Maxwell reciprocal theorem – Castigliano's first and second theorems – virtual work principle – minimum potential energy theorem.	5	20%

	Torsion of non-circular bars: Saint Venant's theory - solutions for circular and elliptical cross-sections	4	
VI	Prandtl's method - solutions for circular and elliptical cross-sections - membrane analogy.	4	20%
	Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections	6	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3 X10 marks = 30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks Students will have to answer any three questions out of 4 (3 X10 marks = 30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4 X 10 marks = 40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME204	**THERMAL ENGINEERING**	**3-1-0-4**	**2016**

Prerequisite: ME205 Thermodynamics

Course Objectives:

1. To acquire knowledge on the working of steam turbines, IC engines and gas turbines
2. To introduce the combustion process in IC engines
3. To understand air pollution from IC engines and its remedies.

Syllabus

Steam engineering, boilers, steam nozzles, steam turbines, internal combustion engines, performance testing of IC Engines, fuels and fuel combustion, air pollution from IC engines and remedies, combustion in I.C. engines, gas turbines

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

1. Integrate the concepts, laws and methodologies from the course in thermodynamics into analysis of cyclic processes
2. To apply the thermodynamic concepts into various thermal application like IC engines, steam turbines, compressors.

Text Books:

1. Rudramoorthy , Thermal Engineering, McGraw Hill Education India,2003
2. R.K Rajput, Thermal Engineering, Laxmi publications,2010

References Books:

1. V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill,2002
2. T.D. Eastop and A McConkey, Applied thermodynamics for engineering technology, Pearson education,1996
3. J.B.Heywood, I.C engine fundamentals. McGraw-Hill,2011
4. Gill, P.W., Smith, JR., J.H., and Ziurys, E.J Fundamentals of internal combustion engines Oxford and IBH,1959
5. Rathore**,** Thermal Engineering, McGraw Hill Education India, 2010

Steam Tables

6. R.S.Khurmi, Steam table with Mollier chart,S.Chand,2008

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Steam engineering- T- S diagram, Mollier chart, Steam cycles- Rankine cycle, Modified Rankine cycle, Relative efficiency, Improvement in steam cycles-Reheat, Regenerative and Binary vapor cycle Steam Boilers: Types of boilers –Cochran boiler, Babcock and Wilcox boiler, Benson boiler, La Mont boiler, Loeffler boiler, Velox boiler, Boiler Mountings and Accessories Steam nozzles:-Types of nozzle- Velocity of steam, mass flow rate, critical pressure ratio and its significance, effect of friction, super saturated flow	8	15%
II	Steam turbines: classification, compounding of turbines-pressure velocity variation, velocity diagrams, work done, efficiency, condition for maximum efficiency, multistage turbines-condition line, stage efficiency. Steam turbine performance-reheat factor, degree of reaction, cycles with reheating and regenerative heating, governing of turbines	8	15%
FIRST INTERNAL EXAM			
III	Internal combustion engines: classification of I.C. Engines- four stroke and two stroke I.C. Engines, Comparison of four stroke and two stroke Engine. Wankel Engine, Air standard cycle-Carnot cycle, Otto cycle; Diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles. Stirling and Ericsson cycles, air standard efficiency, specific work output, work ratio, Actual cycle analysis, deviation of actual engine cycle from ideal cycle. Rotary engines, Stratified charge engine , super charging of SI and CI Engines – turbo charging. Variable specific heats.	10	15%
IV	Performance Testing of I C Engines: Indicator diagram, mean effective pressure. Torque, Engine power- BHP, IHP. Engine efficiency- mechanical efficiency, volumetric efficiency, thermal efficiency and relative efficiency, Specific fuel consumption. Testing of I C engines- Morse test, Heat balance test and Retardation test Fuels and fuel combustion: flash point and fire point, calorific value, Fuels for SI and CI engine, Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas. Analysis of fuel combustion-A/F ratio, equivalence ratio, minimum quantity of air, flue gas analysis, excess air.	10	15%
SECOND INTERNAL EXAM			

V	Air pollution from I.C. Engine and its remedies**:** Pollutants from S.I. and C.I. Engines, Methods of emission control, alternative fuels for I.C. Engines; the blending of fuels, Bio fuels. Combustion in I.C. Engines: Combustion phenomena in S.I. engines; Ignition limits, stages of combustion in S.I. Engines, Ignition lag, velocity of flame propagation, auto ignition, detonation; effects of engine variables on detonation; theories of detonation, octane rating of fuels;	10	20%
	pre-ignition; S.I. engine combustion chambers. Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.		
VI	Gas turbines: classification, Thermodynamic analysis of gas turbine cycles-open , closed and semi closed cycle; ideal working cycle- Brayton cycle-P-v and T-s diagram, thermal efficiency. Effect of compressor and turbine efficiencies. Optimum pressure ratio for maximum specific work output with and without considering machine efficiencies. Comparison of gas turbine and IC engines, Analysis of open cycle gas turbine, Improvements of the basic gas turbine cycles-regeneration, intercooling and reheating-cycle efficiency and work output-Condition for minimum compressor work and maximum turbine work. Combustion chambers for gas turbines. pressure loss in combustion process and stability loop.	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME206	**FLUID MACHINERY**	**2-1-0-3**	**2016**

Prerequisite: ME203 Mechanics of Fluids

Course Objectives:

1. To acquire knowledge on hydraulic machines such as pumps and turbines
2. To understand the working of air compressors and do the analysis

Syllabus

Impact of jets, Hydraulic Turbines, Rotary motion of liquids, Rotodynamic pumps, Positive displacement pumps**,** , Compressors

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

1. Discuss the characteristics of centrifugal pump and reciprocating pumps
2. Calculate forces and work done by a jet on fixed or moving plate and curved plates
3. Know the working of turbines and select the type of turbine for an application.
4. Do the analysis of air compressors and select the suitable one for a specific application

Text Books:

1. Som, Introduction to Fluid Mechanics and Fluid Machines ,McGraw Hill Education India 2011
2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications,2005.

Reference Books:

1. Cengel Y. A. and J. M. Cimbala, Fluid Mechanics, Tata McGraw Hill, 2013
2. Yahya S. M, Fans, Blower and Compressor, Tata McGraw Hill, 2005.
3. Shepherd D. G, Principles of Turbo Machinery, Macmillan, 1969.
4. Stepanoff A. J, Centrifugal and Axial Flow Pumps, John Wiley & Sons, 1991.
5. Rajput R. K, Fluid Mechanics and Hydraulic Machines, S. Chand & Co.,2006.
6. Subramanya, Fluid mechanics and hydraulic machines, 1e McGraw Hill Education India,2010

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Impact of jets: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat and curve),– Series of vanes - work done and efficiency Hydraulic Turbines : Impulse and Reaction Turbines – Degree of reaction – Pelton Wheel – Constructional features - Velocity triangles – Euler's equation – Speed ratio, jet ratio and work done , losses and efficiencies, design of Pelton wheel – Inward and outward flow reaction turbines- Francis Turbine – Constructional features – Velocity triangles, work done and efficiencies.	7	15%
II	Axial flow turbine (Kaplan) Constructional features – Velocity triangles- work done and efficiencies – Characteristic curves of turbines – theory of draft tubes – surge tanks – Cavitation in turbines – Governing of turbines – Specific speed of turbine , Type Number– Characteristic curves, scale Laws – Unit speed – Unit discharge and unit power.	7	15%
FIRST INTERNAL EXAM			
III	Rotary motion of liquids – free, forced and spiral vortex flows Rotodynamic pumps- centrifugal pump impeller types,-velocity triangles-manometric head- work, efficiency and losses, H-Q characteristic, typical flow system characteristics, operating point of a pump. Cavitation in centrifugal pumps- NPSH required and available- Type number-Pumps in series and parallel operations. Performance characteristics- Specific speed-Shape numbers – Impeller shapes based on shape numbers.	7	15%
IV	Positive displacement pumps- reciprocating pump – Single acting and double acting- slip, negative slip and work required and efficiency- indicator diagram- acceleration head - effect of acceleration and friction on indicator diagram – speed calculation- Air vessels and their purposes, saving in work done to air vessels multi cylinder pumps. Multistage pumps-selection of pumps-pumping devices-hydraulic ram, Accumulator, Intensifier, Jet pumps, gear pumps, vane pump and lobe pump.	7	15%
SECOND INTERNAL EXAM			
V	Compressors: classification of compressors, reciprocating compressor- single stage compressor, equation for work with and without clearance volume, efficiencies, multistage compressor, intercooler, free air delivered (FAD)	7	20%
VI	Centrifugal compressor-working, velocity diagram, work done, power required, width of blades of impeller and diffuser, isentropic efficiency, slip factor and pressure coefficient, surging and chocking. Axial flow compressors:- working, velocity diagram, degree of reaction, performance. Roots blower, vane compressor, screw compressor.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100,

Time: 3 hrs

The question paper should consist of three parts **Part A**

4 questions uniformly covering modules I and II. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME220	MANUFACTURING TECHNOLOGY	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:-

1. To give an exposure to different techniques of casting and molds required.
2. To provide an exposure to different rolling processes and different rolled products
3. To familiarize with different forging methods, cautions to be adopted in die design.
4. To give an introduction to various work and tool holding devices used in manufacturing.
5. To introduce to the bending, shearing and drawing processes of sheet metal working and allied machines,
6. To give an understanding of welding metallurgy and weldability and to introduce various metal joining techniques.

SYLLABUS

Casting –patterns - Cores – Gating – Risering – Defects in Castings - Rolling –Defects in Rolled parts- forging – Coining – Heading – Piercing –Die Design– Extrusion Process– Extrusion Defects – Drawing Process -Principles of Location –Principles of Clamping – Types of Clamp -Sheet metal characteristics –Deep drawing –Spinning –Definition of Welding – Weldability – Solidification of Weld Metal – Heat Affected Zone – Welding Defects - Gas Welding -Arc Welding - Ultrasonic Welding – Friction Welding – Resistance Welding — Brazing- Soldering.

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

1. Acquire knowledge in various casting processes and technology related to them.
2. Understand the rolling passes required for getting required shapes of rolled products.
3. Discuss important aspects of forging techniques
4. Discuss sheet metal working processes and their applications to produce various shapes and products.
5. Acquire knowledge in various types of welding processes.

Text books:-

1. Amitabha Ghosh and Ashok Kumar Mallick, Manufacturing Science Affiliated East West Press Ltd, New Delhi, 2002
2. S.Kalpakjian and Steven R Schimid, Manufacturing Engineering and Technology, Pearson,2001

Reference books:-

1. RAO, Manufacturing Technology-Vol 2 3e, McGraw Hill Education India, 2013
2. RAO, Manutacturing Technology-Vol 1 4e, McGraw Hill Education India, 2013
3. Cyril Donaldson and George H LeCain, Tool Design,TMH
4. Handbook of Fixture Design – ASTME
5. Campbell J. S., Principles of Manufacturing Materials and Processes, Tata McGraw Hill, 1999
6. P R Beeley, Foundry Technology, Elsevier, 2001
7. Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, Principles of Metal Casting,

Tata McGraw-Hill Education, 2001

8. Paul Degarma E and Ronald A. Kosher ,Materials and Processes in Manufacturing, Wiley,20111
9. P. N. Rao,Manufacturing Technology Foundry, Forming and Welding, Tata McGraw- Hill Education,2011
10. HMT Production Technology, 1e McGraw Hill,2001

Course Plan			
Module	**Contents**	**Hours**	**Semester Examination Marks**
I	Sand Casting – Sand Molds-Types of Molding Sands and Testing	1	15%
	Type of patterns - Pattern Materials	1	
	Cores –Types and applications –Sand Molding Machines	1	
	Gating System – Risering	1	
	Shell Mold Casting – Ceramic Mold Casting	1	
	Investment Casting – Vacuum Casting – Slush Casting	1	
	Pressure Casting – Die Casting – Centrifugal Casting	1	
	Design Considerations based on Various Shapes - Defects in Castings – simple problems in casting	1	
II	Principles of Rolling –Types of rolling mills, Mechanics of Flat Rolling	1	15%
	Roll Force and Power Requirement - Neutral Point	1	
	Hot and Cold Rolling	1	
	Defects in Rolled Plates - Rolling Mills	1	
	Ring Rolling – Thread Rolling	1	
	Applications- Rolling of tubes, wheels, axles and I-beams	1	
	FIRST INTERNAL EXAM		
III	Classification of forging – Forging methods – Forging under sticking condition	1	15%
	Precision Forging – Coining – Heading – Piercing	1	
	Die Design:- Preshaping, Design Features, Draft Angles – Die Materials and Lubrication	1	
	Forging Machines – Forging Defects and tests	1	
	Extrusion Process - Hot Extrusion – Cold Extrusion	1	
	Impact Extrusion – Extrusion Defects – Drawing Process, wire drawing process	1	

IV	Principles Location - Degrees of Freedom, 3-2-1 principle of locating	1	15%
	Locating from Planes - Locating from Circular Surfaces	1	
	Concentric Locating - Principles of Clamping	1	
	Types of Clamps - Strap Clamps Slide Clamps - Swing Clamps - Hinge Clamps	1	
	Vacuum Clamping - Magnetic Clamping	1	
	SECOND INTERNAL EXAM		
V	Sheet metal characteristics – Typical shearing	1	20%
	Bending Sheet and Plate – Spingback - Bending Force	1	
	Press Brake Forming - Tube Bending	1	
	Stretch Forming - Deep Drawing	1	
	Rubber forming - Spinning Shear Spinning - Tube Spinning	1	
	Definition of Welding - Weldability – Solidification of the Weld Metal	1	
	Heat Affected Zone – correlation of strength of welded joint with structure - Welding Defects	1	
VI	Gas Welding: – Flame Characteristics	1	20%
	Equipment, fluxes and filler rods	1	
	Arc Welding – Applications and Equipment	1	
	Electrodes	1	
	Shielded Metal Arc Welding – Submerged Arc Welding	1	
	GTAW – Plasma Arc Welding	1	
	Ultrasonic Welding – Friction Welding	1	
	Resistance Spot Welding	1	
	Resistance Seam Welding – Stud Welding – Percussion Welding - simple problems in welding	1	
	Brazing:- Filler Metals, Methods - Soldering:- Techniques, Types of Solders and Fluxes	1	
	END SEMESTER EXAM		

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts **Part A**

4 questions uniformly covering modules I and II. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
HS210	LIFE SKILLS	2-0-2	2016

Prerequisite : Nil

Course Objectives

- To develop communication competence in prospective engineers.
- To enable them to convey thoughts and ideas with clarity and focus.
- To develop report writing skills.
- To equip them to face interview & Group Discussion.
- To inculcate critical thinking process.
- To prepare them on problem solving skills.
- To provide symbolic, verbal, and graphical interpretations of statements in a problem description.
- To understand team dynamics & effectiveness.
- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values, Loyalty and also to learn to appreciate the rights of others.
- To learn leadership qualities and practice them.

Syllabus

Communication Skill: Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication.

Critical Thinking & Problem Solving: Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats, Mind Mapping & Analytical Thinking.

Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

Ethics, Moral & Professional Values: Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE.

Leadership Skills: Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation.

Expected outcome

The students will be able to

- Communicate effectively.
- Make effective presentations.
- Write different types of reports.
- Face interview & group discussion.
- Critically think on a particular problem.
- Solve problems.
- Work in Group & Teams
- Handle Engineering Ethics and Human Values.
- Become an effective leader.

Resource Book:

Life Skills for Engineers, Complied by ICT Academy of Kerala, McGraw Hill Education (India) Private Ltd., 2016

References:

- Barun K. Mitra; (2011), *"Personality Development & Soft Skills*", First Edition; Oxford Publishers.
- Kalyana; (2015) "*Soft Skill for Managers*"; First Edition; Wiley Publishing Ltd.
- Larry James (2016); "*The First Book of Life Skills*"; First Edition; Embassy Books.
- Shalini Verma (2014); *"Development of Life Skills and Professional Practice"*; First Edition; Sultan Chand (G/L) & Company
- John C. Maxwell (2014); "The 5 Levels of Leadership", Centre Street, A division of Hachette Book Group Inc.

Course Plan

Module	Contents	Hours L-T-P L	Hours L-T-P P	Sem. Exam Marks
I	Need for Effective Communication, Levels of communication; Flow of communication; Use of language in communication; Communication networks; Significance of technical communication, Types of barriers; Miscommunication; Noise; Overcoming measures, Listening as an active skill; Types of Listeners; Listening for general content; Listening to fill up information; Intensive Listening; Listening for specific information; Developing effective listening skills; Barriers to effective listening skills. **Technical Writing:** Differences between technical and literary style, Elements of style; Common Errors, **Letter Writing:** Formal, informal and demi-official letters; business letters, **Job Application**: Cover letter, Differences between bio-data, CV and Resume, **Report Writing:** Basics of Report Writing; Structure of a report; Types of reports. **Non-verbal Communication and Body Language:** Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language **Interview Skills**: Types of Interviews; Ensuring success in job interviews; Appropriate use of non-verbal communication, **Group Discussion**: Differences between group discussion and debate; Ensuring success in group discussions, **Presentation Skills**: Oral presentation and public speaking skills; business presentations, **Technology-based Communication:** Netiquettes: effective e-mail messages; power-point presentation; enhancing editing skills using computer software.	2 3	2 4 4	See evaluation scheme

II	Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence. Steps in problem solving, Problem Solving Techniques, Problem Solving through Six Thinking Hats, Mind Mapping, Forced Connections. Problem Solving strategies, Analytical Thinking and quantitative reasoning expressed in written form, Numeric, symbolic, and graphic reasoning, Solving application problems.	2 2	2 2	
III	Introduction to Groups and Teams, Team Composition, Managing Team Performance, Importance of Group, Stages of Group, Group Cycle, Group thinking, getting acquainted, Clarifying expectations. Group Problem Solving, Achieving Group Consensus. Group Dynamics techniques, Group vs Team, Team Dynamics, Teams for enhancing productivity, Building & Managing Successful Virtual Teams. Managing Team Performance & Managing Conflict in Teams. Working Together in Teams, Team Decision-Making, Team Culture & Power, Team Leader Development.	3 3	2 2	
IV	Morals, Values and Ethics, Integrity, Work Ethic, Service Learning, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Cooperation, Commitment, Empathy, Self-Confidence, Character Spirituality, Senses of 'Engineering Ethics', variety of moral issued, Types of inquiry, moral dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, Consensus and controversy, Models of Professional Roles, Theories about right action, Self-interest, customs and religion, application of ethical theories. Engineering as experimentation, engineers as responsible experimenters, Codes of ethics, Balanced outlook on. The challenger case study, Multinational corporations, Environmental ethics, computer ethics,	3 3 3	2 2	

	Weapons development, engineers as managers, consulting engineers, engineers as expert witnesses and advisors, moral leadership, sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers(India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers(IETE), India, etc.	3		
V	Introduction, a framework for considering leadership, entrepreneurial and moral leadership, vision, people selection and development, cultural dimensions of leadership, style, followers, crises. Growing as a leader, turnaround leadership, gaining control, trust, managing diverse stakeholders, crisis management Implications of national culture and multicultural leadership Types of Leadership, Leadership Traits. Leadership Styles, VUCA Leadership, DART Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders, making of a Leader, Formulate Leadership	4 2 2	 2 2	
END SEMESTER EXAM				

EVALUATION SCHEME

Internal Evaluation

(Conducted by the College)

Total Marks: 100

Part – A

(To be started after completion of Module 1 and to be completed by 30th working day of the semester)

1. Group Discussion – Create groups of about 10 students each and engage them on a GD on a suitable topic for about 20 minutes. Parameters to be used for evaluation is as follows;

(i)	Communication Skills	–	10 marks
(ii)	Subject Clarity	–	10 marks
(iii)	Group Dynamics	-	10 marks
(iv)	Behaviors & Mannerisms	-	10 marks

(Marks: 40)

Part – B

(To be started from 31st working day and to be completed before 60th working day of the semester)

2. Presentation Skills – Identify a suitable topic and ask the students to prepare a presentation (preferably a power point presentation) for about 10 minutes. Parameters to be used for evaluation is as follows;

(i)	Communication Skills*	-	10 marks
(ii)	Platform Skills**	-	10 marks
(iii)	Subject Clarity/Knowledge	-	10 marks

(Marks: 30)

* Language fluency, auditability, voice modulation, rate of speech, listening, summarizes key learnings etc.

** Postures/Gestures, Smiles/Expressions, Movements, usage of floor area etc.

Part – C

(To be conducted before the termination of semester)

3. Sample Letter writing or report writing following the guidelines and procedures. Parameters to be used for evaluation is as follows;

(i)	Usage of English & Grammar	-	10 marks
(ii)	Following the format	-	10 marks
(iii)	Content clarity	-	10 marks

(Marks: 30)

External Evaluation

(Conducted by the University)

Total Marks: 50 Time: 2 hrs.

Part – A

Short Answer questions

There will be one question from each area (five questions in total). Each question should be written in about maximum of 400 words. Parameters to be used for evaluation are as follows;

(i) Content Clarity/Subject Knowledge
(ii) Presentation style
(iii) Organization of content

(Marks: 5 x 6 = 30)

Part – B

Case Study

The students will be given a case study with questions at the end the students have to analyze the case and answer the question at the end. Parameters to be used for evaluation are as follows;

(i) Analyze the case situation
(ii) Key players/characters of the case
(iii) Identification of the problem (both major & minor if exists)
(iv) Bring out alternatives
(v) Analyze each alternative against the problem
(vi) Choose the best alternative
(vii) Implement as solution
(viii) Conclusion
(ix) Answer the question at the end of the case

(Marks: 1 x 20 = 20)

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME232	THERMAL ENGINEERING LABORATORY	0-0-3-1	2016

Prerequisite : Should have registered for ME204 Thermal Engineering

Course Objectives:

1. To study the various types IC engines and their parts
2. To conduct the performance test on IC engines, compressors and blowers
3. To familiarize equipment used for measuring viscosity, flash and fire point and Calorific value of petroleum products

Syllabus

List of experiments:

Study of I.C engines :-

a) Diesel engines - all systems and parts

b) Petrol engines - all systems and parts Experiments

1. Determination of flash and fire points of petroleum products -flash and fire point apparatus
2. Determination of viscosity of lubricating oil- viscometer
3. Determination of calorific value of solid and liquid fuels- calorimeter
4. Determination of calorific value of and gaseous fuels - calorimeter
5. Performance test on petrol engines with various types of loading systems
6. Performance test on Diesel engines with various types of loading systems
7. Heat Balance test on petrol/Diesel engines
8. Cooling curve of IC engines
9. Valve timing diagram of IC engines
10. Economic speed test on IC engines
11. Retardation test on IC engines
12. Determination volumetric efficiency and Air-fuel ratio of IC engines
13. Morse test on petrol engine
14. Performance test on reciprocating compressor
15. Performance test on rotary compressor/blower
16. Draw velocity profile in a pipe flow using Prandtl -Pitot tube
17. Analysis of automobile exhaust gas and flue gas using exhaust gas analyser Note: 12 experiments are mandatory

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

1. Determine the efficiency and plot the characteristic curves of different types of Internal Combustion engines, compressors and blowers
2. Conduct experiments for the determination of viscosity, calorific value etc of petroleum products

1

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME230	FLUID MECHANICS AND MACHINES LABORATORY	0-0-3-1	2016

Prerequisite: ME203 Mechanics of fluids

Course Objectives: The main objectives of this course is to demonstrate the applications of theories of basic fluid mechanics and hydraulic machines and to provide a more intuitive and physical understanding of the theory.

Syllabus

Study:

1. Study of flow measuring equipments - water meters, venturi meter, orifice meter, current meter, rotameter
2. Study of gauges - pressure gauge, vacuum gauge, manometers.
3. Study of valves - stop valve, gate valve and foot valve.
4. Study of pumps – Centrifugal, Reciprocating, Rotary, Jet.
5. Study of Turbines - Impulse and reaction types.
6. Study of Hydraulic ram, accumulator etc.

List of Experiments:

1. Determination of coefficient of discharge and calibration of Notches
2. Determination of coefficient of discharge and calibration of Orifice meter
3. Determination of coefficient of discharge and calibration of Venturimeter.
4. Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus
5. Determination of hydraulic coefficients of orifices
6. Determination of metacentric height and radius of gyration of floating bodies.
7. Experiments on hydraulic ram
8. Reynolds experiment
9. Bernoulli's experiment
10. Experiment on Torque converter
11. Performance test on positive displacement pumps
12. Performance test on centrifugal pumps, determination of operating point and efficiency
13. Performance test on gear pump
14. Performance test on Impulse turbines
15. Performance test on reaction turbines (Francis and Kaplan Turbines)
16. Speed variation test on Impulse turbine
17. Determination of best guide vane opening for Reaction turbine
18. Impact of jet

Note: 12 experiments are mandatory

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

1. Discuss physical basis of Bernoulli's equation, and apply it in flow measurement (orifice, Nozzle and Venturi meter), and to a variety of problems
2. Determine the efficiency and plot the characteristic curves of different types of pumps and turbines.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME301	MECHANICS OF MACHINERY	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

To provide knowledge on kinematics of selected mechanisms, design of cams, theory and analysis of gears, gear trains and synthesis of mechanisms.

Syllabus

Introduction to kinematics and mechanisms - different mechanisms, displacement, velocity, and acceleration analysis. Cam and followers - displacement, velocity, and acceleration analysis, cam profile synthesis. Gears – law of gearing, interference, gear trains, applications. Kinematic synthesis - dimensional synthesis, graphical synthesis, position synthesis, analytical synthesis, case study.

Expected outcome .

The students will be able to solve practical problems related to kinematics of mechanisms

Text Books:

1. Ballaney P. L., Theory of Machines and Mechanisms, Khanna Publishers,2005
2. S. S. Rattan, Theory of Machines, Tata Mc Graw Hill,2009

References:

1. C. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education,2005
2. D. H. Myszka, Machines and Mechanisms Applied Kinematic Analysis, Pearson Education,2013
3. G. Erdman, G. N. Sandor, Mechanism Design: Analysis and synthesis Vol I & II, Prentice Hall of India,1984.
4. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press,1988
5. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,2010

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to kinematics and mechanisms - various mechanisms, kinematic diagrams, degree of freedom- Grashof's criterion, inversions, coupler curves	3	15%
	straight line mechanisms exact, approximate – Ackerman Steering Mechanism - Hooke's joint - Geneva mechanism - mechanical advantage, transmission angle	4	
	Displacement, velocity and acceleration analysis - relative motion - relative velocity - instant centre -Kennedy's theorem	4	
II	Relative acceleration - Coriolis acceleration - graphical and analytical methods – complex number methods - computer oriented methods.	4	15%
	Cams - classification of cam and followers - displacement diagrams, velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration, cycloidal motion	4	
FIRST INTERNAL EXAMINATION			
III	Graphical cam profile synthesis, pressure angle	2	15%

	Analysis of tangent cam with roller follower and circular cam with flat follower	6	
	Introduction to polynomial cams.	2	
IV	Gears – terminology of spur gears – law of Gearing - involute spur gears involutometry - contact ratio - interference - backlash - gear standardization - interchangability	4	15%
	Non-standard gears, centre distance modification, long and short addendum system. - internal gears - theory and details of bevel, helical and worm gearing	4	
SECOND INTERNAL EXAMINATION			
V	Gear trains - simple and compound gear trains - planetary gear trains – differential -solution of planetary gear train problems - applications	5	20%
	Kinematic synthesis (planar mechanisms) - tasks of kinematic synthesis – type, number and dimensional synthesis – precision points	4	
VI	Graphical synthesis for motion - path and prescribed timing - function generator .	3	20%
	2 position and 3 position synthesis – overlay Method	3	
	Analytical synthesis techniques, Freudenstein's equation – complex number methods - one case study in synthesis of mechanism.	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME303	MACHINE TOOLS AND DIGITAL MANUFACTURING	3-0-0-3	2016

Prerequisite: Nil

Course Objectives: The main objectives of this course are

1. To introduce students to the scientific principles underlying material behavior during manufacturing processes so as to enable them to undertake calculations of forces, tool stresses and material removal rates.
2. To understand various machine tools such as lathe, drilling machine, reciprocating machines etc. and their operations.
3. To impart knowledge of appropriate parameters to be used for various machining operations.
4. To develop knowledge on the importance of milling grinding and super finishing in metal cutting process.
5. To introduce the fundamentals of digital manufacturing.

Syllabus

Introduction to metal cutting, Mechanism of metal removal, Merchants theory, Frictional forces in metal cutting, Thermal aspects of machining, General purpose machine tools, Principle and operation of lathe, Drilling machines, Reciprocating machines, Milling machines, Grinding machines, Super finishing operations, Semi-automatic machine tools, Single and multi-spindle machines, Introduction to digital manufacturing and digital manufacturing science.

Expected outcomes:

The students will be able to

1. Analyze various machining process and calculate relevant quantities such us velocities, forces and powers.
2. Identify and explain the function of the basic components of a machine tool.
3. Understand the limitations of various machining process with regard to shape formation and surface texture.
4. Apply cutting mechanics to metal machining based on cutting force and power consumption.
5. Understand the use of various machine tools and their fields of application.
6. Understand the principle and applications of grinding and super finishing operations.
7. Get a basic knowledge on the importance of digital manufacturing.

Text books

1. Chapman W. A. J., Workshop Technology, Viva books (P) Ltd,1988
2. HMT, Production Technology, Tata McGraw-Hill,2001
3. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited,2012

Reference books

1. Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication,2000
2. Chernov, Machine Tools, MIR Publication,1984
3. Ghosh A. And Malic A. K., Manufacturing Science, East West Press, 2010
4. Hajra Choudary, Elements of workshop technology, Vol I & II, Media Publishers, 2010
5. Lihui Wang and Andrew Yeh Ching Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009
6. Malkin Stephen, Grinding Technology: Theory and Applications of Machining with Abrasives, Industrial press, 2008
7. Poul De Garmo, J.T.Black, R.A.Kosher, Materials and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd.,1997.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to metal cutting: Tool nomenclature – Attributes of each tool nomenclature – Attributes of feed and tool nomenclature on surface roughness obtainable	1	15%
	Orthogonal and oblique cutting - Mechanism of metal removal – Primary and secondary deformation shear zones	1	
	Mechanism of chip formation – Types of chips, need and types of chip breakers – Merchant's theory	1	
	Analysis of cutting forces in orthogonal cutting– Work done, power required (simple problems)	1	
	Friction forces in metal cutting – development of cutting tool Materials	1	
	Thermal aspects of machining -Tool wear and wear mechanisms	1	
	Factors affecting tool life– Economics of machining (simple problems) Cutting fluids	1 1	
II	General purpose machine tools – Principle and operation of lathe – Types of lathes and size specification	1	15%
	Work holding parts of lathes and their functions – Main operations	1	
	Taper turning and thread cutting – Attachments	1	
	Feeding mechanisms, Apron mechanisms	1	
	Drilling Machines – Types – Work holding devices	1	
	Tool holding devices – Drill machine operations	1	
	Drilling machine tools – Twist drill nomenclature- cutting forces in drilling.	1	
FIRST INTERNAL EXAMINATION			
III	Reciprocating machines: Shaping machines – Types – Size – Principal parts – Mechanism	1	15%
	Work holding devices – Operations performed – Tools	1	

	Cutting speed, feed and depth of cut – Machining time.	1	
	Slotting machines – Types – Size – Principal parts – Mechanism – Work holding devices	1	
	Operations performed – Tools – Cutting speed, feed and depth of cut	1	
	Planing machines – Types – Size – Principal parts – Mechanism – Work holding devices	1	
	Operations performed – Tools – Cutting speed, feed and depth of cut – Machining time- Surface roughness obtainable.	1	
IV	Milling machines – Types – Principal parts – Milling mechanism	1	15%
	Work holding devices – Milling machine attachments	1	
	Types of milling cutters – Elements of plain milling cutters	1	
	Nomenclature - Cutting forces in milling – Milling cutter materials	1	
	Up milling, down milling and face milling operations	1	
	Calculation of machining time	1	
	Indexing – Simple indexing – Differential indexing	1	
SECOND INTERNAL EXAMINATION			
V	Grinding machines – Classification – Operations – Surface, cylindrical and centreless grinding	1	20%
	Grinding mechanisms – Grinding wheels: Specification – types of abrasives, grain size	1	
	Types of bond, grade, structure – Marking system of grinding wheels – Selection of grinding wheels	1	
	Glazing and loading of wheels – Dressing and Truing of grinding wheels, surface roughness obtainable	1	
	Superfinishing operations: Lapping operation– Types of hand lapping – Lapping machines – Types of honing –Methods of honing	1	
	Types of honing stones – Honing conditions – Cutting fluids – Types of broaches – Force required for broaching – Surface roughness obtainable in lapping, honing and broaching operations.	1	
	Semi-automatic machine tools – Turret and capstan lathes. Automatic machine tools – Single and multi-spindle machines.	1	
V1	Introduction to Digital Manufacturing: Concepts and research and development status of digital manufacturing	1	20%
	Definition of digital manufacturing – Features and development of digital manufacturing.	1	
	Theory system of digital manufacturing science: Operation Mode and Architecture of Digital Manufacturing System	1	
	Operation reference mode of digital manufacturing system – Architecture of digital manufacturing system	1	
	Modeling theory and method of digital manufacturing science	1	
	Critical modeling theories and technologies of digital manufacturing science	1	
	Theory system of digital manufacturing science – Basic	1	

	architecture model of digital manufacturing system.		
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks) Note: in

all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME305	COMPUTER PROGRAMMING & NUMERICAL METHODS	2-0-1-3	2016

Prerequisite: Nil

Course Objectives:

- To equip students with fundamentals of computer programming
- To provide fundamental idea about the use of computer programming and numerical methods for analyzing the basic engineering problems.

Syllabus

Introduction to computer programming concept, control statements, basics pointers, Introduction to Class and Object, Errors and approximations, curve fitting, Solution of Partial differential equations, Numerical problems and preparation of computer programs.

Expected outcomes:

- The students will be able to write computer programs for numerical solutions for engineering problems like system of equations and heat equations..

Text Books

1. Balagurusamy, Computer Programming 1e McGraw Hill Education , 2013
2. Balagurusamy, Numerical Methods 1e McGraw Hill Education, 1999
3. Jose S., Computer Programming and Numerical Methods, Pentagon, 2015.
4. Ravichandran D., Programming with C++, Tata McGraw Hill, 2007.

Reference Books

1. Balaguruswamy E., Object Oriented Programming with C++, Tata McGraw Hill, 1992.
2. Barkakati N., Object Oriented Programming in C++, SAMS, 1991.
3. Gerald C. F. and P. O. Wheatley, Applied Numerical Analysis, Pearson,2004.
4. Kamthane A. M., Object Oriented Programming with ANSI & Turbo C++,
5. Lippman S. B. and J. Lajoie, C++ Primer, Pearson Education, 2005.
Pearson Education, 2009.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Computer programming concept –internal representation of data - Algorithm and flow chart, Basics of procedure oriented and object oriented programming. Introduction to C++: Structure of C++ program; Keywords; Identifiers; Data types – integer, real, character, string, boolean, enumeration, Constant and Variables; Operators – assignment, arithmetic, relational, logical, increment, decrement and conditional operators; Statements – simple & compound, declaration statements. Input and output streams.	5	15%
II	Control statements: **`if`**, **`if-else`**, **`switch`**, **`for`**, **`while`**, **`do-while`** **`break`** and **`continue`** statements, Arrays – one dimensional & two dimensional; Functions: inline functions, function over loading, Functions with default arguments, recursion.	7	15%
FIRST INTERNAL EXAM			

III	Basics of Pointers. Function call by value, call by reference. Preparation of programs for evaluation of Factorial of a number, infinite series, Sorting, Searching and Matrix multiplication.	8	15%
IV	Introduction to Class and Object- definition, data members, member function. private & public member functions, member access, friend declaration, class objects, predefined classes, initialization. Inheritance- base class and derived class. Simple programs using the above features. (No programming questions for University examination and internals)	7	15%
SECOND INTERNAL EXAM			
V	Errors and approximations, sources of errors. Solution of linear system of equations: Gauss elimination, Gauss-Jordan and Gauss–Seidel methods. Interpolation: Lagrange and Aitken techniques.	7	20%
VI	Curve fitting: method of least squares, non-linear relationships, Linear correlation, measures of correlation. Solution of Partial differential equations: classification, Laplace equation, Finite difference method. Numerical problems and preparation of computer programs for the above methods	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and
II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and
IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and
VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code.	Course Name	L-T-P - Credits	Year of Introduction
EE311	ELECTRICAL DRIVES & CONTROL FOR AUTOMATION	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

1. To understand the basic concepts of different types of electrical machines and their performance.
2. To know the different methods of starting D.C motors and induction motors.
3. To introduce the controllers for automation

.

Syllabus

DC Machines, transformers, three phase induction motor, single phase induction motor, stepper motor, controllers for automation.

Expected outcome .

The students will be able to

1. Select a drive for a particular application based on power rating.
2. Select a drive based on mechanical characteristics for a particular drive application.
3. Discuss the controllers used for automation

Text Books:

1. Kothari D. P. and I. J. Nagrath, Electrical Machines, Tata McGraw Hill, 2004.
2. Nagrath .I.J. & Kothari .D.P, Electrical Machines, Tata McGraw-Hill, 1998
3. Richard Crowder, Electrical Drives and Electromechanical systems, Elsevier, 2013
4. Mehta V. K. and R. Mehta, Principles of Electrical and Electronics, S. Chand & Company Ltd., 1996.
5. Theraja B. L. and A. K. Theraja, A Text Book of Electrical Technology, S. Chand & Company Ltd., 2008.
6. Vedam Subrahmaniam, Electric Drives (concepts and applications), Tata McGraw- Hill, 2001

References:

1. H.Partab, Art and Science and Utilisation of electrical energy, Dhanpat Rai and Sons, 1994
2. M. D.Singh, K. B. Khanchandani, Power Electronics, Tata McGraw-Hill, 1998
3. Pillai.S,K A first course on Electric drives, Wiley Eastern Limited, 1998

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	DC Machines-principle of operation-emf equation-types of excitations. Separately excited, shunt and series excited DC generators, compound generators. General idea of armature reaction, OCC and load characteristics - simple numerical problems.	6	15%
II	Principles of DC motors-torque and speed equations-torque speed characteristics- variations of speed, torque and power with motor current. Applications of dc shunt series and compound motors. Principles of starting, losses and efficiency – load test- simple numerical problems.	6	15%
	FIRST INTERNAL EXAMINATION		
III	Transformers – principles of operations – emf equation- vector	7	15%

	diagrams- losses and efficiency – OC and SC tests. Equivalent circuits- efficiency calculations- maximum efficiency – all day efficiency – simple numerical problems. Auto transformers constant voltage transformer- instrument transformers.		
IV	Three phase induction motors- slip ring and squirrel cage types- principles of operation – rotating magnetic field- torque slip characteristics- no load and blocked rotor tests. Circle diagrams- methods of starting – direct online – auto transformer starting	7	15%
SECOND INTERNAL EXAMINATION			
V	Single phase motors- principle of operation of single phase induction motor – split phase motor – capacitor start motor- stepper motor- universal motor Synchronous machines types – emf equation of alternator – regulation of alternator by emf method. Principles of operation of synchronous motors- methods of starting- V curves- synchronous condenser	8	20%
VI	Stepper motors: Principle of operation, multistack variable reluctance motors, single-stack variable reluctance motors, Hybrid stepper motors, Linear stepper motor, comparison, Torque-speed characteristics, control of stepper motors Controllers for automation, servo control, Digital controllers, Advanced control systems, Digital signal processors, motor controllers, Axis controllers, Machine tool controllers, Programmable Logic Controllers	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P - Credits	Year of Introduction
HS300	Principles of Management	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To develop ability to critically analyse and evaluate a variety of management practices in the contemporary context;
- To understand and apply a variety of management and organisational theories in practice;
- To be able to mirror existing practices or to generate their own innovative management competencies, required for today's complex and global workplace;
- To be able to critically reflect on ethical theories and social responsibility ideologies to create sustainable organisations.

Syllabus

Definition, roles and functions of a manager, management and its science and art perspectives, management challenges and the concepts like, competitive advantage, entrepreneurship and innovation. Early contributors and their contributions to the field of management. Corporate Social Responsibility. Planning, Organizing, Staffing and HRD functions, Leading and Controlling. Decision making under certainty, uncertainty and risk, creative process and innovation involved in decision making.

Expected outcome.

A student who has undergone this course would be able to

i. manage people and organisations
ii. critically analyse and evaluate management theories and practices
iii. plan and make decisions for organisations
iv. do staffing and related HRD functions

Text Book:

Harold Koontz and Heinz Weihrich, *Essentials of Management*, McGraw Hill Companies, 10th Edition.

References:

1. Daft, *New era Management*, 11th Edition, Cengage Learning
2. Griffin, *Management Principles and Applications*, 10th Edition, Cengage Learning
3. Heinz Weirich, Mark V Cannice and Harold Koontz, *Management: a Global, Innovative and Entrepreneurial Perspective*, McGraw Hill Education, 14th Edition
4. Peter F Drucker, *The Practice of Management*, McGraw Hill, New York
5. Robbins and Coulter, *Management*, 13th Edition, 2016, Pearson Education

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Management: definitions, managerial roles and functions; Science or Art perspectives- External environment- global, innovative and entrepreneurial perspectives of Management (3 Hrs.)– Managing people and organizations in the context of New Era- Managing for competitive advantage - the Challenges of Management (3 Hrs.)	6	15%

II	**Early Contributions and Ethics in Management**: Scientific Management- contributions of Taylor, Gilbreths, Human Relations approach-contributions of Mayo, McGregor's Theory, Ouchi's Theory Z (3 Hrs.) Systems Approach, the Contingency Approach, the Mckinsey 7-S Framework Corporate Social responsibility- Managerial Ethics. (3 Hrs)	6	15%
FIRST INTERNAL EXAMINATION			
III	**Planning:** Nature and importance of planning, -types of plans (3 Hrs.)- Steps in planning, Levels of planning - The Planning Process. – MBO (3 Hrs.).	6	15%
IV	**Organising for decision making:** Nature of organizing, organization levels and span of control in management Organisational design and structure –departmentation, line and staff concepts (3 Hrs.) Limitations of decision making- Evaluation and selecting from alternatives- programmed and non programmed decisions - decision under certainty, uncertainty and risk-creative process and innovation (3 Hrs.)	6	15%
SECOND INTERNAL EXAMINATION			
V	**Staffing and related HRD Functions:** definition, Empowerment, staff – delegation, decentralization and recentralisation of authority – Effective Organizing and culture-responsive organizations –Global and entrepreneurial organizing (3 Hrs.) Manager inventory chart-matching person with the job-system approach to selection (3 Hrs.) Job design-skills and personal characteristics needed in managers-selection process, techniques and instruments (3 Hrs.)	9	20%
VI	**Leading and Controlling:** Leading Vs Managing – Trait approach and Contingency approaches to leadership - Dimensions of Leadership (3 Hrs.) - Leadership Behavior and styles – Transactional and Transformational Leadership (3 Hrs.) Basic control process- control as a feedback system – Feed Forward Control – Requirements for effective control – control techniques – Overall controls and preventive controls – Global controlling (3 Hrs.)	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100, Time: 3 hours .

The question paper shall consist of three parts

Part A: 4 questions uniformly covering modules I and II. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B : 4 questions uniformly covering modules III and IV. Each question carries 10 marks Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C: 6 questions uniformly covering modules V and VI. Each question carries 10 marks Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME361	**Advanced Fluid Mechanics**	**3-0-0-3**	**2016**

Prerequisite : ME203 Mechanics of fluids

Course Objectives: The main objectives of this course are to

- To provide knowledge regarding fluid-flow phenomena observed in mechanical engineering systems, such as potential flow, vortex flow, boundary-layer flows, etc.
- To undertake sustained learning in fluid mechanics to advance their knowledge in this field.
- To enhance the understanding of fluid mechanics, including the equations of motion in differential form and turbulence.

Syllabus

Basic Concepts and Fundamentals, Stream function and Potential function, Lagrangian and Eulerian approaches, Potential flow, Incompressible viscous flow, Boundary layer theory, Turbulent Flow.

Expected Outcome:

The students will be able to

i. Recognize the particular flow regime present in typical engineering system.
ii. Demonstrate the concept of stream function, potential function and boundary layer.
iii. Calculate the vorticity of a given velocity field and analyze the vorticity in idealized vortices: forced vortex and free vortex.
iv. Choose the appropriate fluid mechanics principles needed to analyze the fluid-flow situations.
v. Recognize how fluid flow theory can be employed in a modern mechanical engineering design environment.

Text books

1. Bansal R. K., A Text Book of Fluid Mechanics and Machines, Laxmi Publications, 2010.
2. Douglas J. F., Fluid Mechanics, Pearson Education, 2005.
3. Kumar D. S., Fluid Mechanics and Fluid Power Engineering, S. K. Kataria & Sons, 1987.
4. Muralidhar K., G. Biswas, Advanced Engineering Fluid Mechanics, Alpha Science International limited, 2005.
5. Rama D. D., Fluid Mechanics and Machines, New Age International, 2009.

Reference books

1. Schlichting H., K. Gersten , Boundary Layer Theory, 8/e, Springer 2000.
2. Shames I. H., Mechanics of Fluids, 4/e, McGraw-Hill, 2002.
3. Streeter V. L. and E. B. Wylie, Fluid Mechanics, McGraw-Hill, 1979.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks

I	Basic Concepts and Fundamentals: Fluid statics, Cartesian Tensors, Fluid Kinematics, and Description of fluid motion – Types of motion of fluid elements, Vorticity and circulation – Concept of rotational and irrotational flows. Equation of motion of forced and free vortex flow. Stream function and Potential function. Stream function and its relation with velocity field. Relation between stream function and stream lines - Relation between stream function and velocity potential for a 2-D irrotational and incompressible flow.	**7**	**15%**
II	Relation between stream lines and lines of constant potential. Sketching of stream lines. Lagrangian and Eulerian approaches, acceleration, temporal acceleration, convective acceleration. Reynolds transport theorem, derivation of continuity and momentum equations using Reynolds transport theorem. Problems on the application of momentum equation	**6**	**15%**
FIRST INTERNAL EXAMINATION			
III	Potential flow: Uniform flow, source flow, sink flow, free vortex flow and super imposed flow-source and sink pair, doublet, plane source in a uniform flow(flow past a half body), source and sink pair in a uniform flow(flow past a Rankine oval body), doublet in a uniform flow(flow past a circular cylinder). Pressure distribution on the surface of the cylinder. Flow past a cylinder with circulation, Kutta-Juokowsky's law. Complex flow potential, complex flow potentials for source, sink, vortex and doublet. Potential flow between two parallel plates, potential flow in a sector. Introduction to conformal transformation, conformal mapping.	**7**	**15%**
IV	Incompressible viscous flow. Concepts of laminar and turbulent flows . Stokes viscosity law. Navier Stoke's equation and significance (Derivation not necessary).Simplification of Havier stock equation for steady incompressible flows with negligible body forces. Parallel flow through straight channel and couette flow. Hagen - Poiseuille flow. Derivation of Hagen Poissuille equations for velocity and discharge through a pipe, derivation of friction factor for laminar flow, Couette flow for negative, zero and positive pressure gradients, flow in a rotating annulus, Viscometer based on rotating annulus.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Boundary layer theory, Boundary layer thickness, Displacement thickness, momentum thickness, Energy thickness and their calculation. Laminar Boundary Layers, Boundary layer equations; Boundary layer on a flat plate, Prandtl boundary layer equations, Blasius solution for flow over a flat plate, Von- Karman momentum integral	**8**	**20%**

	equations, Pohlhausen approximation solution of boundary layer for non-zero pressure gradient flow, favorable and adverse pressure gradients, Entry flow into a duct, flow separation and vortex shedding.		
V1	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. Boundary layer control.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II Each
question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV Each
question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI Each
question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks) Note: Each

question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME363	COMPOSITE MATERIALS AND MECHANICS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

1. To understand various matrices and reinforcements used in composites
2. To know about polymer matrix composites, metal matrix composites, ceramic matrix composites and its manufacturing and applications
3. To introduce post processing operations and micromechanics of composites

Syllabus

Composites – Reinforcements – Matrices – Polymer matrix composite – Metal matrix composite – Ceramic matrix composite – Post processing operations – Micromechanics of composites

Expected outcome:

- The students will be able to gain knowledge about composites, reinforcements, matrices, post

Text Books:

1. K. K. Chawla, Composite Materials : Science and Engineering, Springer, 3e, 2013.
2. Reddy J N (Ed.), Mechanics of Composite Materials; Selected Works of Nicholas J. Pagano, Springer, 1994
3. Robert M. Jones, Mechanics of Composite Materials, CRC Press, 1998

References Books:

1. F.L.Matthews & R.D.Rawlings, Composite Materials, Engineering and Sciences, Chapman & hall, London, 1994
2. Hand Book of Composites, George Lubin. Van Nostrand, Reinhold Co. 1982
3. Micael hyer, Stress Analysis of Fiber - Reinforced Composite Materials , Tata McGraw Hill, 1998.
4. P.K.Mallicak, Fiber-reinforced composites , Monal Deklar Inc., New York, 1988.
5. Ronald Gibson, Principles of Composite Material Mechanics , TMH, 1994.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Composite : Introduction, definition, characteristics, functions	1	15%
	classification of composites based on structure and matrix	1	
	smart composites, advantages and limitations	1	
	history, industrial scene and applications	1	
	Interfaces: wettability and bonding interface in composites	1	

	types of bonding at interface.	**1**	
II	Fibers : Introduction, types of fibers, natural fibers	**1**	**15%**
	glass fiber fabrication, structure, properties and applications	**2**	
	boron fiber fabrication, structure, properties and applications	**1**	
	carbon fiber, Ex-Pan carbon fiber	**1**	
	Ex cellulose carbon fiber, Ex-Pitch carbon	**1**	
	carbon fiber structure, properties and applications	**1**	
	aramid fiber fabrication, structure, properties and applications	**1**	
	whiskers: characteristics, properties and applications.	**1**	
	FIRST INTERNAL EXAMINATION		
III	Polymer matrix composites (PMC) : thermoset, thermoplastic and elastomeric polymers	**1**	**15%**
	properties, characteristics and applications as matrix materials	**1**	
	processing of polymer matrix composites: hand methods, Lay up method, spray up method	**2**	
	moulding methods, pressure bagging and bag moulding methods,	**1**	
	pultrusion and filament winding process.	**1**	
IV	Metal matrix composites (MMC) : classification of metals, intermetallics, alloys and their potential role as matrices in composites	**1**	**15%**
	properties, characteristics and applications of metals as matrix materials	**1**	
	production techniques: powder metallurgy, diffusion bonding, melt stirring	**2**	
	squeeze casting, liquid infiltration under pressure, spray code position, insitu process.	**2**	
	SECOND INTERNAL EXAMINATION		
V	Ceramic matrix composites (CMC) : classification of ceramics and their potential role as matrices,	**1**	**20%**
	properties, characteristics and applications of ceramics as matrix materials	**1**	
	conventional techniques : cold pressing and sintering, hot pressing, reaction bonding,	**1**	
	hot pressing and reaction bonding new techniques : liquid infiltration, pultrusion,	**1**	
	lanxide process, insitu chemical technique, sol-gel technique	**2**	

V1	Post processing operations : machining, cutting, polishing,	1	20%
	welding, rivetting and painting	1	
	Advanced post processing methods : ultrasonic welding, plasma coating,	1	
	Water jet cutting and laser machining	1	
	Micromechanics of composites: maximum stress and strain criterion (derivations)	2	
	Tsai-Hill and Tsai-Wu failure criterion (derivations)	2	
	mechanics of load transfer from matrix to fiber (description)	1	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I
and II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III
and IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V
and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40

marks) Note: Each question can have a maximum of four sub questions, if

needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME365	Advanced Metal Casting	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To gain theoretical and practical knowledge in material casting processes
- To develops an understanding of the dependent and independent variables which control materials casting in a production processes.
- To impart knowledge on design of gating system for castings
- To know foundry practice of ferrous and non ferrous alloys

Syllabus

Functional requirements of molding materials, gating - type of gating- gating design- factor involved in gating design, risers – primary function of a riser-theoretical consideration-riser design and placement, solidification, heat transfer during solidification, heat flow in solidification, ferrous and non-ferrous foundry practice, steel casting, aluminum and its alloys, magnesium and its alloys, casting design, defects and testing.

Expected outcome:

- The students will have exposed to the different areas of foundry practices, gained idea about metal casting, scope and its applications.

Text Books/References

1. A.K.Chakrabarti, Casting Technology and Cast Alloys, Prentice –Hall Of India Ltd, 2005
2. Beely, Foundry Technology, Newnes-Butterworths, 1979
3. Gruzleski, The Treatment of Liquid Aluminum-Silicon Alloys, the American Foundrymen's Society Inc, USA, 1992
4. Heine, Loper and Rosenthal, Principle of Metal Casting, 2nd Edition, Tata Mc-Graw-Hill Publishing Company Limited, New Delhi, 1978
5. John Cambell, Casting, Butterworth-Heineman Ltd, Jordon Hill, Oxford, 1991
6. T.V.Rama Rao, Metal casting Principles and Practice, New Age International,2010
7. Gruzleski, The Treatment of Liquid Aluminum-Silicon Alloys, the American Foundrymen's Society Inc, USA, 1992.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	**Design of molds** Functional requirements of molding materials, type of sands Properties of molding sand, sand testing techniques Effect of molding on sand properties,	2	15%

	Bonding material	**1**	
	Mould surface coating	**1**	
	Sand design and control	**1**	
	Thermal aspect of molding sand, mould wall movement	**1**	
II	**Pouring and feeding** **Gating -** type of gating- gating design	**1**	**15%**
	Factor involved in gating design-illustrative problems in determination of filling time and discharge rate	**1**	
	Aspiration effect- effects of friction and velocity distribution	**1**	
	Risers – primary function of a riser Theoretical consideration Riser design and placement Determination of dimensions of rise- blind risers	**2**	
	Internal risers-use of chills Use of insulators and exothermic compounds	**1**	
FIRST INTERNAL EXAMINATION			
III	**Solidification**		**15%**
	Freezing of pure metal Skin effects- nucleation and growth	**1**	
	Shrinkage- freezing of alloys	**1**	
	Effect of mould materials and alloy composition on casting	**1**	
	Fluidity- factor affecting fluidity- fluidity measurement and application of fluidity	**1**	
	Gases in metals- degassing	**1**	
	Grain refinement	**1**	
	Illustrative problems related to determination of solidification time	**1**	
IV	**Heat transfer during solidification**		**15%**
	Methods of manipulating heat transfer	**1**	
	Experimental methods for the study of heat transfer during solidification		
	Crystal growth methods	**1**	
	Heat flow in solidification	**1**	
	Heat transfer with in the solid/liquid metal system	**1**	
	Heat transfer at the metal-mould interface	**1**	
	Heat flow in one dimensional solidification geometries	**1**	
	Freezing at mould wall	**1**	
	Rapid freezing in contact with a cold substrate with initial melt super cooling	**1**	
SECOND INTERNAL EXAMINATION			
V	**Ferrous and non ferrous castings** **Steel Casting** – The family of cast iron	**1**	**20%**
	Melting of steels and cast irons–Grey iron Foundry practice – ductile iron – Malleable Iron casting	**1**	

	design		
	Aluminum and its alloys: Different Aluminum alloy systems Advantage and limitation of Aluminum alloy castings	**1**	
	Molding for aluminum castings - melting of Aluminum- degassing- grain refinement	**1**	
	Modification- effect of various melt treatment on the mechanical properties of Aluminum castings.	**1**	
	Magnesium and its alloys: different alloy systems- advantage and limitation of Magnesium alloy castings Molding for magnesium casting- melting of Magnesium- flux and flux less melting	**1**	
	Type and functions of fluxes used- degassing and grain refinement- pouring technique	**1**	
	Copper alloys: advantage of Copper alloys- melting- drossing-oxygen and hydrogen in Copper melting- control of gases- de oxidation	**1**	
V1	**Casting defects and testing**		**20%**
	Functional design- metallurgical design	**1**	
	simplification of foundry practice- economic considerations	**1**	
	design of junction- specification of castings	**1**	
	inspection of castings- analysis of casting defects	**1**	
	nondestructive testing of casting- dye penetrant testing	**1**	
	magnetic flaw detection, radiography, ultrasonic testing, etc.	**1**	
	quality control and quality assurance	**1**	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME367	Non-Destructive Testing	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To introduce the basic principles, techniques, equipment, applications and limitations of NDT methods such as Visual, Penetrant Testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography, Eddy Current.
- To enable selection of appropriate NDT methods.
- To identify advantages and limitations of nondestructive testing methods
- To make aware the developments and future trends in NDT.

Syllabus

Introduction to NDT- Visual Inspection- Liquid Penetrant Inspection- Magnetic Particle Inspection- Ultrasonic Testing- Radiography Testing- Eddy Current Testing.

Expected outcome

- The students will be able to differentiate various defect types and select the appropriate NDT methods for the specimen.

Text book

- Baldev Raj, Practical Non – Destructive Testing, Narosa Publishing House ,1997

Reference books

1. Hull B. and V.John, Non-Destructive Testing, Macmillan,1988
2. Krautkramer, Josef and Hebert Krautkramer, Ultrasonic Testing of Materials, Springer-Verlag, 1990

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to NDT, Comparison between destructive and NDT, Importance of NDT, Scope of NDT, difficulties of NDT, future progress in NDT, economics aspects of NDT.	1 1	15%
	Visual Inspection - tools, applications and limitations - Fundamentals of visual testing: vision, lighting, material attributes, environmental factors.	1 1	
	visual perception, direct and indirect methods mirrors, magnifiers, boroscopes, fibroscopes, closed circuit television, light sources	1 1	
	special lighting, a systems, computer enhanced system	1	
II	**Liquid Penetrant Inspection**: principles, properties required for a good penetrants and developers - Types of penetrants and developers	1 1	15%
	and advantages and limitations of various methods of LPI - LPI technique/ test procedure	1 1	
	interpretation and evaluation of penetrant test indications, false indication	1 1	

	and safety precaution required in LPI, applications, advantages and limitations	**1**	
FIRST INTERNAL EXAMINATION			
III	**Magnetic Particle Inspection (MPI)-** Principles of MPI, basic physics of magnetism, permeability, flux density, cohesive force, magnetizing force, rentivity, residual magnetism	**1** **1**	**15%**
	Methods of magnetization, magnetization techniques such as head shot technique, cold shot technique, central conductor testing, magnetization using products using yokes	**1** **1**	
	direct and indirect method of magnetization, continuous testing of MPI, residual technique of MPI, system sensitivity, checking devices in MPI	**1** **1**	
	Interpretation of MPI, indications, advantage and limitation of MPI.	**1**	
IV	**Ultrasonic Testing (UT):** principle, types of waves, frequency, velocity, wavelength, reflection, divergence, attenuation, mode conversion in ultrasonic UT testing methods	**1** **1**	**15%**
	contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques	**1** **1**	
	resonance testing, through transmission technique, pulse echo testing technique, instruments used UT, accessories such as transducers, types, frequencies, and sizes commonly used	**1** **1**	
	Reference blocks with artificially created defects, calibration of equipment, Applications, advantages, limitations, A, B and C scan - Time of Flight Diffraction (TOFD).	**1**	
SECOND INTERNAL EXAMINATION			
V	**Radiography Testing (RT):** Principle, electromagnetic radiation sources: X-ray source, production of X-rays, high energy X-ray source, gamma ray source - Properties of X-rays and gamma rays	**1** **1**	**20%**
	Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, real time radiography, films used in industrial radiography, types of film, speed of films, qualities of film	**1** **1**	
	screens used in radiography, quality of a good radiograph, film processing, interpretation, evaluation of test results, safety aspects required in radiography	**1** **1**	
	applications, advantages and limitations of RT	**1**	
V1	**Eddy Current Testing (ECT)** - Principle, physics aspects of ECT like conductivity, permeability, resistivity, inductance, inductive reactance, impedance	**1** **1**	**20%**
	Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT, relation between frequency and depth of penetration in ECT	**1** **1**	
	equipments and accessories, various application of ECT such as	**1**	

	conductivity measurement, hardness measurement, defect detection	**1**	
	coating thickness measurement, advantages and limitations of eddy current testing	**1**	
END SEMESTER UNIVERSITY EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME369	Tribology	3-0-0-3	2016
Prerequisite : Nil			

Course Objectives

- To provide broad based understanding of the subject „Tribology" and its technological significance
- To understand the genesis of friction, the theories/laws of sliding and rolling friction and the effect of viscosity
- To learn about consequences of wear, wear mechanisms, wear theories and analysis of wear problems
- To learn about the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques and the application of lubrications in metal working.
- To understand the importance of adhesion property in different applications and to get knowledge about different bearing materials.
- To understand the nature of engineering surfaces, their topography and learn about surface characterization techniques

Syllabus

Introduction to Tribology- Tribology in Design, Tribology in Industry, Tribological Parameters Like Friction, Wear and Lubrication, different types of lubrication techniques and applications, measurement of friction and wear -The Topography of Engineering Surface, Contact Between Surfaces, surface modification techniques- Adhesion properties, Adhesion in Magnetic Recording Systems, Types of Bearings, Comparison of Sliding and Rolling Contact Bearings.

Expected Outcome

The students will be able to

i. Understand the subject „tribology" and its technological significance.
ii. Understanding the theories/laws of sliding and rolling friction and the effect of viscosity.
iii. Get basic idea on consequences of wear, wear mechanisms, wear theories and analysis of wear problems
iv. Get an exposure to theories of hydrodynamic and the advanced lubrication techniques and the application of lubrications in metal working.
v. Gain overview of adhesion property in different applications and to get knowledge about different bearing materials
vi. Get basic idea about the nature of engineering surfaces, their topography and learn about surface characterization techniques.

Text books

1. Ernest Rabinowicz, Friction and Wear of Materials, John Wiley & sons,1995
2. I.M. Hutchings, Tribology: Friction and Wear of Engineering Materials, Butterworth-Heinemann,1992
3. Prasanta Sahoo, Engineering Tribology, PHI Learning Private Ltd, New Delhi, 2011.

Reference books

1. B. Bhushan, Introduction to Tribology, John Wiley & Sons, Inc, New York, 2002
2. B.Bhushan, B.K. Gupta, Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill,1997
3. Halling J ,"Principles of Tribology", McMillan Press Ltd.,1978

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Tribology- Tribology in Design, Tribology in Industry, Economic Aspects of Tribology	1	15%
	Tribological Parameters Like Friction, Wear and Lubrication	1	
	The Topography of Engineering Surface, Contact Between Surfaces.	2	
	Types of Bearings, Comparison of Sliding and Rolling Contact Bearings.	2	
II	Introduction, Empirical Laws of Friction, Kinds of Friction	1	15%
	Causes of Friction, Theories of Friction	1	
	Measurement of Friction	1	
	Friction of Metals, Ceramic Materials, Polymers.	2	
	Rolling Friction- Laws of Rolling Friction, Relation Between Temperature and Friction	1	
	Stick-Slip, Prevention of Stick-Slip, Consequences of Friction.	1	
FIRST INTERNAL EXAMINATION			
III	Types of Wear, Various Factors Affecting Wear	1	15%
	Theories of Wear, Wear Mechanisms	2	
	Measurement of Wear.	1	
	Wear Regime Maps, Alternative Form of Wear Equations	1	
	Lubricated and Unlubricated Wear of Metals, Materials Used in Different Wear Situations.	2	
IV	Fundamentals of Viscosity And Viscous Flow	1	15%
	Principle and Application of; Hydrodynamic Lubrication, Elastrodynamic Lubrication, Boundary and Solid Lubrication	2	
	Types of Lubricants, Properties of Lubricants	1	
	Effect of Speed and Load on Lubrication, Frictional Polymers.	1	
	Lubrication in Metal Working: Rolling, Forging, Drawing and Extrusion.	2	
SECOND INTERNAL EXAMINATION			
V	**Adhesion:** Introduction, Adhesion Effect by Surface Tension, Purely Normal Contact and Compression Plus Shear	2	20%

	Adhesion in Magnetic Recording Systems	**1**	
	Dependence of Adhesion on Material and Geometric Properties.	**1**	
	Bearing Materials: Introduction, Rolling Bearing, Fluid Film Lubricated Bearing, Dry Bearing, Bearing Constructions.	**3**	
V1	Introduction To Surface Engineering, Concept and Scope of Surface Engineering.	**1**	**20%**
	Surface Modification – Transformation Hardening, Surface Melting, Thermo chemical Processes	**3**	
	Surface Coating – Plating and Anoding Processes, Fusion Processes, Vapor Phase Processes.	**3**	
	Selection of Coating For Wear And Corrosion Resistance, Potential Properties and Parameters of Coating.	**1**	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME371	Nuclear Engineering	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To explore the engineering design of nuclear power plants using the basic principles of reactor physics, thermodynamics, fluid flow and heat transfer.
- To provide an overview on reactor principles, nuclear safety, and reactor dynamic behaviour.
- To understand the standards of radiation protection and need for nuclear waste disposal

Syllabus

Review of Elementary nuclear physics, Nuclear fission, Boiling water reactor, Structural materials, Nuclear fuels, Reactor heat removal, Safety and disposal

Expected Outcome:

The students will be able to

1. understand the theories and principles of nuclear power generation
2. understand the heat removal techniques applied to reactor heat transfer systems.
3. acquire knowledge about safe disposal of nuclear wastes

Text books/ Reference books

1. S. Glasstone and A. Sesonske, *Nuclear Reactor Engineering*, D. Van Nostrand Company, INC. 1967.
2. S Glasstone, Source book on atomic energy, Krieger Pub Co., 1979

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Review of Elementary nuclear physics: Atomic structure – nuclear energy and nuclear forces – Nuclear fission. Nuclear reactions and radiations – Principles of radioactive decay interactions of an ray with matter – Neutron cross sections and reactions –The fission process – Chain reactions	7	15%
II	Basic principles of controlled fusion .Nuclear reactor principles – Reactor classification – Critical size. Basic diffusion theory - Slowing down of neutrons – Neutrons – Neutron flux and power – Four factor formula – Criticality condition – Basic features of reactor control .	7	15%
	FIRST INTERNAL EXAMINATION		

III	Boiling water reactor . Description of reactor system – Main components –Control and safety features .Materials of reactor construction – Fuel , moderator , coolant	**7**	**15%**
IV	Structural materials – Cladding –Radiation damage, Nuclear fuels : Metallurgy of Uranium – General principles of solvent extraction – Reprocessing of irradiated fuel – Separation process fuel enrichment .	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Reactor heat removal / equations of heat transfer as applied to reactor cooling– Reactor heat transfer systems – Heat removed in fast reactors. Radiation safety : Reactor shielding – Radiation dozes – Standards of radiation protection	**7**	**20%**
V1	Safety and disposal: Nuclear plant safety-safety systems-changes and consequences of accident-criteria for safety-nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code.	Course Name	L-T-P - Credits	Year of Introduction
ME373	Human Relations Management	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To impart basic idea about human behavior as an individual and relations in group levels.
- To give idea on management of human relations in organizations and collective bargaining.
- To create knowledge on management of employer-employee relations and human conflicts.

Syllabus

Human behaviour as individual, Human behaviour in group, Management of human relations in organisations, Management of human relations and collective bargaining, Managing employer-employee relations, Managing human conflicts, Managing global human relations. Employee safety and health.

Expected outcome

The students will

i. get basic idea about human behavior in individual and group levels.
ii. understand the human relations in organizations and collective bargaining.
iii. be able to manage employer-employee relations and conflicts.

Text Books:

1. Gary Dessler, Human Resource Management., Pearson Education, 2017
2. Seema Sanghi , Stephen P. Robbins, , Timoti A Judge : Organizational Behaviour, Pearson Education, 2009

References:

1. Aubrey. C. Sanford, Human Relations: Theory and Practice, Merrill, 1973
2. C S Venkata Ratnam and B K Srivastava, Personnel Management and Human Resources, TMH, 1996.
3. William Scott, R C Clothier and W Spiegel : Personnel Management Principles: Practices and Points of Views, Tata Mc Graw Hill, 1977.
4. Uma Sekharan, Organizational Behaviour-Text and Cases ,Tata Mc Graw Hill, 1989.
5. V. Kumar, Customer Relationship Management, Wiley India Edition, 2013.

Course Plan

Module		Hours	End Sem. Exam Marks
I	**Human Behaviour**: Biological characteristics, age, gender, tenure. Ability, intellectual and physical abilities. Learning, theories of learning. Values, importance of values, types. Attitudes, types, attitudes and consistency, workforce diversity. Personality and emotions, personality determinants and traits, emotion dimensions. Perception, factors influencing perception, making judgement about others, link between perception and individual decision making.	6	15%
II	**Human Behaviour and Relations in Groups**: Defining and classifying different groups. Stages of group development, Five stage model. Group structure, roles, norms, status and size. Group decision making, group versus the individual. Types of teams, self-managed work teams, problem solving teams. Creating effective teams, composition, work design, process and team players.	6	15%
FIRST INTERNAL EXAMINATION			

III	**Management of Human Relations in Organisations**: Ethics and fair treatment at work, ethics and the law, ethics fair treatment and justice. Ethical behaviour at work, individual factors, organizational factors, the boss's influence, ethics policies and codes, the organization's culture, role of HR in fostering ethics and fair treatment. Disciplining an employee, formal disciplinary appeals process, discipline without punishment, employee privacy.	7	15%
IV	**Management of Human Laws and Collective Bargaining**: Employment law, gross misconduct, personal supervisory liability, layoffs and the plant closing law. Collective bargaining, good faith, negotiating team, bargaining items, bargaining stages, bargaining hints, impasses, mediation, and strikes, the contract agreement. Grievances, sources of grievances, the grievance procedure, guidelines for handling grievances.	7	15%
SECOND INTERNAL EXAMINATION			
V	**Management of Training and Employer-Employee Relations**: Training and development, objectives, strategies, methods and techniques. Design and organisation of training and evaluation of training. Employee relations, management-employee relations, managing discipline, grievance and stress, counselling, are handling problem employees. Industrial relations implications of personnel policies, nature of employment relationship.	8	20%
VI	**Management of Human Conflicts, Customer Relations, Unions and Global Relations:** Industrial and organisational conflict, managing for good industrial relations and managing the moment of conflict. Customer relationship management, what if customer is the problem. Place of unions in organizations. The future scenario, the changing personnel management scenario. Managing global human relations. HRD the development role of personnel to the force. Employee safety and health.	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs.**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks = 30 marks)

Part B

There should be 2 questions each from module III and IV Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks = 30 marks)

Part C

There should be 3 questions each from module V and VI Each question carries 10 marks

Students will have to answer any four questions out of 6 (4x10 marks = 40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
****341**	**DESIGN PROJECT**	**0-1-2-2**	**2016**
Prerequisite : Nil			

Course Objectives

- To understand the engineering aspects of design with reference to simple products
- To foster innovation in design of products, processes or systems
- To develop design that add value to products and solve technical problems

Course Plan

Study : Take minimum three simple products, processes or techniques in the area of specialisation, study, analyse and present them. The analysis shall be focused on functionality, strength, material, manufacture/construction, quality, reliability, aesthetics, ergonomics, safety, maintenance, handling, sustainability, cost etc. whichever are applicable. Each student in the group has to present individually; choosing different products, processes or techniques.

Design: The project team shall identify an innovative product, process or technology and proceed with detailed design. At the end, the team has to document it properly and present and defend it. The design is expected to concentrate on functionality, design for strength is not expected.

Note : The one hour/week allotted for tutorial shall be used for discussions and presentations. The project team (not exceeding four) can be students from different branches, if the design problem is multidisciplinary.

Expected outcome .

The students will be able to

i. Think innovatively on the development of components, products, processes or technologies in the engineering field
ii. Analyse the problem requirements and arrive workable design solutions

Reference:

Michael Luchs, Scott Swan, Abbie Griffin, 2015. Design Thinking. 405 pages, John Wiley & Sons, Inc

Evaluation

First evaluation (Immediately after first internal examination)	20 marks
Second evaluation (Immediately after second internal examination)	20 marks
Final evaluation (Last week of the semester)	60 marks

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME331	MANUFACTURING TECHNOLOGY LABORATORY – I	0-0-3-1	2016

Prerequisite: ME220 Manufacturing Technology

Course Objectives:

1. To practice on machine tools and identify, manipulate and control various process parameters during machining processes in manufacturing industry.
2. To practice arc and gas welding technologies.
3. To gain knowledge on the structure, properties, treatment, testing and applications of Steel, Cast Iron and Brass.

List of Exercises/Experiments :

Centre Lathe

Study of lathe tools: - tool materials - selection of tool for different operations - tool nomenclature and attributes of each tool angles on cutting processes – effect of nose radius, side cutting edge angle, end cutting edge angle and feed on surface roughness obtainable – tool grinding.

- Study the different methods used to observe how the work-piece is precisely fixed on lathe.
- Study the **optimum aspect ratio** of work-piece to avoid vibration and wobbling during turning.
- Machine tool **alignment of test** on the lathe.
- **Re-sharpening** of turning tool to specific geometry

1. Exercises on centre lathe:- Facing, plain turning, step turning and parting – groove cutting, knurling and chamfering - form turning and taper turning – eccentric turning, multi-start thread, square thread and internal thread etc.

2. Exercises on lathe: - Measurement of cutting forces in turning process and correlation of the surface roughness obtainable by varying feed, speed and feed.

3. Measurement of **cutting temperature and tool life** in turning and machine tool **alignment test** on lathe machine.

4. Exercises on Drilling machine- drilling, boring, reaming, tapping and counter sinking etc.

5. Exercises on drilling machine: - Measurement of cutting forces in drilling process and correlate with varying input parameters.

6. Exercises on Shaping machine

Exercises on shaping machine: - flat surfaces, grooves and key ways.

7. Exercises on Slotting machine

Exercises on slotting machine: - flat surfaces, grooves and key ways.

Exercises on Milling machine

8. Exercises on milling machine: - face milling, end milling – spur and helical gear cutting – milling of keyways etc.

9. Exercises on milling machine: - Measurement of cutting forces in milling process and

correlate the surface roughness obtainable by varying input parameters.

10 Machine tool **alignment test** on milling machine

Planing and Broaching machine

11. Study and demonstration of broaching machine.

12. Exercises on planing machine

Exercises on Welding

13. Exercises on arc and gas welding: - butt welding and lap welding of M.S. sheets.

Exercises on Grinding machine

14. Exercise on surface grinding, cylindrical grinding and tool grinding etc.

15. Measurement of cutting forces and roughness in grinding process and correlate with varying input parameters.

Metallurgy

16. Specimen preparation, etching & microscopic study of Steel, Cast iron and Brass and Grain size measurement.

17. Heat treatment study:–Effect on mechanical properties and microstructure of Steel, Cast Iron and Brass.

18. Studies of various quenching mediums, **Carryout heat treatments on steel** based on ASM handbook vol.4 and observe the hardness obtained.

A minimum of 12 experiments are mandatory out of total 18 experiments but all the experiments mentioned in metallurgy are mandatory.

Besides to the skill development in performing the work, oral examination should be conducted during end semester examination.

The student's assessment, continuous evaluation, awarding of sessional marks, oral examination etc. should be carried out by the assistant professor or above.

Expected outcomes:

The students will be able to

1. Identify various process parameters and their influence on surface properties of various metals.
2. Recommend appropriate speed, feed and depth of cut for various processes on lathe machine.
3. Position, hold and locate work material and cutting tools in various basic machine tools.
4. Choose suitable welding process for different metals.
5. Choose appropriate heat treatment process for different metals

Text Books:

1. Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication, 2000.
2. HMT, Production Technology, Tata McGraw Hill, 2001
3. W. A. J. Chapman, Workshop Technology Part I, ELBS & Edward Arnold Publishers, 1956

Course code	Course Name	L-T-P-Credits	Year of Introduction
EE335	ELECTRICAL AND ELECTRONICS LAB	0-0-3-1	2016

Course Objectives: The main objectives of this course are

- To give a practical knowledge on the working of electrical machines including dc machines, induction motors and synchronous motors.
- To impart the basics about design and implementation of small electronic circuits.

Syllabus

List of experiments:

1. OCC on a dc shunt generator, determination of critical resistance, critical speed, additional resistance required in the field circuit
2. Load characteristics of DC Shunt generator
3. Load characteristics of DC Compound generator
4. Load test on DC Series motor
5. Load test on DC Shunt motor
6. Load test on single phase transformer
7. Starting of three phase squirrel cage induction motor by star delta switch, load test on three phase squirrel cage induction motor
8. Load test on three phase slip ring induction motor
9. Load test on single phase induction motor.
10. OC and SC test on single phase transformer
11. V-I Characteristics of diodes and Zener diodes
12. Input and output characteristics of CE configuration of BJT S. Determination of β, input resistance and output resistance.
13. Half wave and full wave rectifiers with and without filters- Observe the waveforms on CRO.

Expected outcome:

The students will be able to

1. Test and validate various types of electrical motors
2. Acquire knowledge on working of semiconductor devices.

SEMESTER 6

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME302	Heat and Mass Transfer	3-1-0-4	2016

Prerequisites : ME203 Mechanics of fluid

Course Objectives:

- To introduce the various modes of heat transfer and to develop methodologies for solving a wide variety of practical heat transfer problems
- To provide useful information concerning the performance and design of simple heat transfer systems
- To introduce mass transfer

Syllabus:

Modes of Heat Transfer: Conduction: Most general heat conduction equation, One dimensional steady state conduction with and without heat generation, Critical radius of insulation, Elementary ideas of hydrodynamics and thermal boundary layers, Convection heat transfer: Newton's law of cooling, Dimensionless numbers, Dimensional analysis, Problems. Fins: Types of fins : Fin efficiency and effectiveness. Boiling and condensation heat transfer, Introduction to heat pipe. Transient heat conduction. Heat exchangers, LMTD and NTU methods. Radiation: laws of radiation, Electrical analogy, Radiation shields. Mass Transfer :Mass transfer by molecular diffusion, Convective mass transfer.

Expected outcome:

The students will be able to

1. Apply principles of heat and mass transfer to engineering problems
2. Analyse and obtain solutions to problems involving various modes of heat transfer
3. Design heat transfer systems such as heat exchangers, fins, radiation shields etc..

Text Books:

1. Sachdeva R C, Fundamentals of Engineering Heat and Mass Transfer, New Age Science Limited, 2009
2. R.K.Rajput. Heat and mass transfer, S.Chand& Co.,2015
3. Nag P K., Heat and Mass Transfer, McGraw Hill,2011
4. Kothandaraman, C.P., Fundamentals of Heat and Mass Transfer, New Age International, New Delhi, 2006

Data Book:

- Heat and Mass Transfer data book: C.P. Kothandaraman, S. Subramanya, New age International publishers,2014

References Books:

1. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill,2015
2. Holman J P, Heat Transfer, McGraw Hill, 2011
3. Frank P. Incropera and David P. Dewitt, Heat and Mass Transfer, John Wiley and sons, 2011

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Modes of Heat Transfer: Conduction: Fourier law of heat conduction-Thermal conductivity of solids, liquids and gases-Factors affecting thermal conductivity- Most general heat conduction equation in Cartesian, cylindrical and spherical coordinates One dimensional steady state conduction with and without heat generation conduction through plane walls, cylinders and spheres-variable thermal conductivity conduction shape factor- heat transfer through corners and edges. Critical radius of insulation.	12	15%
II	Elementary ideas of hydrodynamics and thermal boundary layers-Thickness of Boundary layer-Displacement, Momentum and Energy thickness (description only). Convection heat transfer: Newton's law of cooling- Laminar and Turbulent flow, Reynolds Number, Critical Reynolds Number, Prandtl Number, Nusselt Number, Grashoff Number and Rayleigh's Number. Dimensional analysis Buckingham's Pi theorem- Application of dimensional analysis to free and forced convection- empirical relations- problems using empirical relations	10	15%
FIRST INTERNAL EXAMINATIONEXAM			
III	Transient heat conduction-lumped heat capacity method. Fins: Types of fins - Heat transfer from fins of uniform cross sectional area- Fin efficiency and effectiveness. Boiling and condensation heat transfer(elementary ideas only),Introduction to heat pipe.	8	15%
IV	Combined conduction and convection heat transfer-Overall heat transfer coefficient - Heat exchangers: Types of heat exchangers, AMTD, Fouling factor, Analysis of Heat exchangers- LMTD method, Correction factor, Effectiveness-NTU method, Special type of heat exchangers (condenser and evaporator, simple problems only)	8	15%
SECOND INTERNAL EXAMINATION			
V	Radiation- Nature of thermal radiation-definitions and concepts- monochromatic and total emissive power-Intensity of radiation- solid angle- absorptivity, reflectivity and transmissivity-Concept of black body- Planck' law- Kirchoff's law- Wein's displacement law-Stefan Boltzmann's law- black, gray and real surfaces-Configuration factor (derivation for simple geometries only)- Electrical analogy- Heat exchange between black/gray surfaces- infinite parallel plates, equal and parallel opposite plates-perpendicular rectangles having common edge- parallel discs (simple problems using charts and tables). Radiation shields(no derivation).	10	20%

VI	Mass Transfer :Mass transfer by molecular diffusion- Fick's law of diffusion- diffusion coefficient Steady state diffusion of gases and liquids through solid- equimolar diffusion, Isothermal evaporation of water through air- simple problems. Convective mass transfer- Evaluation of mass transfer coefficient- empirical relations- simple problems- analogy between heat and mass transfer.	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Use of approved data book permitted

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks) Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME304	DYNAMICS OF MACHINERY	2-1-0-3	2016

Prerequisite: ME301 Mechanics of Machinery

Course Objectives:

- To impart knowledge on force analysis of machinery, balancing of rotating and reciprocating masses, Gyroscopes, Energy fluctuation in Machines.
- To introduce the fundamentals in vibration, vibration analysis of single degree of freedom systems.
- To understand the physical significance and design of vibration systems with desired conditions

Syllabus

Force analysis of machinery - static and dynamic force analysis of plane motion mechanisms. Flywheel analysis - static and dynamic balancing - balancing of rotating masses, gyroscopic couples. Vibrations – free vibrations of single degree freedom systems, damping, forced vibration, torsional vibration.

Expected outcome:

The students will be able to

1. Develop the design and practical problem solving skills in the area of mechanisms
2. Understand the basics of vibration and apply the concepts in design problems of mechanisms.

Text Books:

1. Ballaney P.L. Theory of Machines, Khanna Publishers,1994
2. S. S. Rattan, Theory of Machines, Tata McGraw Hill, 2009
3. V. P. Singh, Theory of Machines, Dhanpat Rai,2013

References :

1. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education, 2003
2. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press, 2003
3. H. Myskza, Machines and Mechanisms Applied Kinematic Analysis, Pearson Education, 4e, 2012
4. Holowenko, Dynamics of Machinery, John Wiley, 1995
5. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,1995
6. W.T.Thompson, Theory of vibration, Prentice Hall,1997

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to force analysis in mechanisms - static force analysis (four bar linkages only) - graphical methods	4	15%
	Matrix methods - method of virtual work - analysis with sliding and pin friction	3	
II	Dynamic force analysis: Inertia force and inertia torque. D'Alemberts principle, analysis of mechanisms (four bar linkages only), equivalent dynamical systems	4	15%
	Force Analysis of spur- helical - bevel and worm gearing	3	
FIRST INTERNAL EXAM			
III	Flywheel analysis - balancing - static and dynamic balancing - balancing of masses rotating in several planes	4	15%
	Balancing of reciprocating masses - balancing of multi-cylinder in line engines - V engines - balancing of machines	3	
IV	Gyroscope – gyroscopic couples	3	15%
	Gyroscopic action on vehicles-two wheelers, four wheelers, air planes and ships. Stability of an automobile – stability of a two wheel vehicle –Stabilization of ship.	4	
SECOND INTERNAL EXAM			
V	Introduction to vibrations – free vibrations of single degree freedom systems – energy Method	2	20%
	Undamped and damped free vibrations – viscous damping – critical damping - logarithmic decrement - Coulomb damping – harmonically excited vibrations	3	
	Response of an undamped and damped system – beat phenomenon - transmissibility	2	
VI	Whirling of shafts – critical speed - free torsional vibrations – self excitation and stability analysis - vibration control - vibration isolation – vibration absorbers	4	20%
	Introduction to multi-degree freedom systems - vibration measurement - accelerometer – seismometer – vibration exciters	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and
II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III
and IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V
and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40

marks) Note: Each question can have a maximum of four sub questions, if

needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME306	ADVANCED MANUFACTURING TECHNOLOGY	3-0-0-3	2016

Pre requisite: ME 220 Manufacturing Technology, ME303 Machine Tools and Digital Manufacturing

Course Objectives

1. To introduce machining principles and processes in the manufacturing of precision components and products that use conventional and nonconventional technologies.
2. To give basic understanding of the machining capabilities, limitations, and productivity of advanced manufacturing processes.
3. To describe how PLC's operate and how they control automated equipment and systems
4. To demonstrate tool path simulations with CNC powered equipment
5. To introduce CNC programming

Syllabus:-

Powder Metallurgy- Programmable Logic Controllers- CNC- non-traditional and micro machining process - high velocity forming of metals-material additional process.

Expected outcome:

The students will be able to

i. Become conversant with the non- traditional machining process and to appreciate the effect of process parameters on the surface integrity aspects during the non- traditional machining process.
ii. Appreciate the use of an EDM as a non traditional method of machining complex and hard materials.
iii. Prescribe a laser materials processing technique suitable for a given product with material, size, precision, and surface quality requirements.
iv. Program and operate a CNC mill and lathe.
v. Select the tool material and machining process parameters.

Text books/References

1. ASTME, High velocity forming of metals, PHI, 1968.
2. Davies K and Austin E.R, Developments in high speed metal forming, the machinery publishing Co, 1970.
3. Ibrahim Zeid, R Sivasubrahmanian CAD/CAM: Theory & Practice, McGraw Hill Education, 2009
4. Jain V.K., Introduction to Micromachining, Narosa publishers,2014
5. M.P. Groover, E.M. Zimmers, Jr. CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall of India, 1987
6. Petruzella Frank.D., Programmable logic controllers,McGraw Hill,2016
7. Yoram Koren, Computer control of manufacturing systems, TMH,2006

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam. Marks**
I	Introduction: Need and comparison between traditional, non-traditional and micro & nano machining process.	1	**15%**
	Powder Metallurgy: Need of P/M - Powder Production methods:- Atomization, electrolysıs, Reduction of oxides, Carbonyls (Process parameters, characteristics of powder produced in each method).	1	
	Powder characteristics: properties of fine powder, size, size distribution, shape, compressibility, purity etc.	1	
	Mixing – Compaction:- techniques, pressure distribution, HIP & CIP.	1	
	Mechanism of sintering, driving force for pore shirking, solid and liquid phase sintering - Impregnation and Infiltration Advantages, disadvantages and specific applications of P/M.	1	
	Programmable Logic Controllers (PLC): need – relays - logic ladder program –timers, simple problems only.	1	
	Point to point, straight cut and contouring positioning - incremental and absolute systems – open loop and closed loop systems - control loops in contouring systems: principle of operation.	1	
II	DDA integrator:-Principle of operation, exponential deceleration –liner, circular and complete interpolator.	1	**15%**
	NC part programming: part programming fundamentals - manual programming –	1	
	NC coordinate systems and axes — sequence number, preparatory functions, dimension words, speed word, feed world, tool world, miscellaneous functions –	1	
	Computer aided part programming:– CNC languages – APT language structure: geometry commands, motion	1	
	commands, postprocessor commands, compilation control commands	1	
	Programming exercises: simple problems on turning and drilling etc - machining centers- 5 axis machining **(*At least one programming exercise must be included in the end semester University examination).***	2	
	FIRST INTERNAL EXAMINATION		

III	Electric Discharge Machining (EDM):- Mechanism of metal removal, dielectric fluid, spark generation, recast layer and attributes of process characteristics on MRR, accuracy, HAZ etc, Wire EDM, applications and accessories.	3	**15%**
	Ultrasonic Machining (USM):-mechanics of cutting, effects of parameters on amplitude, frequency of vibration, grain diameter, slurry, tool material attributes and hardness of work material, applications.	2	
	Electro chemical machining (ECM):- Mechanism of metal removal attributes of process characteristics on MRR, accuracy, surface roughness etc, application and limitations.	1	
IV	Laser Beam Machining (LBM), Electron Beam Machining (EBM), Plasma arc Machining (PAM), Ion beam Machining(IBM) - Mechanism of metal removal, attributes of process characteristics on MRR, accuracy etc and structure of HAZ compared with conventional process; application, comparative study of advantages and limitations of each process.	3	**15%**
	Abrasive Jet Machining (AJM), Abrasive Water Jet Machining **(AWJM)** - Working principle, Mechanism of metal removal, Influence of process parameters, Applications, Advantages & disadvantages.	3	
	SECOND INTERNAL EXAMINATION		
V	High velocity forming of metals:-effects of high speeds on the stress strain relationship steel, aluminum, Copper – comparison of conventional and high velocity forming methods- deformation velocity, material behavior, stain distribution.	3	**20%**
	Stress waves and deformation in solids – types of elastic body waves- relation at free boundaries- relative particle velocity.	2	
	Sheet metal forming: - explosive forming:-process variable, properties of explosively formed parts, etc.	2	
	Electro hydraulic forming: - theory, process variables, etc, comparison with explosive forming.	1	
V1	Micromachining: Diamond turn mechanism, material removal mechanism, applications.	1	**20%**
	Advanced finishing processes: - Abrasive Flow Machining, Magnetic Abrasive Finishing.	2	
	Magnetorheological Abrasive Flow Finishing, Magnetic Float Polishing, Elastic Emission Machining.	3	
	Material addition process:- stereo-lithography, selective laser sintering, 3D Printing, fused deposition modeling, laminated object manufacturing, , laser engineered net-shaping, laser welding, LIGA process.	2	

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II Each
question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV Each
question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI Each
question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks) Note: Each

question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME308	COMPUTER AIDED DESIGN AND ANALYSIS	3-0-0-3	2016

Prerequisite: ME201 Mechanics of solids

Course Objectives:

1. To impart basic knowledge on Computer Aided Design methods and procedures
2. To introduce the fundamentals of solid modelling
3. To introduce the concepts of finite element analysis procedures.

Syllabus

Introduction to CAD/CAM, Basics of geometric and solid modeling, transformation, representation points, lines, surfaces and solid models. Introduction to finite element analysis, solution procedures, interpolation, isoparametric formulation, applications.

Expected outcome:

The students will be able to

1. Gain a basic knowledge on Computer Aided Design methods and procedures
2. Understand the fundamentals of solid modelling
3. Have a basic knowledge in finite element analysis procedures.

Text Books:

1. M.P. Groover, E.M. Zimmers, Jr.CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall of India, 1987
2. T. R. Chandrupatla and A. D. Belagundu, Introduction to Finite Elements in Engineering, Pearson Education, 2001

References:

1. Chris Mcmahon and Jimmie Browne - CAD/CAM – Principle Practice and Manufacturing Management, Addision Wesley England,1998
2. D. F. Rogers and J. A. Adams, Mathematical Elements in Computer Graphics, McGraw-Hill,1990
3. Daryl Logan, A First course in Finite Element Method, Thomson Learning,2007
4. David V Hutton, Fundamentals of Finite Element Analysis, THM,2003
5. Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with open GL, Pearson Education,2001
6. Grigore Burdea, Philippe Coiffet, Virtual Reality Technology, John Wiley and sons,2003
7. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill,2007
8. P. Radhakrishnan and S. Subramanyan, CAD / CAM / CIM, New Age Int. Ltd.,2008

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to CAD , Historical developments, Industrial look at CAD, Comparison of CAD with traditional designing, Application of computers in Design	2	15%
	Basics of geometric and solid modeling, Packages for CAD/CAM/CAE/CAPP	1	
	Hardware in CAD components, user interaction devices, design database, graphic Standards, data Exchange Formats, virtual Reality.	4	
II	Transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling.	4	15%
	Shearing,rotation, reflection and translation, combined transformations, orthographic and perspective projections, reconstruction of 3-D objects.	3	
FIRST INTERNAL EXAM			
III	Algebraic and geometric forms, tangents and normal, blending functions, reparametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves.	4	15%
	Plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, bezier surface, B-spline surfaces and their modeling techniques.	3	
IV	Solid models and representation scheme, boundary representation, constructive solid geometry.	3	15%
	Sweep representation, cell decomposition, spatial occupancy enumeration, coordinate systems for solid modeling.	4	
SECOND INTERNAL EXAM			
V	Introduction to finite element analysis - steps involved in FEM- Preprocessing phase – discretisation - types of elements	2	20%
	Formulation of stiffness matrix (direct method, 1-D element) - formulation of load vector - assembly of global equations - implementation of boundary conditions - solution procedure - post processing phase	3	
	Simple problems with axial bar element (structural problems only)	2	
VI	Interpolation – selection of interpolation functions - CST element - isoparametric formulation (using minimum PE theorem) – Gauss-quadrature	4	20%

	Solution of 2D plane stress solid mechanics problems (linear static analysis)	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and
II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III
and IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V
and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40

marks) Note: Each question can have a maximum of four sub questions, if

needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME312	METROLOGY AND INSTRUMENTATION	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To understand the working of linear and angular measuring instruments.
- To familiarize with the working of optical measuring instruments and fundamentals of limits and limit gauges.
- To give basic idea about various methods for measurement of screw thread and surface finish parameters.
- To give an exposure to advanced measuring devices and machine tool metrology.
- To provide students an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
- To provide basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Syllabus

Introduction to Metrology - Errors in Measurement- Basic standards of length - Linear Measurement, Comparators - Angular Measurement - Limits and Limit gauges - Optical Measuring Instruments - Screw thread measurement - Measurement of surface texture - Machine tool metrology - Coordinate Measuring Machine (CMM) and Machine Vision.
Introduction to Mechanical Measurement - Motion and Dimension measurement, Strain and Stress Measurement - Measurement of Force, Torque and Temperature Measurement.

Expected outcome:

The students will be able to

i. Understand the working of linear and angular measuring instruments.
ii. Know the fundamentals of limits and limit gauges, various methods for measurement of screw thread and surface roughness parameters and the working of optical measuring instruments.
iii. Get an exposure to advanced measuring devices and machine tool metrology.
iv. Acquire an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
v. Get basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Text books

1. Anand K Bewoor, Vinay A Kulkarni, Metrology & Measurement, McGraw-Hill, 2009
2. Ernest O. Doebelin, Dhanesh N. Manik, Measurement Systems Application and Design, McGraw-Hill, 2004
3. Galyer J.F.W., Schotbolt C.R., Metrology for Engineers, ELBS,1990
4. Thomas G. Beckwith, John H. L., Roy D. M., Mechanical Measurements, 6/E , Pearson Prentice Hall, 2007

Reference books

1. ASME, Hand book of Industrial Metrology,1998
2. Hume K. J., Engineering Metrology, Macdonald &Co. Ltd.,1990
3. J.P.Holman, Experimental Methods for Engineers,Mcgraw-Hill, 2007
4. Sharp K.W.B., Practical Engineering Metrology, Sir Isaac Pitman & Sons Ltd.,1958

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Concept of measurement:-Introduction to Metrology; Need for high precision measurements; Terminologies in Measurement- Precision, accuracy, sensitivity, calibration.	1	15%
	Errors in Measurement, types of errors, Abbe's Principle.	1	
	Basic standards of length- Line standard, End standards, Wavelength standard; Various Shop floor standards.	1	
	Linear Measurement – Slip gauges, wringing, grades; Surface plate; Dial indicators; Height gauges and Vernier calipers.	1	
	Comparators- mechanical, electrical, optical and pneumatic.	1	
	Angular Measurement – Bevel protractor; Sine Bar, principle and use of sine bar, sine centre; Angle gauges.	1	
	Sprit level; Angle Dekkor; Clinometers.	1	
II	Limits and Limit gauges – Making to suit, selective assembly, systems of limits and fits; Types of fits; Hole basis system and Shaft basis system.	1	15%
	Standard systems of limits and fits; Shaft and Hole system; Tolerance, allowance and deviation (as per BIS).	1	
	Simple problems on tolerance and allowance, shaft and hole system.	1	
	Limit Gauges – GO and NO GO gauges; types of limit gauges.	1	
	Gauge design - Taylor's principle of gauging; Gauge tolerance, disposition of gauge tolerance, wear allowance.	1	
	Optical Measuring Instruments: - Benefits of using light waves as standards; Monochromatic light; Principle of Interference.	1	
	Interference band using optical flat, application in surface measurement.	1	
	Interferometers – NPL flatness interferometer, Pitter-NPL gauge interferometer.	1	
	FIRST INTERNAL EXAMINATION		
	Screw thread measurement – Screw thread terminology; Measurement of major diameter; Measurement of minor or root diameter.	1	
	Measurement of pitch; Measurement of effective diameter with two wire method and three wire method.	1	
	Measurement of flank angle and form by profile projector and	1	

III	microscope.		**15%**
	Measurement of surface texture – Meaning of surface texture, roughness and waviness; Analysis of surface traces, peak to valley height, R.M.S. value, Centre Line Average and R_a value, Rt, Rz etc.	**1**	
	Methods of measuring surface roughness – Stylus probe, Tomlinson surface meter, Talysurf; Terms used in surface roughness measurement – assessment length, roughness width cut-off, sampling length and evaluation length.	**1**	
	Interference method for measuring surface roughness – using optical flat and interferometers.	**1**	
	Autocollimator, principle and use of autocollimator.	**1**	
IV	Machine tool metrology – Alignment testing of machine tools like lathe, milling machine, drilling machine.	**1**	**15%**
	Advanced measuring devices – Laser interferometers.	**1**	
	Coordinate Measuring Machine (CMM) – Introduction to CMM; Components and construction of CMM.	**1**	
	Types of CMM; Advantages and application of CMM	**1**	
	CMM probes, types of probes – contact probes and non contact probes	**1**	
	Machine Vision – Introduction to machine vision, functions, applications and advantages of machine vision.	**1**	
	Steps in machine vision	**1**	
	SECOND INTERNAL EXAMINATION		
V	Introduction to Mechanical Measurement – significance of mechanical measurement; Fundamental methods of measurement; Classification of measuring instrument.	**1**	**20%**
	Stages in generalized measuring system – Sensor-Transducer stage, Signal-Conditioning stage, Readout-Recording stage; Types of input quantities; Active and Passive transducers.	**1**	
	Performance characteristic of measuring devices – Static characteristics – Accuracy, Precision, Repeatability, Sensitivity, Reproducibility, Drift, Resolution, Threshold, Hysteresis, Static calibration.	**1**	
	Dynamic characteristics- different order systems and their response-, Measuring lag, Fidelity, Dynamic error; Types of errors in measurement.	**1**	
	Transducers – Working, Classification of transducers.	**1**	
	Motion and Dimension measurement – LVDT – Principle, applications, advantages and limitations.	**1**	
V1	Strain and Stress Measurement - Electrical resistance strain gauge - Principle, operation.	**1**	
	Measurement of Force and Torque – Strain-Gauge Load Cells, Hydraulic and Pneumatic load cells – basic principle and three component force measurement using piezoelectric quartz crystal.	**1**	
	Torque Measurement – Dynamometers – Mechanical, Hydraulic and Electrical.	**1**	
	Vibration measurement – Vibrometers and Accelerometers – Basic principles and operation.	**1**	

	Temperature Measurement – Use of Thermal Expansion – Liquid-in-glass thermometers, Bimetallic strip thermometer, Pressure thermometers.	**1**	**20%**
	Thermocouples – Principle, application laws for Thermocouples, Thermocouple materials and construction, measurement of Thermocouple EMF.	**1**	
	Resistance Temperature Detectors (RTD); Thermistors; Pyrometers (Basic Principles).	**1**	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME362	Control System Engineering	3-0-0-3	2016

Course Objectives: :

1. To introduce the concepts of controls and modelling of physical systems.
2. To give idea on system response analysis and stability of systems.
3. To use different methods to analyse stability of control systems

Syllabus:

Control systems and components, Mathematical models, Block diagrams, Signal Flow graphs, Transient and Steady state response analysis, Stability , Routh's stability criterion, Root locus method. Frequency response analysis using polar plots ,Bode plots, Nyquist stability criterion

Expected Outcomes: At the end of the course students will be able

1. To model and analyse physical systems.
2. To analyse the stability of feedback control systems

Text books:

1. Kuo, B. C., Automatic Control Systems, Prentice Hall,2012
2. Thaler and Brown, Analysis and Design of Feedback Control Systems, McGraw Hill, 1960.
3. Nagrath I J and Gopal M, Control Systems Engineering, New Age India Pvt Limited, 2009

References:

1. Ogata, K., Modern Control Engineering, Pearson Education, 2004
2. NPTEL courses, http//nptel.iitm.ac.in/courses.php, web and video courses on Control Engineering

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to control systems. Elementary ideas on types of control systems- Open loop and closed loop systems, Servo systems, Automatic regulating systems, Process control systems, Adaptive control systems, Learning control systems, Discrete control systems, Multivariable control systems, Linear and Non-linear systems. Elementary ideas on types of controls- proportional, integral, proportional integral, proportional integral derivative controls. Direct and indirect controls. Mathematical models of physical systems – typical examples of mechanical, thermal, electrical, hydraulic and pneumatic systems.	7	15%
II	Block diagram, transfer function, reduction of block diagrams, signal flow graphs :Manson's gain formula. Control system components – servomotors, stepper motor, synchros, hydraulic pumps and motors, hydraulic valves, pneumatic bellows, pneumatic valve, pneumatic relay, pneumatic actuator, gyroscopes (elementary ideas only. No derivations)	7	15%

	FIRST INTERNAL EXAMINATION		
III	System response- Time response of first and second order systems, steady state errors and error constants, specifications in time domain. Effect of pole locations, Concept of stability, Routh's stability criterion	**7**	**15%**
IV	Root locus method of analysis and design. Lead and lag compensation	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Frequency response analysis- relationship between time & frequency response, Bode's plot, stability in frequency domain, gain margin and Phase margin	**7**	**20%**
V1	Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME364	Turbomachinery	3-0-0-3	2016

Prerequisite : ME205 Thermodynamics

Course Objectives: :

1. To know the principle of operation of turbomachines
2. To provide students thorough understanding of velocity triangles, turbomachinery
3. To introduce students to fans, turbines, pumps etc..

Syllabus:

Definition of turbomachine, Application of first and second laws of thermodynamics to turbomachines, Efficiencies, Centrifugal fans and blowers, Centrifugal Compressors, Axial flow compressors, Axial and radial flow turbines

Expected Outcomes:

The students will be able to

1. Understand the operation of turbomachines
2. Gain ideas on performance characteristics, governing and selection of turbomachinery.

Text books

1. Bruneck, Fans, Pergamom Press, 1973.
2. Dixon, S.I, Fluid Mechanics and Thermodynamics of Turbomachinery , Pergamom, Press, 1990.
3. Ganesan .V, Gas Turbines , Tata McGraw Hill Pub. Co., New Delhi, 1999.
4. Stepanff, A.J, Blowers and Pumps , John Wiley and Sons Inc., 1965.
5. Yahya, S.H, Turbines, Compressor and Fans , Tata Mc Graw Hill, 1996.

Reference books

1. Earl Logan, Jr, Hand book of Turbomachinery, Marcel Dekker Inc, 1992.
2. Shepherd, D.G, Principles of Turbomachinery , Macmillan, 1969.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Definition of turbomachine, parts of turbomachines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies.	7	15%
II	Application of first and second laws of thermodynamics to turbomachines, Efficiencies of turbomachines. Stage velocity triangles, work and efficiency for compressors and turbines	7	15%
FIRST INTERNAL EXAMINATION			

III	Centrifugal fans and blowers : Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristics curves and selection, fan drives and fan noise.	**7**	**15%**
IV	Centrifugal Compressors: Construction details, types, impeller flow losses, slip factor, diffuser analysis, losses and performance curves.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Axial flow compressors : Stage velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, simple stage design problems and performance characteristics.	**7**	**20%**
V1	Axial and radial flow turbines : Stage velocity diagrams, reaction stages, losses and coefficients blade design principles, testing and performance characteristics.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40

marks) Note: Each question can have a maximum of four sub questions, if

needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME366	ADVANCED METAL JOINING TECHNOLOGY	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To expose the students to the fundamental concepts of advanced welding technologies and their relevance

Syllabus

Radiant energy welding, Electron beam and Laser beam welding, Plasma arc welding, Micro plasma welding, Magnetically impelled arc butt welding, Underwater welding, Explosive welding, Adhesive bonding, Friction welding, Friction stir welding, Friction stir processing, Diffusion welding, Cold Pressure welding, Ultrasonic welding, Vacuum brazing.

Expected outcome

- The students will be able to understand the advancements in welding technologies and processes, their significance, application areas etc. leading to the development of products and processes.

References Books:

1. ASM Metals Hand Book "Welding and Brazing", Vol. 6, ASM, Ohio, 1988.
2. Parmar R.S., "Welding Processes and Technology", Khanna Publishers, Delhi, 1998.
3. Parmer R. S., Welding Engineering and Technology", Khanna Publishers, 1997
4. Rossi, Welding Engineering, McGraw Hill, 1954.
5. Schwartz M.M., "Metals Joining Manual", McGraw-Hill Inc., 1979.
6. Udin et al., Welding for Engineers, John Wiley & Sons, New York, 1967.
7. Welding Engineers Hand Book- ASHE Vol . I, II, III and IV.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Radiant energy welding: Electron Beam Welding- Background of the Process, Guns, Weld Environment, Welding in Different Degrees of Vacuum, Equipment and Safety, Joint Design, Applications, Laser Beam Welding, Physics of Lasers, Types of Lasers, Process Parameters, Applications and Limitations.	7	15%

II	Diffusion Welding- theory and Principle of Process, Key Variables, Intermediate Materials, Deformation Welding, Equipment and Tooling, Joint Design, Economics, Advantages and Limitations, Materials and Applications, Cold Pressure Welding- Process, Equipment and Setup, Applications	6	15%
FIRST INTERNAL EXAM			
III	Explosive Welding- theory and Key Variables, Parameters, Weld Quality, Equipment and Tooling, Advantages and Limitations, Joint Design, Materials and Applications, Adhesive Bonding- theory and Key Parameters, Physical Characteristics, Metal Adhesive, Equipment, Design, Economics of Process, Materials and Applications.	7	15%
IV	Ultrasonic welding-Principles of operation, Process Characteristics and Applications, Vacuum brazing- Theory, Mechanisms and Key Variables, Equipment and Tooling, Stop-Off and Parting Agents, Advantages, Limitations, Economics Materials and Applications.	6	15%
SECOND INTERNAL EXAM			
V	Plasma arc welding: Plasma Arc Welding- theory and Principles, Transferred arc and Non-Transferred arc Techniques, Equipment and Tooling, Joint Design Advantages, Disadvantages, Economics, Materials and Applications, Needle Arc Micro Plasma Welding - Characteristics of Process, Operating Characteristics, Fixturing and Joint Design, Shielding, Weld Penetration and Shape, Applications, Magnetically impelled arc butt (MIAB) welding, Under Water Welding- Wet and Dry Under Water Welding	8	20%
VI	Friction Welding- Basic Principles, Process Variants, Different Stages of Friction Welding, Mechanism of Bonding, Influence of Process Parameters, Weld Quality and Process Control, Joining of Dissimilar Materials, Advantages, Limitations and Applications, Friction Stir Welding-Metal flow phenomena, tools, process variables and applications, Friction Stir Processing- Process, Application	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks) Note:

Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME368	Marketing Management	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To introduce the concept of market and marketing
- To give idea about launching a new product
- To introduce the various marketing strategies

Syllabus:

Introduction to marketing, Social and Marketing planning, Consumer behavior, Marketing communication, Designing the message, New trends in marketing

Expected Outcomes:

The students will be able to

i. state the role and functions of marketing within a range of organizations.

ii. describe key marketing concepts, theories and techniques for analyzing a variety of marketing situations.

iii. identify and demonstrate the dynamic nature of the environment in which marketing decisions are taken

iv. synthesize ideas into a marketing plan

Text books:

1. Majumdar R., Marketing Research, Text, Applications and Case Studies, New Age International (P), 1991
2. Ramaswamy V.S. & Namkumari S, Marketing Management: Planning, Implementation and Control, Macmillan India Limited, 2002
3. Robert, Marketing Research, Prentice Hall of India,1999
4. T N Chabra and S K Grover : Marketing management, Dhanpat Rai, 2007

Reference books:

1. Kotler P, Marketing Management: Analysis, Planning, Implementation and Control, Prentice Hall of India,1993
2. Stanton W.J., Etzel M.J. & Walker B.J, Fundamentals of Marketing, McGraw Hill International Edition, 1994

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to marketing - concept of market and marketing – marketing environment - controllable factors - factors directed by top management - factors directed by marketing - uncontrollable factors - demography, economic conditions, competition.	7	15%
II	Social and Marketing planning - marketing planning process - Boston consultancy group model - marketing mix - marketing mix variables. Developing, testing and launching of new products .	7	15%

	FIRST INTERNAL EXAMINATION		
III	Market segmentation and market targeting - introduction to segmentation - targeting and product positioning. Marketing research - need and scope - marketing research process – research objectives, developing research plan, collecting information, analysis, and findings.	**7**	**15%**
IV	Consumer behaviour - factors influencing consumer behaviour - perceived risks Product life cycle - marketing strategies for different stages of product life cycle	**6**	**15%**
SECOND INTERNAL EXAMINATION			
V	Marketing communication - marketing mix variables - steps in developing effective communication - identification of target audience - determination of communication objectives	**7**	**20%**
V1	Designing the message - selecting the communication channels - promotion mix evaluation - advertising and sales promotion - factors in advertising - sales promotion tools. New trends in marketing- Brand management - significance of branding to consumers and firms	**8**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME372	Operations Research	3-0-0-3	2016

Prerequisite -Nil

Course Objectives:

- To understand the role of operation research in decision making
- To impart the various operation research techniques for effective problem solving.

Syllabus:

Operations research models, linear programming, transportation problem, assignment problem, sequencing problem, network analysis, queuing theory, inventory control, decision theory, game theory – simulation.

Expected Outcome:

- The students will be able to understand operations research techniques and apply them in solving practical problems in industry.

Text Books:

1. Miller, D. M. and Schmidt, J. W., Industrial Engineering and Operations Research, John Wiley & Sons, Signapore, 1990.
2. Paneerselvam, R., Operations Research, Prentice Hall of India, New Delhi, 2008.
3. Pannerselvam, R., Design and Analysis of Algorithms, Prentice Hall of India, New Delhi, 2007.
4. Srinivasan, G. "Operations Research-Principles and Applications", Latest edition, PHI Pvt. Ltd., 2010.
5. Taha, H. A., Operations Research, Pearson, 2004.

Reference Books:

1. Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D. M., Discrete-Event System Simulation, Third Edition, Pearson Education, Inc., 2001.
2. Goel, B. S. and Mittal, S. K., Operations Research, Pragati Prakashan, Meerut, 1999.
3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Willey & Sons, 1987.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Basics of operations research–OR models–applications.	1	15%
	Linear programming – problem formulation	1	
	Graphical method	1	
	Simplex method	1	

	Big-M method	**1**	
	Two–phase method	**1**	
	Duality in linear programming	**1**	
II	Transportation problem – formulation – balanced & unbalanced transportation problems	**1**	**15%**
	North west corner rule – least cost method	**1**	
	Vogel's method –stepping stone method	**1**	
	MODI method	**1**	
	Assignment problem – formulation – optimal solution, Hungarian algorithm	**1**	
	Variants of assignment problems	**1**	
	Traveling salesman problem.	**1**	
FIRST INTERNAL EXAMINATION			
III	Sequencing problem– terminology and notations – assumptions – problems with *n* jobs through two machines	**1**	**15%**
	Problems with *n* jobs through three machines	**1**	
	Problems with *n* jobs through *m* machines.	**1**	
	Network analysis – basic terms – network construction – time analysis	**1**	
	Critical path method (CPM)	**1**	
	Programme evaluation and review technique (PERT)	**1**	
	Cost considerations in network analysis – crashing	**1**	
IV	Introduction to queuing theory–terminologies– classification of queuing models	**1**	**15%**
	Single server problems	**1**	
	Multi server problems	**1**	
	Inventory control – variables – deterministic inventory models – purchasing model without shortages	**1**	
	Manufacturing model without shortages	**1**	
	Purchasing model with shortages	**1**	
	Manufacturing model with shortages	**1**	
SECOND INTERNAL EXAMINATION			
V	Decision theory – steps in decision theory approach – decision making conditions	**1**	**20%**
	Decisions under conditions of risk	**1**	
	Decisions under uncertainty conditions	**1**	
	Decision tree analysis	**1**	
	Game theory – games with saddle points	**1**	
	Games without saddle points – 2 x 2 games	**1**	

	Graphical method for m x 2 & 2 x n games	**1**	
VI	Simulation – types of simulation – phases of simulation – applications– advantages and disadvantages	**1**	**20%**
	Design of simulation, models & experiments, model validation	**1**	
	Generation of random numbers	**1**	
	Monte Carlo simulation	**1**	
	Queuing simulation model	**1**	
	Inventory simulation model	**1**	
	Simulation languages	**1**	

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks) Note:

Each question can have a maximum of four sub questions, if needed.

Course code.	Course Name	L-T-P-Credits	Year of Introduction
ME374	THEORY OF VIBRATIONS	3-0-0-3	2016

Prerequisite: ME304 Dynamics of machinery

Course Objectives

- To understand the principles of vibration theory.
- To introduce techniques for solving vibration problems.
- To enable development of mathematical model for engineering problems in vibrations.

Syllabus

Introduction to mechanical vibrations; Analysis of free, forced single degree of freedom systems; Damping; Vibration measuring instruments; Multi degree of freedom systems; Eigen value problems; Lagrange's equation; Vibration of continuous systems; Transient vibrations; Introduction to non linear and random vibrations.

Expected outcome

The students will be able to

i. formulate differential equations of motion of mechanical systems
ii. determine the natural frequencies of multi degree of freedom systems
iii. understand non linear and random vibrations.

Text Books:

1. Graham Kelly S, Schaum's outline of Mechanical Vibrations, Schaum's Outlines,1996
2. Singiresu S Rao, Mechanical Vibrations, Pearson, 2016
3. Thomson, W T , Theory of Vibration with Applications., Prentice Hall India,1981

References Books:

1. Den Hartog, J P, Mechanical Vibrations, McGrawHill, 1956.
2. Leonard Meirovitch, Elements of Vibration Analysis,McGraw Hill,1975.

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to mechanical vibrations- Simple harmonic motion- Natural frequency -Equation of motion-- Energy method-Rayleigh method	2	20%
	Free vibration of single degree of freedom (DOF) systems with damping- Viscous damping- Logarithmic decrement. Coulomb damping-Energy dissipated by damping- Structural damping -Equivalent viscous damping.	4	
II	Forced harmonic vibration- Magnification factor-Transmissibility-Vibration isolation-Base excitation-Rotating unbalance- whirling of shafts- Resonance Vibration measuring instruments. Seismometer-Accelerometer	5	15%
FIRST INTERNAL EXAM			
III	Two degree of freedom systems-Normal mode vibration-Principal co-ordinates-Coordinate coupling.	3	15%
	Beat phenomenon-Undamped vibration absorbers- Vibration dampers.	2	
IV	Multi degree of freedom systems- Matrix formulation- Influence coefficients-Flexibility matrix-Stiffness matrix	5	20%
	Eigen Value problem:Eigen value and Eigen vectors-Frequency mode shape -Modal analysis.	4	
SECOND INTERNAL EXAM			
V	Lagrange's equation- Solution to problems using Lagrange's equation.	4	15%
	Vibration of continous systems-Vibrating strings- Longitudinal vibration of rods—Torsional vibration of rods	6	
VI	Transient vibrations- Impulse excitation- Convolution integral.	4	15%
	Introduction to non linear vibrations and random vibrations	3	
END SEMESTER EXAM			

Question Paper
Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and
IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and
VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME332	COMPUTER AIDED DESIGN AND ANALYSIS LAB	0-0-3-1	2016

Prerequisite: ME308 Computer aided design and analysis

Course Objectives:

- To provide working knowledge on Computer Aided Design methods and procedures
- To impart training on solid modelling software
- To impart training on finite element analysis software

Syllabus

Introduction to solid modeling and Finite Element Analysis software.

Exercises on modeling and assembly.

a. Creation of higher end 3D solid models.(minimum 3 models)

b. Creation of assembled views of riveted joints, cotter joints and shaft couplings. (minimum 3 models)

Exercises on the application of Finite Element Method/Finite Volume Method to engineering systems:-

a. Structural analysis. (minimum 3 problems)

b. Thermal analysis. (minimum 2 problems)

c. Fluid flow analysis. (minimum 1 problem)

Expected outcome:

The students will be able to

i. Gain working knowledge in Computer Aided Design methods and procedures

ii. Solve simple structural, heat and fluid flow problems using standard software

Points to note:

- Any appropriate solid modeling software (like CATIA, Solids Works, ProE, IDEAS, Siemens Solid Edge and NX, free software, etc.) and package (like ANSYS, Comsol Multi Physics, NASTRAN, ABAQUS, ADINA, Siemens Femap Nastran,free software etc.) may be used.
- **Evaluation**

  Class exercises 60 marks
  Regular class viva 10 marks
  Final internal exam using software 30 marks
  All the above three evaluations are mandatory.

References Books:

1. Daryl Logan, A First course in Finite Element Method, Thomson Learning, 2007
2. David V Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill,2003
3. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill, 2007
4. Mikell P. Groover and Emory W. Zimmer, CAD/ CAM – Computer aided design and manufacturing, Pearson Education,1987
5. T. R. Chandrupatla and A. D. Belagundu, Introduction to Finite Elements in Engineering, Pearson Education, 2012

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME334	MANUFACTURING TECHNOLOGY LABORATORY – II	0-0-3-1	2016

Prerequisite: ME312 Metrology and Instrumentation

Course Objectives:

- To provide programming practice on CNC machine tools
- To impart knowledge on the fundamental concepts and principles of metrology
- To explain the need of various modern measuring instruments and precision measurements

List of Experiments/Exercises:	Sessions
Exercise on grinding machine	1
Study and preparation of program, simulation and exercise on CNC lathe:-turning, step turning, taper turning, thread cutting, ball and cup turning etc.	2
Study and preparation of program, simulation and exercise on CNC milling machine: - surface milling, pocket milling, contour milling etc.	2
Basics for mechanical measurements Calibration of vernier caliper, micrometer and dial gauge etc. Determination of dimensions of given specimen using vernier caliper, micrometer, height gauge, bore dial gauge etc. Determination of dimensions of a rectangular, square, cylindrical specimens using slip gauges and comparing with height gauge/vernier caliper etc	1
Experiments on Limits, Fits and Tolerance Determine the class of fits between given shaft and hole. etc.	
Linear measurements Study of different linear measuring instruments. Calibration of LVDT using slip gauges.	1
Straightness error measurement Study of different straightness error measuring instruments – basic principle of auto collimator and spirit level. Measurement of straightness error of a CI surface plate using auto collimator and comparing with sprit level. laser interferometer used to determine straightness error To check straightness error of a straight edge by the wedge method using slip gauges.	1
Angle measurements Angular measurements using bevel protractor, combination sets, clinometers, angle dekkor etc. Measurement of angle and width of a V-block and comparing with combination sets. Measurement of angle using sine bar of different samples.	1

Out of roundness measurement Study of different methods used for measurement out of roundness Measurement of out of roundness using form measuring instrument Measurement of out of roundness using V-block and dial gauge Measurement of out of roundness using bench centre and dial gauge etc.	**1**
Screw thread measurement Measurement of screw thread parameters using two wire and three wire method. Measurement of screw thread parameters using tool maker's microscope etc. Measurement of screw thread parameters using thread ring gage, thread plug gage, thread snap gage, screw thread micrometer, optical comparator etc.	**1**
Bore measurement Measurement of a bore by two ball method. Measurement of a bore by four ball method. Bore measurement using slip gauges and rollers. Bore measurement using bore dial gauge etc.	**1**
Calibration and determination of uncertainties Strain measurement using strain gauge load cells. Calibration of a cantilever strain gauge load cell. **Rotation measurement** Determination of rpm using tachometer, optical tachometer and stroboscope, etc.	**1**
Area determination Study of planimeter and Green's theorem Determination of given irregular area using planimeter.	**1**
Gear metrology Types of gears – gear terminology – gear errors - study of Profile Projector. Measurement of profile error and gear parameters using profile projector etc. **Use of Comparators** Exercise on comparators: mechanical, optical, pneumatic and electronic comparators.	**1**
Use of Tool makers microscope Study of tool maker's microscope – use at shop floor applications. Measurement of gear tooth parameters using tool maker's microscope. Measurement of different angles of single point cutting tool using tool maker's microscope.	**1**
Surface roughness measurement Measurement of surface roughness using surface profilometer /roughness measuring machine of turned, milled, grounded, lapped and glass etc specimens.	**1**
Squareness measurement Determination of squareness of a trisquare using angle plate and slip gauges.	**1**
Flatness measurement Study of optical flat and variation of fringe patterns for different surfaces. Determination of parallelism error between micrometer faces. Compare given surface using optical flat with interpretation chart**.**	**1**
Vibration measurement Measurement of displacement, velocity and acceleration of vibration.	**1**

Use of Pneumatic comparator Checking the limits of dimensional tolerances using pneumatic comparator Calibration using air plug gauge etc	**1**

Reference books

1. Collett, C.V. and Hope, A.D, Engineering Measurements, Second edition, ELBS/Longman,1983
2. Sharp K.W.B. and Hume, Practical Engineering Metrology, Sir Isaac Pitman and sons Ltd, London,1958
3. Shotbolt C.R. and Gayler J.F.W, Metrology for Engineers, 5th edition, ELBS, London,1990
4. Yoram Koren, Numerical Control of Machine Tools, McGraw-Hill,1983

A minimum of 12 experiments are mandatory but the experiments/exercises in CNC machines are mandatory.

The academic evaluation shall be carried out by faculty.

Course code	Course Name	L-T-P - Credits	Year of Introduction
**352	Comprehensive Examination	0-1-1-2	2016
Prerequisite : Nil			

Course Objectives

- To assess the comprehensive knowledge gained in basic courses relevant to the branch of study
- To comprehend the questions asked and answer them with confidence.

Assessment

Oral examination – To be conducted weekly during the slot allotted for the course in the curriculum (@ three students/hour) – 50 marks
Written examination - To be conducted by the Dept. immediately after the second internal examination– common to all students of the same branch – objective type (1 hour duration)– 50 multiple choice questions (4 choices) of 1 mark each covering all the courses up to and including semester V – no negative marks – 50 marks.

Note: Both oral and written examinations are mandatory. But separate minimum marks is not insisted for pass. If a students does not complete any of the two assessments, grade I shall be awarded and the final grade shall be given only after the completion of both the assessments.
The two hours allotted for the course may be used by the students for library reading and for oral assessment.

Expected outcome .

- The students will be confident in discussing the fundamental aspects of any engineering problem/situation and give answers in dealing with them

SEMESTER 7

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME401	DESIGN OF MACHINE ELEMENTS - I	3-1-0-4	2016

Prerequisite: ME201 Mechanics of Solids

Course Objectives:

- To review concepts of statics and strength of materials.
- To introduce fundamental approaches to failure prevention of components.
- To provide knowledge in the design of common machine elements such as fasteners, shafts, springs cotter joints and couplings.

Syllabus

Introduction to Design, Materials and their properties, Theories of Failure, Shock and impact loads,Threaded Joints, Bolted joints, Design of riveted joints, Cotter and Knuckle joints, Design of welded joints, Helical springs, Leaf springs, Shafting, Design of Coupling.

Expected outcome:

The students will be able to

i. Find out various stresses induced in a machine element under different type of loading conditions.

ii. Devise machine components for its conceptual design.

Text Books:

1. Jalaludeen , Machine Design, Anuradha Publications, Chennai,2014
2. R. L. Norton, Machine Design – An Integrated Approach, Pearson Education, 2001
3. V.B.Bhandari, Design of Machine elements, McGraw Hill, 2010

Data books permitted for reference in the final examination:

1. K. Mahadevan, K.Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors, 2013
2. NarayanaIyengar B.R & Lingaiah K, Machine Design Data Handbook, Tata McGraw Hill/Suma Publications, 1984
3. PSG Design Data, DPV Printers, Coimbatore, 2012

References Books:

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill,2003
2. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley,2003
3. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2006
4. Rajendra Karwa, Machine Design, Laxmi Publications,2006

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to Design- Definition, steps in design process, preferred numbers, standards and codes in design	4	15%
	Materials and their properties- Elastic and plastic behaviour of metals, ductile and brittle behaviour, shear, bending and torsional stresses, combined stresses, stress concentration factor.	5	
II	Theories of Failure- Guest's Theory, Rankine's Theory, St. Venant's Theory, Haigh's Theory, and Von Mises and Hencky Theory.	5	15%
	Shock and impact loads, fatigue loading, endurance limit stress, factors affecting endurance limit, factor of safety	6	
FIRST INTERNAL EXAM			
III	Threaded Joints- Terminology, thread standards, types of threads, stresses in screw threads	3	15%
	Bolted joints- effect of initial tension, eccentric loading, design of bolts for static and fatigue loading, gasketed joints, power screws	4	
IV	Design of riveted joints- Material for rivets, modes of failure, efficiency of joint, design of boiler and tank joints, structural joints	4	15%
	Cotter and Knuckle joints- Gib and Cotter Joint, analysis of knuckle joint.	4	
	Design of welded joints- welding symbols, stresses in fillet and butt welds, Butt joint in tension, fillet weld in tension, fillet joint under torsion, fillet wed under bending, eccentrically loaded welds.	4	
SECOND INTERNAL EXAM			
V	Springs- classification, spring materials, stresses and deflection of helical springs, axial loading, curvature effect, resilience, static and fatigue loading, surging, critical frequency, concentric springs, end construction.	5	20%
	Leaf springs- Flat springs, semi elliptical laminated leaf springs, design of leaf springs, nipping	4	
VI	Shafting- material, design considerations, causes of failure in shafts, design based on strength, rigidity and critical speed, design for static and fatigue loads, repeated loading, reversed bending	5	20%
	Design of Coupling- selection, classification, rigid and flexible coupling, design of keys and pins	3	
END SEMESTER EXAM			

Question paper pattern

Use of approved data book permitted

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 3 questions from module I and II and at least 1 question from each module Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part B
There should be 3 questions from module III and IV and at least 1 question from each module Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part C
There should be 3 questions from module V and VI and at least 1 question from each module Each question carries 20 marks
Students will have to answer any 2 questions out of 3 (2X20 marks =40 marks) Note:

Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME403	ADVANCED ENERGY ENGINEERING	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

1. To give an idea about global energy scenario and conventional energy sources
2. To understand solar, wind and Biomass energy
3. To know concepts of other renewable energy sources
4. To create awareness on the impacts of energy conversion and importance of sustainable energy

Syllabus

Global and Indian energy scenario, conventional energy sources, environmental effect of energy conversion, renewable energy sources- solar, wind, biomass, brief account of other renewable energy sources –geothermal, tidal, MHD, hydrogen, fuel cells, small scale hydro power plants. Environmental impact and Sustainability issues.

Expected outcome:

The students will be able to

i. Understand energy scenario and the environmental effects of energy conversion.
ii. Become aware of different renewable energy sources and choose sustainable energy for

Text Books:

1. Jefferson W Tester et.al., Sustainable Energy: Choosing Among Options, PHI, 2006
2. P K Nag, Power Plant Engineering, TMH, 2002
3. Tiwari G N, Ghosal M K, Fundamentals of renewable energy sources, Alpha Science International Ltd., 2007

References Books:

1. David Merick, Richard Marshall, Energy, Present and Future Options, Vol.I & II, John Wiley & Sons, 2001
2. Godfrey Boyle, Renewable Energy : Power for a Sustainable Future, Oxford University Press, 2012
3. Roland Wengenmayr, Thomas Buhrke, 'Renewable Energy: Sustainable energy concepts for the future, Wiley – VCH, 2012
4. Twidell J W and Weir A D, Renewable Energy Resources, UK, E&F.N. Spon Ltd., 2006

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to the course. Global and Indian energy resources. Energy Demand and supply. Components, layout and working principles of steam, hydro, nuclear, gas turbine and diesel power plants	7	15%
II	Solar Energy- passive and active solar thermal energy, solar collectors, solar thermal electric systems, solar photovoltaic systems. Economics of solar power. Sustainability attributes.	7	15%
	FIRST INTERNAL EXAM		

III	Wind Energy-Principle of wind energy conversion system, wind data and energy estimation, wind turbines, aerodynamics of wind turbines, wind power economics. Introduction to solar-wind hybrid energy systems	7	15%
IV	Biomass Energy – Biomass as a fuel, thermo-chemical, bio-chemical and agro-chemical conversion of biomass- pyrolysis, gasification, combustion and fermentation, transesterification, economics of biomass power generation, future prospects.	6	15%
SECOND INTERNAL EXAM			
V	Other Renewable Energy sources – Brief account of Geothermal, Tidal , Wave, MHD power generation, Small, mini and micro hydro power plants. Fuel cells – general description, types, applications. Hydrogen energy conversion systems, hybrid systems- Economics and technical feasibility	8	20%
VI	Environmental impact of energy conversion – ozone layer depletion, global warming, greenhouse effect, loss of biodiversity, eutrophication, acid rain, air and water pollution, land degradation, thermal pollution, Sustainable energy, promising technologies, development pathways	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and
IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and
VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME 405	REFRIGERATION AND AIR CONDITIONING	2-1-0-3	2016

Prerequisite: ME205 Thermodynamics

Course Objectives:

1. To introduce vapour compression and vapour adsorption systems
2. To impart knowledge on refrigeration cycles and methods to improve performance
3. To familiarize the components of refrigeration systems
4. To introduce air conditioning systems
5. To know the applications of refrigeration and air conditioning systems

Syllabus

Introduction, Thermodynamics of refrigeration, Air refrigeration systems, Vortex tube refrigeration, Adiabatic demagnetization of paramagnetic salts, Vapour compression systems, Refrigerants and their properties, Application of refrigeration, Refrigeration system components, Air conditioning, Psychrometry, Air conditioning systems.

Expected outcome:

The students will be able to

i. Understand the principles refrigeration of air-conditioning and basic design considerations.

ii. Carry out analysis of refrigeration cycles

iii. Apply the concepts of indoor environmental comfort.

iv. Perform psychrometric calculations, humidity control and analysis of air-conditioning processes

v. Know the various applications of Refrigeration and air conditioning

Text Books:

1. Arora C. P, Refrigeration and Air-Conditioning, McGraw-Hill, 2008
2. Arora S. C. and Domkundwar, Refrigeration and Air-Conditioning, Dhanpat Rai, 2010
3. Ballaney P. L, Refrigeration and Air-Conditioning, Khanna Publishers, New Delhi, 2014
4. Manohar Prasad, Refrigeration and Air-Conditioning, New Age International, 2011

References Books:

1. ASHRAE Handbook
2. Dossat. R. J, Principles of Refrigeration, Pearson Education India, 2002
3. Stoecker W.F, Refrigeration and Air-Conditioning, McGraw-Hill Publishing Company, 2009

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction – Brief history and applications of refrigeration. Thermodynamics of refrigeration- reversed Carnot cycle- heat pump and refrigeration machines, Limitations of reversed Carnot cycle. Unit of refrigeration- Air refrigeration systems- Reversed Joule cycle, Air craft refrigeration systems, simple bootstrap- Regenerative and reduced ambient system	6	15%

II	Vortex tube refrigeration-Very low temperature refrigeration systems (concept only). Adiabatic demagnetization of paramagnetic salts Vapour compression systems-simple cycle - representation on T- s and P- h Diagrams. COP- Effect of operating parameters on COP – methods of improving COP of simple cycle- super- heating , under cooling, Liquid suction heat exchanger, actual cycle.	8	15%
FIRST INTERNAL EXAM			
III	Multi pressure systems - multi compression and multi evaporator, systems. Inter cooling - flash inter cooling and flash gas removal- Different combinations of evaporator and compressor for different applications, Cascade system Refrigerants and their properties-Eco-friendly Refrigerants, mixed refrigerants, selection of refrigerants for different applications Vapour absorption systems - Ammonia – water system - simple system- drawbacks-Lithium Bromide water system- Electrolux-comparison with vapour compression system- steam jet refrigeration.	7	15%
IV	Application of refrigeration- domestic refrigerators- water coolers-ice plants. Cold storages- food preservation methods- plate freezing , quick-freezing. Refrigeration system components- Compressors, condensers, expansion devices, evaporators. Cooling towers- Different types and their application fields- Refrigerant leakage and detection – charging of refrigerant – system controls.	6	15%
SECOND INTERNAL EXAM			
V	Air conditioning – meaning and utility, comfort and industrial air conditioning. Psychometric properties- saturated and unsaturated air, dry, wet and dew point temperature – humidity, specific humidity, absolute humidity, relative humidity and degree of saturation-thermodynamic equations- enthalpy of moisture- adiabatic saturation process -psychrometers. Thermodynamic wet bulb temperature, psychometric chart- Psychometric processes- adiabatic mixing-sensible heating and cooling- humidifying and dehumidifying, air washer – bypass factor- sensible heat factor-RSHF and GSHF line-Design condition- Apparent dew point temperature – Choice of supply condition, state and mass rate of dehumidified air quantity – Fresh air supplied –air refrigeration. Comfort air conditioning- factors affecting human comfort. Effective temperature – comfort chart. Summer air conditioning- factors affecting-cooling load estimation.	8	20%
VI	Air conditioning systems- room air conditioner- split system-packaged system-all air system-chilled water system. Winter air conditioning – factors affecting heating system, humidifiers. Year round air conditioning AC system controls-thermostat and humidistat. Air distribution systems- duct system and design- Air conditioning of restaurants, hospitals, retail outlets, computer center, cinema theatre, and other place of amusement. Industrial applications of air conditioning.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Use of approved Refrigerant tables permitted

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks) Note:

Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME407	MECHATRONICS	3-0-0- 3	2016

Prerequisite: Nil

Course Objectives:

- To introduce the features of various sensors used in CNC machines and robots
- To study the fabrication and functioning of MEMS pressure and inertial sensors
- To enable development of hydraulic/pneumatic circuit and PLC programs for simple applications

Syllabus

Introduction to Mechatronics, sensors, Actuators, Micro Electro Mechanical Systems (MEMS), Mechatronics in Computer Numerical Control (CNC) machines, Mechatronics in Robotics-Electrical drives, Force and tactile sensors, Image processing techniques, Case studies of Mechatronics systems.

Expected outcome:

The students will be able to

i. Know the mechanical systems used in mechatronics

ii. Integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems

Text Books:

1. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007
2. Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education, Inc., New Delhi, 2006.

References Books:

1. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA, 2003.
2. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998.
3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
4. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England, 2006.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Mechatronics: Structure of Mechatronics system. Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute, gray coded encoder. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. Principle and types of vibration sensors.	8	15%

II	Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols.	7	15%
FIRST INTERNAL EXAM			
III	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.	6	15%
IV	Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Mechatronics elements - Machine structure: guide ways, drives. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws, pre-loading methods. Re-circulating roller screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.	8	15%
SECOND INTERNAL EXAM			
V	System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. Mechatronics in Robotics-Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive. Force and tactile sensors. Range finders: ultrasonic and light based range finders	6	20%
VI	Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding. Case studies of Mechatronics systems: Automatic camera, bar code reader, pick and place robot, automatic car park barrier system, automobile engine management system.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3X10 =30 marks)

Part B

There should be 2 questions each from module III and IV. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME409	COMPRESSIBLE FLUID FLOW	2-1-0-3	2016

Prerequisite: ME205 Thermodynamics

Course Objectives:

- To familiarize with behavior of compressible gas flow.
- To understand the difference between subsonic and supersonic flow
- To familiarize with high speed test facilities

Syllabus

Introduction to Compressible Flow, Wave propagation, One dimensional steady isentropic flow, Irreversible discontinuity in supersonic flow, Flow in a constant area duct with friction (Fanno Flow), Flow through constant area duct with heat transfer (Rayleigh Flow), Compressible flow field visualization and measurement, measurement in compressible flow, Wind tunnels

Expected outcome:

The students will be able to

i. Formulate and solve problems in one -dimensional steady compressible flow including: isentropic nozzle flow, constant area flow with friction (Fanno flow) and constant area flow with heat transfer (Rayliegh flow).

ii. Derive the conditions for the change in pressure, density and temperature for flow through a normal shock.

iii. Determine the strength of oblique shock waves on wedge shaped bodies and concave corners

iv. Know the various measuring instruments used in compressible flow

Data book/Gas tables:

1. Yahya S. M., Gas Tables**,** New Age International, 2011
2. Balachandran P., Gas Tables, Prentice-Hall of India Pvt. Limited, 2011

Text Books:

1. Balachandran P., Fundamentals of Compressible Fluid Dynamics, PHI Learning. 2006
2. Rathakrishnan E., Gas Dynamics, PHI Learning, 2014
3. Yahya S. M., Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, New Age International Publishers, 2003

References Books:

1. Anderson**,** Modern compressible flow, 3e McGraw Hill Education, 2012
2. Shapiro, Dynamics and Thermodynamics of Compressible Flow – Vol 1., John Wiley & Sons,1953

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to Compressible Flow- Concept of continuum-system and control volume approach- conservation of mass, momentum and energy- stagnation state- compressibility-Entropy relations. Wave propagation- Acoustic velocity-Mach number-effect of Mach number on compressibility- Pressure coefficient-physical difference between incompressible, subsonic, sonic and supersonic flows- Mach cone-Sonic boom-Reference velocities- Impulse function-adiabatic energy equation-representation of various flow regimes on steady flow adiabatic ellipse.	8	15%
II	One dimensional steady isentropic flow- Adiabatic and isentropic flow of a perfect gas- basic equations- Area-Velocity relation using 1D approximation-nozzle and diffuser-mass flow rate-chocking in isentropic flow-flow coefficients and efficiency of nozzle and diffuser- working tables-charts and tables for isentropic flow-operation of nozzle under varying pressure ratios –over expansion and under expansion in nozzles.	7	15%
FIRST INTERNAL EXAM			
III	Irreversible discontinuity in supersonic flow- one dimensional shock wave- stationary normal shock- governing equations- Prandtl- Meyer relations- Shock strength- Rankine- Hugoniot Relation- Normal Shock on T-S diagram- working formula- curves and tables-Oblique shock waves - supersonic flow over compression and expansion corners (basic idea only).	7	15%
IV	Flow in a constant area duct with friction (Fanno Flow) – Governing Equations- Fanno line on h-s and P-v diagram- Fanno relation for a perfect gas- Chocking due to friction- working tables for Fanno flow- Isothermal flow(elementary treatment only)	6	15%
SECOND INTERNAL EXAM			
V	Flow through constant area duct with heat transfer (Rayleigh Flow)- Governing equations- Rayleigh line on h-s and P-v diagram- Rayleigh relation for perfect gas- maximum possible heat addition- location of maximum enthalpy point- thermal chocking- working tables for Rayleigh flow.	6	20%
VI	Compressible flow field visualization and measurement- Shadowgraph-Schlieren technique- interferometer- subsonic compressible flow field -measurement (Pressure, Velocity and Temperature) – compressibility - correction factor- hot wire anemometer- supersonic flow measurement- Shock tube-Rayleigh Pitot tube- wedge probe- stagnation temperature probe- temperature recovery factor –Kiel probe - Wind tunnels – closed and open type-	8	20%
END SEMESTER EXAM			

Question Paper
Pattern

Use of approved gas tables permitted

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40

marks) Note: Each question can have a maximum of four sub questions, if

needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME461	Aerospace Engineering	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To understand the fundamentals of aerospace engineering
- To provide an understanding of flight instruments

Syllabus:

The atmosphere, airfoil theory, 2D, 3D or Finite aero foils Propellers, Aircraft performance, Flight Instruments, stability of aircrafts, wind tunnel testing

Expected Outcomes:

The students will be able to

i. Identify, formulate and solve aerospace engineering problems
ii. Perform analysis of flight dynamics of aircrafts

Text books:

1. A.C. Kermode, Mechanics of flight, Prentice Hall, 2007
2. Anderson, Fundamentals of Aerodynamics, McGraw-Hill, 2010
3. EHJ Pallett, Aircraft Instruments and Integrated systems, Longman,1992

Reference books:

1. Houghton and brock, Aerodynamics for Engineering Student, Hodder & Stoughton,1977

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	The atmosphere-characteristics of troposphere , stratosphere , thermosphere, and ionosphere- pressure, temperature and density variations in the atmosphere. Application of dimensional analysis – aerodynamic force – model study and similitude. 2D aero foils -Nomenclature and classification- pressure distribution in inviscid and real flows- momentum and circulation theory of aerofoil- characteristics.	8	15%
II	3D or Finite aero foils – effect of releasing the wingtips- wing tip vortices- replacement of finite wing by horse shoe vertex system, lifting line theory-wing load distribution – aspect ratio, induced drag calculation of induced drag from momentum considerations. Skin friction and from drag- changes in finite wing plan shape	7	15%
FIRST INTERNAL EXAMINATION			

III	Propellers – momentum and blade element theories –propeller coefficients and charts. Aircraft performance-straight and level flight –power required and power available graphs for propeller and jet aircraft	**6**	**15%**
IV	Gliding and climbing –rate of climb-service and absolute ceilings-gliding angle and speed of flattest glide takeoff and landing performance – length of runway required- aircraft ground run- circling flight – radius of tightest turn-jet and rocket assisted take –off high lift devices-range and endurance of airplanes- charts for piston and jet engine aircrafts.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Flight Instruments-airspeed indicator, calculation of true air speed-altimeter, gyrohorizon -direction indicator-vertical speed indicator –turn and back indicator-air temperature indicator. (Brief description and qualitative ideas only). Ideas on stability- static and dynamic stability- longitudinal, lateral and directional stability- controls of an aero plane- aerodynamic balancing of control surfaces- mass balancing (Qualitative ideas only).	**7**	**20%**
V1	Principles of wind tunnel testing –open and closed type wind tunnels-wind tunnel balances supersonic wind tunnels. Study of subsonic, Transonic, and supersonic aircraft engines (Description with figures Only).Elementary ideas on space travel-calculation of earth orbiting and escape velocities ignoring air resistance and assuming circular orbit.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks) Note:

Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME463	Automobile Engineering	3-0-0-3	2016

Pre requisites: Nil

Course objectives

- To know the anatomy of automobile in general
- To understand the working of different automotive systems and subsystems
- To update the latest developments in automobiles

Syllabus:- Engine, clutch, transmission, steering, brakes, suspension and aerodynamics

COURSE OUTCOMES:

The students will be able to:

i. Practically identify different automotive systems and subsystems.

ii. Understand the principles of transmission, suspension, steering and braking systems of an automobile

iii. Develop a strong base for understanding future developments in the automobile industry

Text Books

1. Gupta R.B. Auto design , Satya Prakash, New Delhi, 2015
2. Heinz Heisler, Advanced engine technology, Butterworth-Heinemann,1995
3. Heinz Heisler, Advanced vehicle technology, Society of Automotive Engineers Inc, 2002
4. Hillier and Peter Coobes, Fundamentals of motor vehicle technology, Nelson Thornes, 2004
5. Tom Denton, Automobile mechanical and electrical systems, Butterworth-Heinemann, 2011

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Piston: - material for piston, clearances, piston rings, types, need for two compression rings, oil control ring, piston pin.	1	15%
	Piston for IC engine, piston rings, piston pin, connecting rod, crank shaft, crank pin, cam shaft, valves, fly wheel, fluctuation of energy and size of fly wheel, hub and arms, stress in a fly wheel rim, simple problems.	1	
		1	
	Petrol fuel injection systems: - comparison petrol injection and carbureted fuel supply systems- comparison –multiport fuel injection (MPFI) and common rail direct injection (CRDI) systems.	1	
		1	
	Super charging systems: fundamentals, naturally aspirated engines and supercharged engines– Turbo charger, turbo lag.	1	

	Hybrid cars, safety overview -Formula-I engine technology: overview, electrical technology, brakes, transmission technology.	1	
II	Friction clutch:- fundamentals, driven plate inertia, driven plate transmitted torque, driven plate wear –angular driven plate cushioning and torsional damping, clutch friction materials, when clutch is worn out.	1	**15%**
	Pull type diaphragm clutch, multiple diaphragm clutch, multi-plate hydraulically operated automatic transmission clutch, semi centrifugal clutch, fully automatic centrifugal clutch, and integral single plate diaphragm clutch.	1 1	
	Need of gear box, resistance to vehicle motion, power to weight ratio, speed operating range-five speed and reverse sliding mesh, constant mesh, and synchromesh gear boxes:- gear synchronization and engagement.	1 1	
	Over drives – hydrodynamic fluid couplings: - efficiency and torque capacity – fluid friction coupling- torque converters.	1 1	
FIRST INTERNAL EXAMINATION			
III	Steering:-basic principle of a steering system:- swinging beam system – Ackermann –over steer and under steer – slip angle, camber, caster etc.	1 1	**15%**
	Swivel axis inclination: centre point steering, camber, king pin inclination, negative offset, caster, toe-in and toe-out	1	
	Steering gear box: - fundamentals screw and nut steering gear mechanism-worm and roller type steering gear box – Re-circulating ball nut and rocker lever, re-circulating ball rack and sector steering gear box– need of power assisted steering.	1 1 1	
	External direct coupled and rack and pinion and integrated steering power cylinder, power assisted steering lock limitations	1	
IV	Suspension: - suspension geometry, terminology- Macpherson strut friction and spring offset - suspension roll centers:-roll centers, roll axis, roll centre height, short swing and long arm suspension, transverse double wishbone, parallel trailing double arm and vertical pill strut suspension, Macpherson strut suspension, semi-trailing arm rear suspension, telescopic suspension.	1 1	**15%**
	High load beam axle leaf spring, sprung body roll stability. Rear axle beam suspension- body roll stability analysis:- body roll couple, body roll stiffness, body over turning couple	1	

	Body weight transfer, body direct weight transfer couple, body roll couple distribution, body roll weight transfer, lateral force distribution.	1	
	Anti roll bars and roll stiffness:- anti roll bar function, operating principle, anti roll bar action caused by the body rolling, single wheel lift -rubber spring bumper:-bump stop function and characteristics, axis inclination.	1	
	Rear suspension: - live rigid axle suspension, non drive rear suspension- swing arm rear wheel drive independent suspension.	1	
	Low pivot split axle coil spring wheel drive independent suspension, trailing and semi trailing arm rear wheel drive independent suspension.	1	**15%**
	Transverse double link arm rear wheel drive independent suspension, De Dion axle rear wheel suspension - Hydrogen suspension, hydro-pneumatic automatic height correction suspension.	1	
SECOND INTERNAL EXAMINATION			
V	Brakes:- mechanical and hydraulic brakes (review only) – properties of friction lining and pad materials, efficiency, stopping distance, theory of internal shoe brake, equations – effect of expanding mechanism of shoes on total braking torque, equations.	1	**20%**
		1	
	Braking vehicles:- brakes applied on rear, front and all four wheels, equations –calculation of mean lining pressure and heat generation during braking operation, equations. – braking of vehicle moving on curved path, simple problems.	1	
		1	
	Anti Lock Braking system (ABS):- need and advantages of ABS – hydro-mechanical ABS - hydro-electric ABS - air-electric ABS.	1	
	Brake servos: - operating principle, vacuum servo - direct acting suspended vacuum assisted brake servo unit operation - hydraulic servo assisted brake systems.	1	
	Pneumatic operated disc brakes – air operated brake systems: - air over hydraulic brake system - Three line brake system-– electronic-pneumatic brakes.	1	
V1	Aerodynamic drag: pressure drag, air resistance, opposing motion of a vehicle, equations, after flow wake, drag coefficients, various body shapes, base drag, vortices, trailing vortex drag, attached transverse vortices.	1	**20%**
		1	
	Aerodynamic lift:-lift coefficients, vehicle lift, underbody floor height versus aerodynamic lift and drag, aerofoil lift and drag, front end nose shape.	1	
		1	
	Car body drag reduction:-profile edge chamfering, bonnet	1	

	slope and wind screen rake, roof and side panel chamfering, rear side panel taper, underbody rear end upward taper, rear end tail extension, underbody roughness.		
	Aerodynamic lift control:- underbody dams, exposed wheel air flow pattern, partial enclosed wheel air flow pattern, rear end spoiler, negative lift aerofoil wings.	1	
	After body drag: - square back drag, fast back drag, hatch back drag, notch back drag.	1	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and
II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and
VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40

marks) Note: Each question can have a maximum of four sub questions, if

needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME465	Industrial Hydraulics	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

1. To introduce various fluid power systems
2. To get knowledge on fluid power circuits

Syllabus:

Introduction to fluid power, Properties of fluids. Selection of fluids, Pumps, Hydraulic cylinders and rams, Fluid power pumping systems and components, Hydraulic Actuators, Fluid temperature control, Piping systems, Control circuits

Expected Outcomes:

The students will be able

1. To understand the various components used in fluid power systems
2. To select the suitable system for a particular application
3. To know the various fluid circuits used in hydraulic systems

Text books:

1. B. Lall, Oil Hydraulics, International Literature Association
2. D. A. Pease, Basic Fluid Power, Prentice Hall,1986
3. J. J. Pipenger, Tyler Gregory Hicks, Industrial Hydraulics, McGraw Hill,1979
4. Pinches, Industrial Fluid Power, Prentice Hall,1989
5. R.K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd.,2017

Reference:

1. ISO - 1219, Fluid Systems and components, Graphic Symbols
2. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier ,1999
3. Michael J. Prinches and Ashby J. G, Power Hydraulics, Prentice Hall,1988
4. Yeaple, Fluid Power Design Handbook, CRC Press,1995

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to fluid power – Hydraulics and Pneumatics systems – Fluid power systems – Fundamentals of fluid mechanics , Properties of fluids. Selection of fluids, additives, effect of temperature and pressure on hydraulic fluids , Measurement of physical parameters – Hydraulic symbols	7	15%
II	Pumps: Types , classification , principle of working & constructional details of vane pump, gear pumps, radial and axial plunger pumps, Power and efficiency calculations, char, Curves, selection of pumps for hydraulic power transmission	7	15%
FIRST INTERNAL EXAMINATION			

III	Hydraulic cylinders and rams – Fluid power pumping systems and components. Pressure accumulators – Functions – Fluid reservoirs – Filter in hydraulic circuits. Loading and replacement of filter elements – Materials for filters.	**7**	**15%**
IV	Hydraulic Actuators (i) Linear and Rotary. (ii) Hydraulic motors - Types- Vane, Gear, Piston types, radial piston. (iii) Methods of control of acceleration, deceleration. (iv) Types of cylinders and mountings. (v) Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads. (vi) Design considerations for cylinders. Cushioning of cylinders.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Fluid temperature control – Fluid pressure control –control valves – Sequence -valve – Counterbalance valve-unloading valve – Friction control valve – Servo systems, Hoses & Pipes : Types , materials , pressure drop in hoses/pipes. Hydraulic piping connections.	**7**	**20%**
V1	Simple reciprocating, Regenerative, Speed control (Meter in, Meter out and bleed off), Sequencing, Synchronization, transverse and feed, circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit (Numerical treatment), motor breaking circuit	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks) Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P	Credits	Year of Introduction
IE306	SUPPLY CHAIN AND LOGISTICS MANAGEMENT	3-0-0	3	2016

Prerequisite: Nil

Course Objectives

- To develop knowledge on structures, decision phases, measures and tools of supply chains.
- To develop understanding on the strategic, tactical and operational decision tools of supply chains.
- To impart knowledge on logistics management and related advanced tools and techniques.

Syllabus

General features of supply chains, planning demand and supply, forecasting, aggregate planning, network design, locations, layouts etc. Supply chain inventory planning decisions, multi-echelon cycle and safety inventory systems: Logistics management: design of transportation network. Routing, scheduling and sequencing. Advanced logistics decision models.

Expected Outcome

The students will

i. Understand the structures, decision phases, measures and tools of supply chains.
ii. Understand the strategic, tactical and operational decision tools of supply chains.
iii. Understand knowledge on logistics management and related advanced tools and techniques.

Text Books

1. G. Sreenivasan, Quantitative Models in Operations and Supply Chain Management, PHI
2. Sunil Chopra, Peter Meindl, Supply Chain Management – Strategy, Planning and Operation, Pearson Education.

References

1. David Simchi – Levi & Philip Kaminsk, Designing and Managing the Supply Chain, McGraw-Hill Companies Inc.
2. David Taylor and David Brunt, Manufacturing Operations and Supply Chain Management, Vikas Thomson Learning, 2001.
3. Donald J. Bowersox & David J. Closs, Logistical Management, TMH.
4. Jeremy F. Shapiro, Modeling and Supply Chain,. Thomson Learning, 2001.
5. Martin Christopher, Logistics and supply chain management, Financial times management.

COURSE PLAN

Module	Contents	Hours	End-Sem. Exam. Marks
I	**General Features of Supply Chains:** Supply Chains – Structures, Decision Phases, Performance Drivers and Measures, Metrics. Achieving Strategic Fit and its Obstacles.	7	15%

II	**Planning Demand & Supply:** Planning demand and supply in supply chains – Forecasting techniques for supply chains, Seasonal Forecasting Models, Measure of Forecasterrors.	**7**	**15%**
FIRST INTERNAL EXAM			
III	**Aggregate Planning:** Aggregate Planning Strategies, Aggregate Planning models - Quantitative Examples. **Network Design, Locations and Layouts:** Network design in Uncertain Environment, Facility Location and Layout decisions.	**7**	**15%**
IV	**Multi-echelon Inventory Systems:** Inventory Planning Decisions –Estimate of Cycle Inventory, Discounting Models, Multi-item Inventory models, Determination of Safety Inventory, Impact of Supply Uncertainty, Multi- echelon Inventory models, Quantitative Examples. Bullwhip effect.	**7**	**15%**
SECOND INTERNAL			
V	**Logistics Management**: 3PL, 4PL, Design Options for Transportation Network. Routing, Scheduling and Sequencing in Transportation, Vehicle Routing Problems. QuantitativeExamples.	**7**	**20%**
VI	**Reverse Logistics:** Reverse logistics and Closed Loop Supply Chains. **Advanced Logistics Decision Models:** Bin Packing Problems, Fixed Charge Problems, Knapsack Problems, Multi-stage transportation problems.	**7**	**20%**
END SEMESTER EXAM			

End Semester Examination Question Paper Pattern

Examination duration: 3 hours Maximum Marks: 100

Part A (Modules I and II):
Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV):
(Same as for part A marks)
Part C (Modules V and VI):
(Same as for part A, except that each full question carries 20 marks)
Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME467	Cryogenic Engineering	3-0-0-3	2016

Prerequisite : NIL

Course Objectives: :

- To provide the knowledge of evolution of low temperature science
- To provide knowledge on the properties of materials at low temperature
- To familiarize with various gas liquefaction systems and to provide design aspects of cryogenic storage and transfer lines

Syllabus:

Introduction to Cryogenics, Applications of Cryogenics, Properties of materials at cryogenic temperature, Liquefaction systems, Gas liquefaction systems, Cryogenic Refrigeration systems, Cryogenic fluid storage and transfer systems, Cryogenic instrumentation, heat exchangers used in cryogenic systems

Expected Outcomes:

The students will be able to

i. Understand properties of material at cryogenic temperatures.
ii. Know about various liquefaction systems
iii. Get ideas on cryogenic refrigeration systems, cryogenic instrumentation and cryogenic heat exchangers

Text books

1. J. H. Boll Jr, Cryogenic Engineering
2. R. B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959
3. Randal F.Barron, Cryogenic systems, McGraw Hill, 1986

Reference books:

1. Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Cryogenic Systems, Historical development, Low Temperature properties of Engineering Materials, Mechanical properties- Thermal properties- Electric and magnetic properties – Cryogenic fluids and their properties. Applications of Cryogenics: Applications in space, Food Processing, super conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry. Low temperature properties of engineering materials	8	15%
II	Liquefaction systems ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers.	7	15%
FIRST INTERNAL EXAMINATION			

III	Gas liquefaction systems: Introduction-Production of low temperatures-General Liquefaction systems- Liquefaction systems for Neon. Hydrogen and Helium –Critical components of Liquefaction systems	**6**	**15%**
IV	Cryogenic Refrigeration systems: Ideal Refrigeration systems-Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media;,	**6**	**15%**
SECOND INTERNAL EXAMINATION			
V	Cryogenic fluid storage and transfer systems: Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems.	**8**	**20%**
V1	Cryogenic instrumentation, Pressure flow-level and temperature measurements. Types of heat exchangers used in cryogenic systems(only description with figure) Cryo pumping Applications	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks) Note:

Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME469	FINITE ELEMENT ANALYSIS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

1. To learn the mathematical background of finite element methods.
2. To understand the basics of finite element formulation.
3. To practice finite element methodologies through structural and heat transfer problems.

Syllabus

Introduction; Brief history; Review of elasticity; Direct approach;1D bar element; Analogous problems; Beam elements; Plane truss; Coordinate transformations; Interpolation functions; Shape functions; Variational methods; Strong and weak form; Rayleigh Ritz method; FE formulation using minimization of potential; Consistent nodal loads; Higher order elements; Iso parametric elements; Weighted residual methods; FEA software packages.

Expected outcome

The students will be able to

i. understand the mathematical background of FEM .
ii. solve real life problems using finite element analysis

Text Books:

1. Chandrupatla T R., Finite Element Analysis for Engineering and Technology, University Press, 2004
2. Hutton D V., Fundamentals of Finite Element Analysis, Tata McGraw-Hill, 2005
3. Logan D L., A first course in the Finite Element Method, Thomson-Engineering, 2012
4. Seshu P., Text Book of Finite Element Analysis, PHI Learning Pvt. Ltd., 2003

References Books:

1. Cook R D., Malkus D S., Plesha M E.,Witt R J., Concepts and Analysis of Finite Element Applications, John Wiley & Sons,1981
2. Reddy J N., An introduction to the Finite Element Method, McGraw- Hill, 2006

Course

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Finite Element Method (FEM)- Brief history- Application of FEA- Advantages and disadvantages. Review of elasticity- Strain displacement relations- Compatibility-Stress strain relations- Boundary conditions- Plane stress, plane strain and axisymmetry.	2	15%

	Direct approach-1D bar element- element stiffness- Assembly of elements- properties of [K] matrix- Treatment of boundary conditions- Stress computation.	4	
II	Analogous problems of torsion, heat conduction and laminar pipe flow. Beam elements- FE formulation-element stiffness matrix- boundary conditions.	4	20%
	Plane truss- Element formulation-Co ordinate transformation- Local and global co ordinates- Stress calculations.	4	
FIRST INTERNAL EXAMINATION			
III	Interpolation functions-Shape functions- Lagrange interpolation- 1D linear and quadratic element	3	15%
	Variational methods: Functionals- Strong and weak form- Essential and natural boundary conditions.	3	
IV	Principle of stationary potential energy- Rayleigh Ritz method.	3	20%
	FE formulation using minimization of potential- B matrix- Element matrices for bar element- Consistent nodal loads.	4	
SECOND INTERNAL EXAMINATION			
V	Higher order elements- Quadratic and cubic elements-Pascal's triangle-Serendipity elements.	3	15%
	Iso parametric elements, Natural coordinates, Area co ordinates-Quadrilateral elements-Jacobian matrix-Gauss quadrature.	5	
VI	Weighted residual method: Galerkin FE formulation. Axially loaded bar-Heat flow in a bar	5	15%
	Structure of FEA software package. Introduction to Modal analysis, non linear analysis and coupled analysis.	2	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100, **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and
VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
**451	Seminar and Project Preliminary	0-1-4-2	2016
Prerequisite : Nil			

Course Objectives

- To develop skills in doing literature survey, technical presentation and report preparation.
- To enable project identification and execution of preliminary works on final semester project

Course Plan

Seminar: Each student shall identify a topic of current relevance in his/her branch of engineering, get approval of faculty concerned, collect sufficient literature on the topic, study it thoroughly, prepare own report and present in the class.

Project preliminary:

Identify suitable project relevant to the branch of study. Form project team (not exceeding four students). The students can do the project individually also. Identify a project supervisor. Present the project proposal before the assessment board (excluding the external expert) and get it approved by the board.

The preliminary work to be completed: (1) Literature survey (2) Formulation of objectives (3) Formulation of hypothesis/design/methodology (4) Formulation of work plan (5) Seeking funds (6) Preparation of preliminary report

Note: The same project should be continued in the eighth semester by the same project team.

Expected outcome .

The students will be able to

i. Analyse a current topic of professional interest and present it before an audience
ii. Identify an engineering problem, analyse it and propose a work plan to solve it.

Evaluation

Seminar : **50 marks**

(Distribution of marks for the seminar is as follows: i. Presentation : 40% ii. Ability to answer questions : 30% & iii. Report : 30%)

Project preliminary : **50 marks** (Progress evaluation by the supervisor : 40% and progress evaluation by the assessment board excluding external expert : 60%. Two progress evaluations, mid semester and end semester, are mandatory.)

Note: All evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	Credits	Year of Introduction
**492	PROJECT	6	2016

Prerequisite : Nil

Course Objectives

- To apply engineering knowledge in practical problem solving
- To foster innovation in design of products, processes or systems
- To develop creative thinking in finding viable solutions to engineering problems

Course Plan

In depth study of the topic assigned in the light of the preliminary report prepared in the seventh semester
Review and finalization of the approach to the problem relating to the assigned topic
Preparing a detailed action plan for conducting the investigation, including team work
Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed
Final development of product/process, testing, results, conclusions and future directions
Preparing a paper for Conference presentation/Publication in Journals, if possible
Preparing a report in the standard format for being evaluated by the dept. assessment board
Final project presentation and viva voce by the assessment board including external expert

Expected outcome

The students will be able to

iii. Think innovatively on the development of components, products, processes or technologies in the engineering field
iv. Apply knowledge gained in solving real life engineering problems

Evaluation

Maximum Marks : 100

(i) Two progress assessments	20% by the faculty supervisor(s)
(ii) Final project report	30% by the assessment board
(iii) Project presentation and viva voce	50% by the assessment board

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME431	MECHANICAL ENGINEERING LAB.	0-0-3-1	2016

Prerequisite : ME302 Heat and mass transfer, ME304 Dynamics of machinery

Course Objectives:

- To conduct the various heat transfer experiments
- To practice calibration of thermometer and pressure gauges
- To do experiments on dynamics

Syllabus

List of experiments:

Hear transfer

1. Determination of LMTD and effectiveness of parallel flow, Counter flow and cross flow heat exchangers(double pipe heat exchanger)
2. Determination of heat transfer coefficients in free convection(free convection apparatus)
3. Determination of heat transfer coefficients in forced convection (forced convection apparatus)
4. Determination of thermal conductivity of solids(composite wall)
5. Determination of thermal conductivity of powder
6. Determination of Thermal conductivity of liquids
7. Determination of emissivity of a specimen (emissivity apparatus)
8. Determination of Stefan Boltzman constant (Stefan Boltzmann apparatus)
9. Study and performance test on refrigeration (Refrigeration Test rig)
10. Study and performance test air conditioning equipment(air conditioning test rig)
11. Performance study on heat pipe(Heat pipe)
12. Calibration of Thermocouples
13. Calibration of Pressure gauge

Dynamics

14. Whirling of shaft
15. Gyroscope
16. Universal governor apparatus
17. Free vibration analysis
18. Forced vibration analysis

Note: Minimum 9 experiments in heat transfer and 3 experiments in dynamics are mandatory

Expected outcome:

The students will be able to

1. Conduct experiments to determine thermal conductivity of materials
2. Determine heat transfer coefficient, LMTD etc..
3. Do calibration of thermometers and pressure gauges
4. Demonstrate the effect of unbalances resulting from rotary motions
5. Visualise the effect of dynamics on vibrations in single and multi degree of freedom system
6. Demonstrate the working principle of governor /gyroscope and demonstrate the effect of forces and moments on their motion

SEMESTER 8

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME 402	Design of Machine Elements-II	3-0-0-3	2016

Prerequisite: ME401 Design of Machine Elements-I

Course Objectives:

- To provide basic design methods for clutches, brakes, belt drives, bearings, gears and connecting rod.
- To introduce the design modifications to be considered for ease of manufacturing.

Syllabus

Design of single plate clutches, multiple disc clutches, cone clutch, centrifugal clutch, block brake, band brake, band and block brake, internal expanding shoe brake, rolling contact bearing, sliding contact bearing, spur gear, helical gear , bevel gear, worm and worm wheel, design of flat belt, design of V-belt drives, selection of roller chains, connecting road, design recommendations for forgings, castings, welded products, rolled sections, turned parts, screw machined products, parts produced on milling machines.

Expected outcome:

The students will be able to

1. Apply design procedures for industrial requirements.
2. Design machine components to ease the manufacturing limitations.

Text Books:

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill,2003
2. Jalaludeen , Machine Dsign, Anuradha Publications, 2016
3. V.B.Bhandari, Design of Machine elements, McGraw Hill, 2016

References Books:

1. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley, 2011
2. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2006
3. Rajendra Karwa, Machine Design , Laxmi Publications (P) LTD, New Delhi, 2006
4. Siegel, Maleev& Hartman, Mechanical Design of Machines, International Book Company, 1983

Data books permitted for reference in the examination:

1. K. Mahadevan, K.Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors, 2013
2. Narayana Iyengar B.R & Lingaiah K, Machine Design Data Handbook, Tata McGraw Hill, 1984
3. PSG Design Data, DPV Printers, Coimbatore, 2012

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Clutches – friction clutches, design considerations, multiple disc clutches, cone clutch, centrifugal clutch	2	15%
	Brakes- Block brake, band brake, band and block brake, internal expanding shoe brake	3	
II	Rolling contact bearing- Design of bearings, Types, Selection of a bearing type, bearing life, static and dynamic load capacity, axial and radial loads, selection of bearings, dynamic equivalent load	4	15%
	Sliding contact bearing- lubrication, lubricants, viscosity, Journal bearings, hydrodynamic theory, Sommerfield number, design considerations, heat balance, bearing housing and mountings	4	
FIRST INTERNAL EXAM			
III	Gears- classification, Gear nomenclature, Tooth profiles, Materials of gears, Law of gearing (review only), virtual or formative number of teeth, gear tooth failures, Beam strength, Lewis equation, Buckingham's equation for dynamic load, wear load, endurance strength of tooth, surface durability, heat dissipation – lubrication of gears – Merits and demerits of each type of gears.	3	15%
	Design of spur gear	3	
IV	Design of helical gear	2	15%
	Design of bevel gear	2	
	Design of worm & worm wheel	3	
SECOND INTERNAL EXAM			
V	Design of flat belt- materials for belts, slip of the belts, creep, centrifugal tension	3	20%
	Design of V-belt drives, Advantages and limitations of V-belt drive	3	
	Selection of roller chains, power rating of roller chains, galling of roller chains, polygonal action, silent chain.	3	
VI	Connecting rod – material, connecting rod shank, small end, big end, connecting rod bolts, inertia bending stress, piston	5	20%
	Pressure vessels, thin cylinders, Thick cylinder equation, open and closed cylinders.	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Note : Use of approved data book is permitted

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 3 questions from module I and II and at least 1 question from each module
Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part B
There should be 3 questions from module III and IV and at least 1 question from each module
Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part C
There should be 3 questions from module V and VI and at least 1 question from each module
Each question carries 20 marks
Students will have to answer any 2 questions out of 3 (2X20 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME404	INDUSTRIAL ENGINEERING	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To impart theoretical knowledge about various tools and techniques of Industrial Engineering.
- To create awareness about various safety procedures to be followed in carrying out different types of projects.
- To get acquainted with the Inventory management Principles and Techniques.
- To equip with the theoretical knowledge on Quality control practices and testing methods.

Syllabus

Introduction to Industrial Engineering, Plant layout and Material handling, Methods engineering, Industrial relations, Production planning and control, Quality control and Inspection

Expected outcomes:

The students will be able to

i. Know various tools and techniques in industrial Engineering.
ii. Develop work procedure applying the principles of work study.
iii. Apply inventory control techniques in materials management.
iv. Formulate replacement and purchase decisions and arrive at conclusions

Text Books:

1. B. Kumar, Industrial Engineering Khanna Publishers,2013
2. M Mahajan, Industrial Engineering & Production Management, Dhanpat Rai, 2005
3. Martand Telsang, Industrial Engineering & Production Management, S. Chand, 2006
4. O. P. Khanna, Industrial Engineering and Management, Dhanpat Rai, 2010

References:

1. E. S. Buffa, Modern Production management, John Wiley, 1983
2. Grant and Ieven Worth, Statistical Quality Control, McGraw Hill, 2000
3. Introduction to work study – ILO, Oxford And IBH Publishing,2008
4. Ralph M Barnes, Motion and Time Study, Wiley, 1980

Course

Module		Hours	End Sem. Exam Marks
I	Introduction to Industrial Engineering - Evolution of modern Concepts in Industrial Engineering - Functions of Industrial Engineering - Field of application of Industrial Engineering Product Development and research- Design function - Objectives of design, - Manufacturing vs purchase- Economic aspects- C-V-P analysis – simple problems-Development of designs- prototype, production and testing - Human factors in design- Value Engineering .	7	15%
II	Plant layout and Material handling- principles of material handling, Types of material handling equipments, Selection and application. Preventive and break- down maintenance - Replacement policy-- Methods of replacement analysis-Method of providing for depreciation- Determination of economic life - Simple problems.	7	15%

FIRST INTERNAL EXAM			
III	Methods engineering: Analysis of work methods using different types of process chart and flow diagrams- Critical examination- Micro motion study and therbligs- Principles of motion economy – Work measurement-Performance rating.-Determination of allowances and standard time. - Job evaluation and merit rating - Objectives and principles of job evaluation--Wages and Incentives- Primary wage systems- Wage incentive plans.	7	15%
IV	Industrial relations- Psychological attitudes to work and working conditions - fatigue- Methods of eliminating fatigue- Effect of Communication in Industry-Industrial safety-personal protective devices-, causes and effects of industrial disputes- Collective bargaining- Trade union - Workers participation in management.	7	15%
SECOND INTERNAL EXAM			
V	Production planning and control- Importance of planning - job, batch and mass production-Introduction and need for a new product-product life cycle. - Functions of production control - Routing , Scheduling, dispatching and follow up- Gantt charts. Inventory Control, Inventory models -Determination of EOQ and reorder level-simple problems- Selective inventory control techniques.	7	20%
VI	Quality control and Inspection- Destructive and non-destructive testing methods- process capability- Statistical quality control – causes of variation in quality- control charts for X and R. Reliability-causes of failures- Bath tub curve.-System reliability- life testing- Introduction to concepts of, TQM, ISO, Six Sigma and Quality circles (Brief description only).	7	20%
END SEMESTER EXAM			

Question paper pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II. Each question carries 10 marks.
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV. Each question carries 10 marks.
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI. Each question carries 10 marks.
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME462	Propulsion Engineering	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To give an overview of various air craft engines, rocket engines and their applications.
- To provide knowhow on tools to analyze various rocket propulsion.
- To know the testing of rocket engines .

Syllabus:

Fundamentals of Propulsion, Types of propulsive devices, Efficiencies, Thermodynamics analysis of turbojet, Turbojet engine components, Rocket propulsion, Types of rockets, Flight Performance, Testing of rockets

Expected Outcomes:

The students will be able to

i. Perform thermodynamic analysis of aircraft engines
ii. Carry out performance analysis of aircraft systems and components
iii. Formulate and solve rocket engine problems

Text books:

1. K Ramamurthi, Rocket Propulsion, Laxmi Publications, 2016
2. Saeed Farokhi, Aircraft Propulsion, Wiley, 2e, 2014

Reference books:

1. G. P. Sutton and Oscar Biblarz, Rocket Propulsion elements- John Wiley & Sons, 2013
2. J Mattingly, H von Ohain, Elements of Propulsion: Gas Turbines and Rockets, AIAA, 2006
3. Philip Hill, Carl Peterson: Mechanics and Thermodynamics of Propulsion, Pearson, 2014
4. Ronald D Flack, Fundamentals of Jet Propulsion with Applications, Cambridge University Press, 2005

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Fundamentals of Propulsion- Classification types of propulsive devices-Airscrew, Turbojet, Turboprop, turbofan, Turboshaft, Ramjet, Scramjet, Pulsejet and Rocket engines. Comparative study of performance characteristics applications.	7	15%
II	Theory of propulsion – Thrust, thrust power and efficiencies of turbojet engine. Thermodynamics analysis of turbojet engine cycle, Propellers: Types of propellers	7	15%
FIRST INTERNAL EXAMINATION			

III	Turbojet engine components- air intakes, Compressors, Combustion chambers, turbines, nozzles turbine and compression matching – Thrust augmentation.	**7**	**15%**
IV	Rocket propulsion- general operating principles of chemical, electrical nuclear and solar rockets. Chemical Rockets- Classification. Performance parameters for chemical rockets and their relationship, Energy and efficiencies, simple problems, Solid propellants- Types- burning rate- grain Configurations, - Classification- Typical fuels and oxidizers, properties and specifications, Selection.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Liquid propellant feed systems, injectors, Starting and ignition, Igniters liquid propellant, Precautions in propellant handling. Hybrid Rockets combustion processes in SPR and LPR combustion instability- Control of instabilities –Cooling of Rocket motors	**7**	**20%**
V1	Flight Performance- Velocity and attitude in simplified vertical Refractory staging of rockets. Rocket Testing- Test facilities and safeguards. Measurement System Terminology, Flight Testing.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME464	Robotics and Automation	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To provide the concepts of vision system and image processing
- To equip students to write programs for automatic functioning of a robot
- To familiarise various robot sensors and their perception principles that enable a robot

Syllabus:

Definition ,Co-ordinate Systems, Work Envelope, types and classification, Robot drive systems, End Effectors, Grippers, Sensors and machine vision, Robot kinematics and robot programming, Application of robots in machining.

Expected Outcomes:

The students will be able to

i. Become familiar with the history, concept, development and key components of robotics technologies

ii. Classify and characterize the robots based on the configuration and work volume

iii. Solve the problems related to robot design and control

Text books:

1. Industrial Robots, Yu.Kozyrev, Mir Publishers
2. Janakiraman.P.A., Robotics and Image Processing, Tata McGraw-Hill, 1995
3. M.P.Groover, Industrial Robotics – Technology, Programming and Applications, McGraw-Hill, 2001
4. Yoram Koren, Robotics for Engineers, McGraw-Hill Book Co., 1992

References:

1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., Robotics Control, Sensing, Vision and Intelligence, McGraw-Hill Book Co., 1987
2. K.S.Fu., R.C.Gonalez, C.S.G.Lee, Robotics Control sensing, Vision andIntelligence, McGraw Hill International Edition, 1987
3. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Robotic engineering- An Integrated Approach , Prentice Hall Inc, 1989

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Definition – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Basic robot motions - Point to point control, Continuous path control. Robot Parts and Their Functions – Need for Robots Different Applications.	7	15%
II	Robot drive systems: Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications	7	15%

	and Comparison of all these Drives.		
FIRST INTERNAL EXAMINATION			
III	End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations	**7**	**15%**
IV	Sensors and machine vision: Requirements of a sensor, Principles and Applications of the following types of sensors – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Laser Range Meters).	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Proximity Sensors(Inductive, Capacitive, and Ultrasonic), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors. Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Robot kinematics and robot programming: Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two Degrees of Freedom (In 2 Dimensional) – Deviations and Problems.	**7**	**20%**
V1	Teach Pendant Programming, Lead through programming, Robot programming Languages –VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs. Industrial Applications: Application of robots in machining, welding, assembly, and material handling.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum **marks: 100** **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)
Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME466	Computational Fluid Dynamics	3-0-0-3	2016

Prerequisite : ME203 Mechanics of fluids

Course Objectives: :

- To introduce governing equations of viscous fluid flows
- To introduce numerical modelling and its role in the field of fluid flow and heat transfer
- To enable the students to understand the various discretization methods, solution procedures and turbulence modelling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer using high speed computers.

Syllabus:

Introduction to CFD, Governing equations, Steady and unsteady flows, Analytical solution of a one dimensional convection diffusion equation, Statistical representation of turbulent flows, Different types of turbulence models, Grid generation, Pressure-velocity decoupling for incompressible flows, Typical results of CFD analysis

Expected Outcomes:

The students will be able to

i. Grasp numerical modelling and its role in the field of fluid flow and heat transfer
ii. Apply the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems
iii. Know established engineering methods to solve complex engineering problem

Text books:

1. Patankar Suhas V., Numerical Heat Transfer and Fluid Flow, Taylor &Francis,1980
2. Versteeg H.K. &Malalasekera W., An introduction to Computational Fluid Dynamics, Longman,2008

Reference books:

1. Anderson Dale A., Tannehill John C. &Pletcher Richard H., Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 2016
2. Fletcher C.A.J., Computational Techniques for Fluid Dynamics I, Springer Verlag,1984

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to CFD, Historical background, applications, advantages. Basic steps of CFD. Meshes, Structured and unstructured mesh, Classification of structured grids. Governing equations: continuity and momentum equations. Equation of transport of a scalar. Potential, Euler and Navier-Stokes equations	7	15%
II	Steady and unsteady flows. Typical boundary conditions such as Dirichlets and Neumann conditions. TDMA method., Numerical	7	15%

	problem up to four unknowns using TDMA. Cell centred finite volume discretisation of terms of governing equations such as time derivative, convective and diffusion.		
FIRST INTERNAL EXAMINATION			
III	Analytical solution of a one dimensional convection diffusion equation. Upwind, central and blended difference approximations for convection term, QUICK scheme. Implicit, explicit and Crank-Nicolson schemes	**7**	**15%**
IV	Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Turbulence modeling, Different types of turbulence models: advantages and disadvantages. Structured Grid generation – Unstructured Grid generation– Mesh refinement – Adaptive mesh	**7**	**20%**
VI	Pressure-velocity decoupling for incompressible flows - SIMPLE and PISO algorithms. Density based solutions for compressible flow, TVD and Van-leerschemes for compressible flow. Typical results of CFD analysis. Stream lines, method for generating stream line, velocity contours and pressure contours, Method of drawing a velocity vector. Solution of Lagrangian coordinates of a fluid particle. Commercial CFD packages.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME468	Nanotechnology	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To introduce nanotechnology and nanostructures
- To introduce fabrication and characterization techniques used in nanotechnology

Syllabus:

Introduction and scope, nanostructures Effect of Nanoscale dimensions on various properties, Fabrication methods, Characterisation methods, Applications of Nanotechnology (nano materials and devices), Nanomachines, Nanofluids, Nanoswitches, nano computers, nanofilters

Expected Outcomes:

The students will be able to

i. Understand properties of materials at nanoscale
ii. Know the fabrication and characterization methods used in nanotechnology
iii. Acquaint with the various applications of nanotechnology

Text books:

1. A.K. Bandyopdhyay, Nanomaterials, , New age international publishers,2008
2. Bharat Bhushan, Springer Handbook of Nanotechnology, 2010
   Charles P Poole, Frank J Owens, Introduction to Nanotechnology, John Wiley and Sons, 2003
3. Jeremy Ramsden,Nanotechnology, William Andrew, Elsevier, 2011
4. T Pradeep, Nano: The essentials, McGraw – Hill education,2 007
5. V.S.Muralidharan, A Subramnya,Nano science and Technology, Ane books Pvt Ltd

Reference books:

1. Gregory Timp, Nanotechnology, Springer-Verlag, 2009
2. John Mongillo, Nano Technology, Greenwood Press, 2007
3. Kelsall Robert. W, Ian Hamley, MarkGeoghegan, Nanoscale Science and Technology, Wiley Eastern,2005

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction and scope-Classification of nanostructures: Quantum dots, quantum wires, quantum wells, nanoclusters, nanotubes, super lattices, nanocrystalline materials-Effects of nanometer length scale – Changes to the system total energy, changes to the system structures.	7	15%
II	Effect of Nanoscale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical and electronic properties.	7	15%
FIRST INTERNAL EXAMINATION			

III	Fabrication methods: Top down and bottom up approaches-Top down processes: Milling, Lithographics, machining process, pulsed laser methods- Bottom up processes: Vapour phase deposition methods, PVD, CVD, electro deposition, plasma assisted deposition process, MBE, chemical methods, colloidal and solgel methods	**7**	**15%**
IV	Characterisation methods: General classification of characterization methods, Microscopy techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Diffraction Techniques-Spectroscopy Techniques – Raman Spectroscopy, Surface analysis and depth profiling- Mechanical Properties- Magnetic and Thermal properties.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Applications of Nanotechnology (nano materials and devices)- Applications of nanocomposites, nanocrystalline materials, nano layered structures, nanomagnetic materials-magneto resistance- Carbon nanotubes: SW, MW, nanostructured coatings- nano sensors: order from chaos, characterization, perception, nano sensor based on quantum size effect, Electrochemical sensors, Sensors based on physical properties, Nanobiosensors, smart dust	**7**	**20%**
V1	Nanomachines: covalent and non covalent approaches, Molecular motors and machines, molecular devices, single molecular devices, practical problems with molecular device- Nanofluids: nanoparticles, preparation of nanofluids, thermophysical properties of nanofluids in comparison with base fluid. Nanoswitches - nano computers- nanofilters	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME472	FAILURE ANALYSIS AND DESIGN	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

1. To understand the failure modes and theories of failure.
2. To include the effect of cyclic loading, fatigue and endurance limit in design.
3. To understand the methods for lifecycle prediction.

Syllabus

Material failure modes and their identification. Static loading, combined stress, theories of failure. Fatigue loading, high cycle fatigue, fatigue testing, S-N-P curves, endurance diagrams, influence factors, stress concentration factors and notch sensitivity, fatigue design for combined stress, cumulative damage and life prediction, low cycle fatigue, fracture mechanics principles in design practice, contact fatigue, high temperatures, corrosion. Shock and impact loading.

Expected outcome

The students will be able to

i. analyze real life failure modes and use of theories for failure prediction
ii. design for fatigue and cyclic loading
iii. make comprehensive life cycle prediction of designed products

Text Books:

1. Collins. J. A., Failure of Materials in Mechanical Design, John Wiley & Sons, 1993
2. Suresh S, Fatigue of Materials, Cambridge University Press, 1998

References Books:

1. Prashant Kumar, Elements of Fracture Mechanics, Wheeler Publishing, 1999
2. Withered C. E., Mechanical Failure Avoidance Strategies and Techniques, McGraw-Hill, 1994

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to material failure modes- Identification of failure modes	3	15%
	Combined stresses –Theories of failure	5	

II	Fatigue loading, high cycle fatigue, fatigue testing, S-N-P curves-factors affecting S-N-P curve- endurance diagrams	6	20%
FIRST INTERNAL EXAM			
III	Cumulative damage and life prediction- Fracture control	5	15%
	Fatigue design for combined stress	2	
IV	Low cycle fatigue – Cumulative damage in low cycle fatigue	4	20%
	Influence factors- Stress concentration factors and notch sensitivity	4	
SECOND INTERNAL EXAM			
V	Fracture mechanics principles in design practice	6	15%
VI	Contact fatigue, high temperatures, corrosion	4	15%
	Shock and impact loading.	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I
and II Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and
IV Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V
and VI Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40

marks) Note: Each question can have a maximum of four sub questions, if

needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME474	Micro and Nano Manufacturing	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

1. To give awareness of different techniques used in micro and nano manufacturing
2. To give in-depth idea of the conventional techniques used in micro manufacturing
3. To introduce Non-conventional micro-nano manufacturing and finishing approaches
4. To introduce Micro and Nanofabrication Techniques and other processing routes in Micro and nano manufacturing
5. To know different techniques used in Micro Joining and the metrology tools in micro and nano manufacturing.

Syllabus

Introduction to Precision engineering- Bulk micromachining – Micro-energy -Carbon Nanotubes - Molecular Logic Gates and Nanolevel Biosensors - Conventional Micro Machining - Non-conventional micro-nano manufacturing and finishing approaches - Micro and Nano Finishing Processes - Micro and Nanofabrication Techniques - Micro Joining - Characterization and metrology tools.

Expected outcome

The students will

1. get an awareness of different techniques used in micro and nano manufacturing.
2. get in-depth idea of the conventional techniques used in micro manufacturing.
3. become aware about non-conventional micro-nano manufacturing and finishing approaches.
4. get awareness on micro and nano finishing processes.
5. understand micro and nanofabrication techniques and other processing routes in micro and nano manufacturing.
6. know about different techniques used in micro joining and the metrology tools in micro and nano manufacturing.

References:

1. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
2. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006.
3. Nitaigour Premchand Mahalik, Micro-manufacturing and Nanotechnology, 2006.
4. V.K.Jain, Micro-manufacturing Processes, CRC Press, 2012.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Precision engineering, macro milling and micro drilling, Micro-electromechanical systems – merits and applications, Micro phenomenon in Electro-photography – applications	1	15%

	Introduction to Bulk micromachining, Surface micromachining-steps, Micro instrumentation – applications, Micro Mechatronics, Nanofinishing – finishing operations.	**1**	
	Laser technology in micro manufacturing- Practical Lasers, application of technology fundamentals	**1**	
	Introduction to Micro-energy and chemical system (MECS), Space Micro-propulsion, e-Beam Nanolithography – important techniques, Introduction to Nanotechnology	**1**	
	Carbon Nano-tubes – properties and structures, Molecular Logic Gates and Nano level Biosensors - applications	**1**	
II	Introduction to mechanical micromachining, Micro drilling – process, tools and applications	**1**	**15%**
	Micro turning- process, tools and applications, Diamond Micro turning – process, tools and applications	**1**	
	Micro milling and Micro grinding – process, tools and applications	**1**	
	Micro extrusion- process and applications	**1**	
	micro bending with Laser	**1**	
	Nano- Plastic forming and Roller Imprinting	**1**	
	FIRST INTERNAL EXAMINATION		
III	Introduction to Non-conventional micro-nano manufacturing	**1**	**15%**
	Process, principle and applications – Abrasive Jet Micro Machining, WAJMM	**1**	
	Micro EDM, Micro WEDM, Micro EBM – Process principle, description and applications	**1**	
	Micro ECM, Micro LBM - Process principle, description and applications	**1**	
	Focused ion beams - Principle and applications	**1**	
IV	Introduction to Micro and Nano Finishing Processes	**1**	**15%**
	Magnetorheological Finishing (MRF) processes, Magnetorheological abrasive flow finishing processes (MRAFF) – process principle and applications	**1**	
	Force analysis of MRAFF process,	**1**	
	Magnetorheological Jet finishing processes	**1**	
	Working principle and polishing performance of MR Jet Machine	**1**	
	Elastic Emission Machining (EEM) – machine description, applications	**1**	
	Ion Beam Machining (IBM) – principle, mechanism of material removal, applications	**1**	
	Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications	**1**	
	SECOND INTERNAL EXAMINATION		
V	Introduction to Micro Fabrication: basics, flowchart, basic chip	**1**	**20%**

	making processes		
	Introduction to Nanofabrication, Nanofabrication using soft lithography – principle, applications – Examples (Field Effect Transistor, Elastic Stamp)	**1**	
	Manipulative techniques – process principle, applications	**1**	
	Introduction to Carbon nano materials – CN Tubes	**1**	
	CN Tubes – properties and applications	**1**	
	CN Tube Transistors – Description only	**1**	
	Diamond - Properties and applications	**1**	
	CVD Diamond Technology	**1**	
	LIGA Process	**1**	
V1	Laser Micro welding – description and applications, Defects	**1**	**20%**
	Electron Beam Micro-welding – description and applications	**1**	
	Introduction to micro and nano measurement, defining the scale, uncertainty	**1**	
	Scanning Electron Microscopy – description, principle	**1**	
	Scanning White-light Interferometry – Principle and application	**1**	
	Optical Microscopy – description, application	**1**	
	Scanning Probe Microscopy, scanning tunneling microscopy- description, application	**1**	
	Confocal Microscopy - description, application	**1**	
	Introduction to On-Machine Metrology	**1**	
	END SEMESTER EXAMINATION		

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME476	Material Handling & Facilities Planning	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To understand the overall facilities planning process
- To educate product, process and schedule design and their effects on the facility layout
- To introduce concepts of material handling and safety in industries.

Syllabus:

Design of layout of factories, General equipment for amenities of working people, Computer applications in layout designs, Environmental aspects, Plant safety, Economical aspects

Expected Outcomes:

The students will be able to

i. Assess the value of facility planning on the strategy of a firm
ii. Develop a systematic plant layout
iii. Know the environmental and economical aspects in facilities planning
iv. Understand various material handling systems

Text books/Reference books:

1. A W Peymberton, Plant layout and Material Handling, John Wiley
2. James A Apple, Plant layout and Material Handlin, Krieger Pub Co,1998
3. John A Sehbin, Plant layout and Material Handling-
4. K C Arora & Shinde, Aspects of Material handling, Lakshmi Publications.
5. P B Mahapatra, Operations Management, PHI, 2010

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Design of layout of factories, Office, Storage area etc. on consideration of facilities of working people, Storage facilities and general equipment for amenities of working people – Product, Process and combination layout –Systematic layout planning, Design of Assembly lines, Line balancing methods.	8	15%
II	Computer applications in layout designs, Environmental aspects like lighting, Ventilation, dust control, humidity. Different type of Plant services like steam compressed air etc.	6	15%
	FIRST INTERNAL EXAMINATION		
III	Plant safety, Elements off Industrial safety- Causes and prevention of accidents – Pollution and environmental consideration.	6	15%
IV	Introduction, Material Handling systems, Material Handling principles, Classification of Material Handling Equipment, Relationship of material handling to plant layout.	8	15%

SECOND INTERNAL EXAMINATION			
V	Basic Material Handling systems: Selection, Material Handling method- path, Equipment, function oriented systems.	**7**	**20%**
V1	Methods to minimize cost of material handling- Maintenance of Material Handling Equipments, Safety in handling, Ergonomics of Material Handling equipment. Design, Miscellaneous equipment	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II Each
question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks) Note:

Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	Credits	Year of Introduction
**492	PROJECT	6	2016

Prerequisite : Nil

Course Objectives

- To apply engineering knowledge in practical problem solving
- To foster innovation in design of products, processes or systems
- To develop creative thinking in finding viable solutions to engineering problems

Course Plan

In depth study of the topic assigned in the light of the preliminary report prepared in the seventh semester
Review and finalization of the approach to the problem relating to the assigned topic
Preparing a detailed action plan for conducting the investigation, including team work
Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed
Final development of product/process, testing, results, conclusions and future directions
Preparing a paper for Conference presentation/Publication in Journals, if possible
Preparing a report in the standard format for being evaluated by the dept. assessment board
Final project presentation and viva voce by the assessment board including external expert

Expected outcome

The students will be able to

iii. Think innovatively on the development of components, products, processes or technologies in the engineering field
iv. Apply knowledge gained in solving real life engineering problems

Evaluation

Maximum Marks : 100

(i) Two progress assessments	20% by the faculty supervisor(s)
(ii) Final project report	30% by the assessment board
(iii) Project presentation and viva voce	50% by the assessment board

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.