University of Calicut

Syllabus: 3rd – 8th Semesters
B. Tech. - Mechanical Engineering
2014

From

Prof. C.P Muhammad,

HOD(ME) & Chirman(BoS),

MES College of Engineering, Kuttippuram .

To

The Registrar,

University of Calicut.

Sir,

Sub: Revised Syllabi 2014 forwarding:

Ref: Your letter No: 67049/GA-IV-E1/2013/CU dt./26-06-14

With reference to the above I am sending through a special messenger the hard and soft copies (C.D) of the finalised version of syllabi-2014 for B.tech courses of Mechanical Engineering(ME), Production Engineering(PE), Automobile Engineering(AE). and Printing Technology(PT) (III rd to VIII th semesters) after correcting discrepancies.

In this connection I am to bring in to your kind attention that the syllabi up loaded in the Calicut University site is the pre revised version; this is the final version for these four courses coming under the UG board of M.E. Please acknowledge the receipt.

Thanking you,

Yours Faithfully

25-11-14

C.P. Muhammad

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File Ref.No.67049/GA - IV - E1/2013/CU

UNIVERSITY OF CALICUT

Abstract

Faculty of Engineering- BTech Degree Course-2014 admission- Anomalies rectified in the Syllabus of IIIrd to VIIIth semester- Mechanical Engineering, Printing Technology, Production Engineering, Automobile Engineering and Electrical & Electronics Engineering - Implemented- Orders issued.

G & A - IV - E

U.O.No. 9884/2015/Admn Dated, Calicut University.P.O, 19.09.2015

Read:-1) U.O.No.5156/2014/Admn dated.29.05.2014

2) UO Notes received from EX-II Section.

3) Orders of the Vice Chancellor in the file of even no.dated.18.09.2015.

ORDER

As per paper read First above, the revised scheme and syllabus of IIIrd to VIIIth semester BTech courses were implemented w.e.f.2014 admission.

As per paper read second above, certain anomalies have been pointed out by EX branch of Pareekshabhavan in the approved syllabus of various BTech Programmes of (2014admissions) and the same was forwarded to the Chairmen of the Boards of Studies concerned for rectifying the anomalies noted in the syllabi of Mechanical Engineering, Printing Technology, Production Engineering Automobile Engineering and Electrical & Electronics Engineering courses.

The Chairmen Board of Studies concerned after having rectified the discrepancies in the syllabus, have forwarded corrected copies of the syllabi of the BTech courses.

Sanction has therefore been accorded by the Vice Chancellor for implementing the corrected version of the syllabus of IIIrd to VIIIth semester BTech Programmes in Mechanical Engineering, Printing Technology, Production Engineering, Automobile Engineering and Electriacal & Electronices Engineering programmes of 2014 admissions.

Orders are issued accordingly.

(Copies of the Syllabi appended)

Usha K
Deputy Registrar

To

Principals of all Engineering Colleges,
Controller of Examinations/JCE-6/EX section/SF/

Forwarded / By Order

Scheme of III Semester B. Tech Mechanical Engineering								
Code	Subject	Hours/ Week			Marks		Duration of End Semester examination (Hours)	Credits
		L	T	P/D	Internal	End Semester		
EN14 301	Engineering Mathematics III	3	1	0	50	100	3	4
EN14 302	Computer Programming in C	2	0	2	50	100	3	4
ME14 303	Fluid Mechanics	3	1	0	50	100	3	4
ME14 304	Mechanics of Solids	3	1	0	50	100	3	4
ME14 305	Metallurgy and Materials Science	3	1	0	50	100	3	4
ME14 306	Electrical Technology	3	1	0	50	100	3	4
ME14 307 (P)	Computer Assisted Machine Drawing	0	0	3	50	100	3	2
ME14 308 (P)	Electrical Technology Lab	0	0	3	50	100	3	2
	TOTAL	17	5	8				28

Note:

- For EN 14 302 Computer Programming in C, the end semester examination will be held by the University as a theory paper.
- Even though the subject ME14 307 (P) Computer Assisted Machine Drawing is considered as a practical, the end semester examination will be conducted by the University.

Scheme of IV Semester B. Tech Mechanical Engineering								
Code	Subject	Hours/ Week			Marks		Duration of End Semester examination (Hours)	Credits
		L	T	P/D	Internal	End Semester		
EN14 401A	Engineering Mathematics IV	3	1	0	50	100	3	4
EN14 402	Environmental Science	3	1	0	50	100	3	4
ME14 403	Thermodynamics	3	1	0	50	100	3	4
ME14 404	Advanced Mechanics of Solids	3	1	0	50	100	3	4
ME14 405	Fluid Machinery	3	1	0	50	100	3	4
ME14 406	Casting and joining	3	1	0	50	100	3	4
ME14 407 (P)	Materials Testing Lab	0	0	3	50	100	3	2
ME14 408 (P)	Production Engineering Lab I	0	0	3	50	100	3	2
	TOTAL	18	6	6				28

Scheme of V Semester B. Tech Mechanical Engineering								
Code	Subject	Hours/ Week			Marks		Duration of End Semester examination (Hours)	Credits
		L	T	P/D	Internal	End Semester		
ME14 501*	Engineering Economics and Principles of Management*	3	1	0	50	100	3	4
ME14 502	Metal Cutting and Forming	3	1	0	50	100	3	4
ME14 503	Heat and Mass Transfer	3	1	0	50	100	3	4
ME14 504	Mechanics of Machinery	3	1	0	50	100	3	4
ME14 505	Internal Combustion Engines	3	1	0	50	100	3	4
ME14 506	Computational Methods in Engineering	3	1	0	50	100	3	4
ME14 507 (P)	Fluids Lab	0	0	3	50	100	3	2
ME14 508 (P)	Production Engineering lab II	0	0	3	50	100	3	2
	TOTAL	18	6	6				28

*Common for ME, AI, AM, PT, PE, CE, CS, EC, EE, BM and IC

Scheme of VI Semester B. Tech Mechanical Engineering								
Code	Subject	Hours/ Week			Marks		Duration of End Semester examination (Hours)	Credits
		L	T	P/D	Internal	End Semester		
ME14 601	Gas Dynamics & Jet Propulsion	3	1	0	50	100	3	4
ME14 602	Metrology and Instrumentation	3	1	0	50	100	3	4
ME14 603	Dynamics of Machinery	3	1	0	50	100	3	4
ME14 604	Machine Design I	3	1	0	50	100	3	4
ME14 605	Operations Research	3	1	0	50	100	3	4
ME14 606	Automobile Engineering	3	1	0	50	100	3	4
ME14 607 (P)	Thermal Lab I	0	0	3	50	100	3	2
ME14 608 (P)	Instrumentation Lab	0	0	3	50	100	3	2
	TOTAL	18	6	6				28

Scheme of VII Semester B. Tech Mechanical Engineering								
Code	Subject	Hours/ Week			Marks		Duration of End Semester examination (Hours)	Credits
		L	T	P/D	Internal	End Semester		
ME14 701	Refrigeration and Air Conditioning	3	1	0	50	100	3	4
ME14 702	Machine Design II	3	1	0	50	100	3	4
ME14 703	Computer Integrated Manufacturing	3	1	0	50	100	3	4
ME14 704	Elective I	3	1	0	50	100	3	4
ME14 705	Elective II	3	1	0	50	100	3	4
ME14 706 (P)	Thermal Lab II	0	0	3	50	100	3	2
ME14 707 (P)	CAD/CAM Lab	0	0	3	50	100	3	2
ME14 708 (P)	Project	0	0	4	100	-	-	4
	TOTAL	15	5	10				28

Scheme of VIII Semester B. Tech Mechanical Engineering								
Code	Subject	Hours/ Week			Marks		Duration of End Semester examination (Hours)	Credits
		L	T	P/D	Internal	End Semester		
ME14 801	Mechatronics	3	1	0	50	100	3	4
ME14 802	Power Plant Engineering	3	1	0	50	100	3	4
ME14 803	Operations Management	3	1	0	50	100	3	4
ME14 804	Elective III	3	1	0	50	100	3	4
ME14 805	Elective IV	3	1	0	50	100	3	4
ME14 806 (P)	Seminar	0	0	3	100	-	-	2
ME14 807 (P)	Project	0	0	7	100	-	-	4
ME14 808 (P)	Viva Voce	0	0	0	-	100	-	4
	TOTAL	15	5	10				30

Total Credits =212

ELECTIVES

ELECTIVE I

ME14 704(A)	Financial Management
ME14 704(B)	Industrial Safety Engineering
ME14 704(C)	Renewable Energy Technology
ME14 704(D)	Energy Conservation in Thermal Systems
ME14 704(E)	Industrial Automation
ME14 704(F)	Combustion Engineering
ME 14704(G)	Finite Element Methods

ELECTIVE II

ME14 705(A)	Logistics and Supply Chain Management
ME14 705(B)	Design of Heat Transfer Equipments
ME14 705(C)	Advanced Fluid Mechanics
ME14 705(D)	Design of Jigs and Fixtures
ME14 705(E)	Fracture Mechanics
ME14 705(F)	Composite Materials
ME14 705 (G)	Entrepreneurship

ELECTIVE III

ME14 804(A)	Marketing Management
ME14 804(B)	Aerospace Engineering
ME14 804(C)	Energy Engineering and Management
ME14 804(D)	Cryogenic Engineering
ME14 804(E)	Control System Engineering
ME14 804(F)	Industrial Tribology
ME14 804(G)	Wind Energy and its utilization

ELECTIVE IV

ME14 805(A)	Quality Engineering and Management
ME14 805(B)	Heating Ventilation and Air Conditioning Design
ME14 805(C)	Computational Fluid Dynamics
ME14 805(D)	Computerized Materials Management
ME14 805(E)	Design of Pressure Vessels and Piping
ME14 806(F)	Industrial Maintenance
ME14 806(G)	Tool Engineering and Design

EN14 301 Engineering Mathematics III

(Common for all branches)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objective

- *To provide a quick overview of the concepts and results in complex analysis that may be useful in engineering.*
- *To introduce the concepts of linear algebra and Fourier transform which are wealth of ideas and results with wide area of application.*

Module I: Functions of a Complex Variable (12 hours)

Functions of a Complex Variable – Limit – Continuity – Derivative of a Complex function – Analytic functions – Cauchy-Riemann Equations – Laplace equation – Harmonic Functions – Conformal Mapping – Examples: e^z, sinz, coshz, $(z+1/z)$ – Mobius Transformation.

Module II: Functions of a Complex Variable (14 hours)

Definition of Line integral in the complex plane – Cauchy's integral theorem (Proof of existence of indefinite integral to be omitted) – Independence of path – Cauchy's integral formula – Derivatives of analytic functions (Proof not required) – Taylor series (No proof) – Laurent series (No proof) – Singularities - Zeros – Poles - Residues – Evaluation of residues – Cauchy's residue theorem – Evaluation of real definite integrals.

Module III: Linear Algebra (12 hours) – (Proofs not required)

Vector spaces – Definition, Examples – Subspaces – Linear Span – Linear Independence – Linear Dependence – Basis – Dimension– Orthogonal and Orthonormal Sets – Orthogonal Basis – Orthonormal Basis – Gram-Schmidt orthogonalisation process – Inner product spaces – Definition – Examples – Inequalities ; Schwartz, Triangle (No proof).

Module IV: Fourier Transforms (14 hours)

Fourier Integral theorem (Proof not required) – Fourier Sine and Cosine integral representations – Fourier transforms – transforms of some elementary functions – Elementary properties of Fourier transforms – Convolution theorem (No proof) – Fourier Sine and Cosine transforms – transforms of some elementary functions –Properties of Fourier Sine and Cosine transforms.

Text Books:

Module I: Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons, Inc.
Sections: 12.3, 12.4, 12.5, 12.6, 12.7, 12.9

Module II: Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons, Inc.
Sections: 13.1, 13.2, 13.3, 13.4, 14.4, 15.1, 15.2, 15.3, 15.4

Module III: Bernaed Kolman, David R Hill, *Introductory Linear Algebra, An Applied First Course,* Pearson Education.
Sections: 6.1, 6.2, 6.3, 6.4, 6.8, Appendix.B.1

Module IV: Wylie C.R and L.C. Barrett, *Advanced Engineering Mathematics*, McGraw Hill.
Sections: 9.1, 9.3, 9.5

Reference books:

1. H S Kasana, *Complex Variables, Theory and Applications,* 2e, Prentice Hall of India.
2. John M Howie, *Complex Analysis,* Springer International Edition.
3. Anuradha Gupta, *Complex Analysis*, Ane Books India.
4. Shahnaz bathul, *Text book of Engineering Mathematics, Special functions and Complex Variables,* Prentice Hall of India.
5. Gerald Dennis Mahan, *Applied mathematics*, Springer International Edition.
6. David Towers, *Guide to Linear Algebra*, MacMillan Mathematical Guides.
7. Inder K Rana, *An Introduction to Linear Algebra*, Ane Books India.
8. Surjeet Singh, *Linear Algebra,* Vikas Publishing House.
9. Howard Anton, Chris Rorres, *Elementary Linear Algebra, Applications Version*, John Wiley and Sons.
10. Anthony Croft, Robert Davison, Martin Hargreaves, *Engineering Mathematics*, Pearson Education.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

EN14 302 Computer Programming in C

(Common for all branches)

Teaching scheme Credits: 4

2 hours lectures and 2 hour lab per week

Objectives

- *To impart the basic concepts of computer and information technology*
- *To develop skill in problem solving concepts through learning C programming in practical approach.*

Module I (13 hours)

Introduction to Computers: CPU, Memory, input-output devices, secondary storage devices, Processor Concepts - Evolution and comparative study of processors. Machine language, assembly language, and high level language. Inside a PC, Latest trends and technologies of storage, memory, processor, printing etc. Concept of Program and data, System software - BIOS, Operating System- Definition-Functions-Windows, and Linux. Compilers and assemblers, Computer networks, LAN, WiFi.

Module II (13 hours)

Basic elements of C: Flow chart and algorithm – Development of algorithms for simple problems. Structure of C program – Operators and expressions – Procedure and order of evaluation – **Input and Output functions.** *while, do-while* and *for* statements, *if, if-else, switch, break, continue, goto,* and *labels*. Programming examples.

Module III (13 hours)

Functions and Program structures: Functions – declaring, defining, and accessing functions – parameter passing methods – **Recursion** – Storage classes – *extern*, *auto*, *register* and *static*. Library functions. Header files – C pre-processor. Example programs. **Arrays**: Defining and processing arrays – passing arrays to functions – two dimensional and multidimensional arrays – application of arrays. Example programs.

Module IV (13 hours)

Structures – declaration, definition and initialization of structures, unions, **Pointers**: Concepts, declaration, initialization of pointer variables simple examples **Concept of a file** – File operations File pointer.

Text Books

1. P. Norton, *Peter Norton's Introduction to Computers*, Tata McGraw Hill, New Delhi.
2. E. Balaguruswamy, *Programming in ANSI C*, 3rd ed., Tata McGraw Hill, New Delhi, 2004

Reference Books

1. B. Gottfried, *Programming with C*, 2nd ed, Tata McGraw Hill, New Delhi, 2006
2. B. W. Kernighan, and D. M. Ritchie, *The C Programming Language*, Prentice Hall of India, New Delhi, 1988
3. K. N. King. *C Programming: A Modern Approach*, 2nd ed., W. W. Norton & Company, 2008
4. P. Norton, *Peter Norton's Computing Fundamentals*, 6th ed., Tata McGraw Hill, New Delhi, 2004.
5. S. Kochan, *Programming in C*, CBS publishers & distributors
6. M. Meyer, R. Baber, B. Pfaffenberger, *Computers in Your Future*, 3rd ed., Pearson Education India

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Lab Practical Tests
20% - Assignments
20% - Main Record
10% - Regularity in the class

University Examination Pattern

PART A: *Analytical/problem solving SHORT questions* — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 303 Fluid Mechanics

Teaching scheme **Credits: 4**

3 hours lecture and 1 hour tutorial per week

Objective

- *To study the physical behaviour of fluids and fluid systems, and laws governing this behaviour*
- *To study the action of forces on fluids and of the resulting flow pattern*

Module I (13 hours)

Fundamental Concepts : Characteristics of fluids – continuum – properties of fluids – density, specific weight, specific volumes, specific gravity, viscosity, capillarity, compressibility and bulk modulus, surface tension, vapour pressure

Fluid Statics : Pressure – Pascal's law-Hydrostatic law-variation of pressure in static fluids –absolute and gauge pressures – measurement of high and low pressures – manometers – forces on bodies and surfaces submerged in fluids – Buoyancy and flotation- stability of bodies submerged and floating in fluids – metacentric height.

Module II (13 hours)

System and control volume approach - basic equations – Reynold's transport equations – differential and integral form of continuity , momentum and energy equations – application of the above equations for one dimensional flow – velocity and momentum corrections - one dimensional flow along streamline and stream tubes – Euler's equation – Bernoulli's equation – applications - Venturimeter, Orificemeter, Pitot tube, Orifice , Mouthpiece, Notches and weirs.

Module III (13 hours)

Fluid Kinematics – Eulerian and Lagrangian flow descriptions – classification of fluid flow – graphical description of flow pattern – stream lines , path lines, streak lines, stream tubes – velocity and acceleration in fluid flow. Ideal fluids – rotational and irrotational flow – circulation and vorticity – stream function and potential function – basic flow fields – rectilinear flow - source and sink, Doublet,Rankine Half body, Rectilinear oval . Flow through pipes – Reynold's experiment - laminar and turbulent flow – critical Reynold's number – laminar flow in circular pipes – Hagen–Poiseuille flow – turbulent flows in circular pipes – Darcy - Weisbach equations – Eddy properties – Minor losses in pipes – total head - pressure lines.

Module IV (13 hours)

Boundary layer – Introduction –boundary layer over flat plate – continuity and momentum equations for laminar boundary layer – boundary layer thickness – velocity profile – integral solutions of momentum equations –Von-karman equation- Blasius equation- Prandtl's equations- boundary layer on immersed bodies – drag and lift – skin friction – boundary layer separation Introduction to turbulence, classification, scales of turbulence – Reynold's stresses- turbulence models- Prandtl mixing length concept.

Text Books:

1. Douglas, *Fluid Mechanics*, Pearson Education
2. R K Bansal, Text book of Fluid Mechanics and Hydraulic Machines, DhanpatRai Publications.
3. P.Balachandran, *Fluid Mechanics*, prentice hall , India
3. J K Jain, Fluid Mechanics, S Chand
4. R K Rajput, Text book of Fluid Mechanics and Hydraulic Machines, Laxmi Publications.

Reference Books:

1. F. M. White, *Fluid Mechanics*, 5th Edition, McGraw Hill
2. I. H. Shames, *Fluid Mechanics*, 4th Edition, McGraw Hill
3. S. K. Som, G. Biswas, *Fluid Mechanics*, Tata McGraw Hill
4. Fox, *Introduction to Fluid Mechanics*, Eastern Wiley.
5. D. Ramadingeih, *Fluid Mechanics*, New Age International

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 304 Mechanics of Solids

Teaching scheme **Credits: 4**
3 hours lecture and 1 hour tutorial per week

Objectives

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

Module I (13 hours)
Simple Stress and Strain: Introduction to analysis of deformable bodies – internal forces – method of sections – assumptions and limitations. Simple stresses – stresses due to normal, shear and bearing loads – strength design of simple members. Definition of linear and shear strains.
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 – deformation in axially loaded bars – thermal effects – statically indeterminate problems – principle of superposition. Elastic strain energy for uniaxial stress. 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 constants.

Module II (13 hours)
Torsion: Torsion theory of elastic circular bars – assumptions and limitations – polar modulus - torsional rigidity – economic cross-sections – statically indeterminate problems – shaft design for torsional load.
Axial force, shear force and bending moment: Diagrammatic conventions for supports and loading - axial force, shear force and bending moment in a beam – differential relations between load, shear force and bending moment - shear force and bending moment diagrams by direct and summation approach – elastic curve – point of inflection.

Module III (13 hours)
Stresses in beams: Pure bending – flexure formula for beams – assumptions and limitations – section modulus - flexural rigidity - economic sections – beam of uniform strength. Shearing stress formula for beams – assumptions and limitations – design for flexure and shear (beams with rectangular and circular c/s only).
Deflection of beams: Moment-curvature relation – assumptions and limitations - double integration method – Macaulays method – superposition techniques – moment area method and conjugate beam ideas for simple cases.

Module IV (13 hours)

Transformation of stress and strains: Plane state of stress - equations of transformation - principal stresses. Plane state of strain – analogy between stress and strain transformation – Mohr's circles of stress and strain – strain rosettes.

Compound stresses: Combined axial, flexural and shear loads – eccentric loading under tension/compression - combined bending and twisting loads.

Theory of columns: Buckling theory –Euler's formula for long columns – assumptions and limitations – effect of end conditions - slenderness ratio – Rankine's formula for intermediate columns.

Text Books:

1. E. P. Popov, T. A. Balan, *Engineering Mechanics of Solids,* Pearson Education, New Delhi.
2. R K Bansal, Mechanics of solids, Laxmi Publications
3. P. N. Singh, P. K. Jha, *Elementary Mechanics of Solids*, Wiley Eastern Limited, New Delhi.

Reference Books:

1. Gere, Timoshenko, *Mechanics of Materials*, CBS Publishers & Distributors, New Delhi.
2. I.H. Shames, J. H. Pitarresi, *Introduction to Solid Mechanics*, Prentice Hall of India, New Delhi.
3. F. Beer, E. R. Johnston, J. T. DeWolf, *Mechanics of Materials*, Tata McGraw Hill, New Delhi
4. S. H. Crandal, N. C. Dhal, T. J. Lardner, An *Introduction to the Mechanics of Solids,* McGraw Hill
5. A. Pytel, F. L. Singer, *Strength of Materials,* Harper & Row Publishers, New York.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 305 Metallurgy and Material Science

Teaching scheme **Credits: 4**

3 hours lecture and 1 hour tutorial per week

Objective:

- *To impart knowledge on engineering materials, deformation of the crystals, equilibrium diagrams of selected alloy systems, heat treatment of steels, properties of steels, cast iron and other alloys, and its application*

Module I (12 hours)

Introduction to materials science and engineering-Materials classification- polymorphism-allotropy-levels of structure- microscopic examination-Specimen preparation for microstructural examination–etching-metallurgical microscope--scanning electron microscope(SEM) and Transmission Electron Microscope(TEM)-Crystal structure of metallic materials. Imperfections in crystals. - Point defects- line defects- surface defects.

Module II(14 hours)

Solidification of metals and alloys- Solid solution, Hume Rothery's rules-Diffusion-laws of diffusion-Mechanisms of diffusion- applications-Phase diagrams- Phase rule- -Isomorphous systems-Lever Rule- Cu-Ni – eutectic system- Pb-Sn- eutectoid - peritectic reactions Iron- Carbon equilibrium diagram. Development of microstructure in Iron Carbon alloys, Phase transformation in steel. TTT diagram, Heat treatment of steel, Annealing, tempering, austempering, martempering, Hardenability, Jomni test- surface hardening methods.

Module III(14 hours)

Elastic, anelastic and visco - elastic, behavior - Plastic Deformation of Metals and Alloys- Mechanisms of plastic deformation, role of Dislocation; slip and twinning - Schmid"s law. Strengthening mechanisms - Grain size reduction, solid solution strengthening, Work hardening; Recovery recrystallisation and grain growth - failure of materials – Fracture - ductile fracture, brittle fracture, -protection against fracture-fracture toughness, Fatigue-mechanism of fatigue, S-N curve - creep curve

Module IV (12 hours)

Applications of ferrous alloys-Steels-low carbon steels-high strength low alloy steels-Medium carbon steels-high carbon steels-Stainless steels - ferritic, austenitic and martensitic stainless steels - Cast irons - Grey cast irons - Ductile cast irons - White iron and Malleable iron - copper and its alloys - brasses and bronzes - aluminum and its alloys - magnesium and its alloys - titanium and its alloys - Refractory metals - Super alloys – Composites - particle reinforced and fiber reinforced composites - the fiber phase and the matrix phase - polymer and metal matrix composites - processing of fiber reinforced composites - shape memory alloys - Nano materials - bio materials - bio compatibility

Text Books

1. William D Callister, *Material Science and Engineering, John wiley and Sons*
2. Raghavan V, *Material science and engineering,*
3. Jose S & Mathew E.V, *Metallurgy and Materials Science* , Pentagon Educational Services, 1st edition 2011

Reference Books

1. James F Shackelford Shackelford, *Materials science for Engineers,*
2. Van Vlack, *Materials science and Engineering, Pearson Education*
3. G. Dieter, *Mechanical Metallurgy,* McGraw Hill Pub.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*
		Maximum Total Marks: 100

ME14 306 Electrical Technology

Teaching scheme **Credits: 4**
3 hours lecture and 1 hour tutorial per week

Objectives

- *To study the operation, performance and characteristics of different types of electrical machines*
- *To familiarise various electrical measuring instruments.*
- *To study an overview of power electronic converters & electric drives*

Module I (12 hours)

Review of transformers – equivalent circuit – phasor diagram – voltage regulation – losses and efficiency – open circuit and short circuit test – Autotransformer – saving of copper – 3 phase transformer - Δ-Δ, Y-Y, Δ - Y, Y - Δ connections – applications.

Principle of indicating instruments – moving coil, moving iron and dynamometer type instruments - principle and working of induction type energy meter

Module II (14 hours)

Power semiconductor devices – symbol & static characteristics of SCR – turn-on by gate triggering – RC-firing circuit – comparison of SCR, power MOSFET & IGBT – Controlled rectifier – 1-phase fully controlled rectifier with R load & waveforms (load voltage & current only) – expression for average output voltage - 1-phase full-bridge inverter with R load & waveforms – expression for RMS output voltage - 1-phase full-wave ac voltage controller with R load & waveforms – expression for RMS output voltage – Step-down dc-dc converter with RL load & waveforms (output voltage & current only) (Reference Book 1 or 2)

Electrical Drives – advantages of electric drives - parts of electrical drives – fundamental torque equation – four quadrant operation – components of load torque - friction, windage & load torques – steady state stability

Module III (13 hours)

Review of DC generators – DC generator on no load – open circuit characteristics –Armature reaction and commutation (basics only) - load characteristics of shunt, series and compound generators – Review of dc motors – performance characteristics of shunt, series and compound motors – starter – need of starter - 3 point starter – losses in DC machines – power flow diagram – efficiency – speed control – armature voltage control of a separately excited dc motor – 1-phase full converter drive.

Review of alternators – distribution and chording factor – EMF equation – armature reaction – phasor diagram – voltage regulation – predetermination of voltage regulation by EMF method

Module IV (13 hours)

Review of 3-phase induction motor – slip – rotor frequency – equivalent circuit – phasor diagram – torque equation – torque-slip characteristics – losses and efficiency – power flow diagram – no-load and blocked rotor tests – starting of 3-phase induction motors – direct-on-line, auto transformer, star-delta and rotor resistance starting - 3-phase induction motor drives – stator voltage control by using a 3-phase AC voltage controller (concept only: no waveform analysis) – stator voltage & frequency control (block diagram approach)

Text Books

1. Ashfaq Hussain, *Electrical Machines*, Dhanpat Rai& Co.

Reference Books

1. P.S. Bimbhra, *Power Electronics*, Khanna Publishers
2. A.K. Gupta, L.P. Singh &AkhileshUpadhyay, *Power Electronics*, DhanpatRai Publishing Co.
3. Dubey G.K., *Fundamentals of Electrical Drives*, Narosa Publishing House
4. VedamSubrahmanyam, *Electric Drives – Concepts & Applications*, Tata McGraw Hill Education
5. A. K. Sawhney, *Electrical and Electronics measuring Instruments*, DhanpatRai& Sons

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class.

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* *Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.*	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* *Two questions from each module with choice to answer one question.*	*4 x 15 marks=60 marks*
		Maximum Total Marks: 100

ME14 307 Computer Assisted Machine Drawing

Teaching scheme: **Credits: 2**

3 hours drawing per week

Objectives

- *To impart the fundamental concepts of machine drawing.*
- *To develop primary knowledge of working drawings.*
- *To produce orthographic drawing of different machine parts.*
- *To develop skill to produce assembly drawings.*
- *To develop skill to produce detailed drawings of machines parts from assembly drawing.*
- *To develop skill to produce drawings by using any standard CAD software.*

Module 0: (6 Hours).

Preparation of working Drawings with specification using any popular drafting software.

Module I (9 hours - 1 Printout, 2 Drawing sheets)

Preparation of Sketch & working drawings for:

a) Joints: Sleeve and cotter joints, knuckle joints, Socket and spigot joints, Flanged hydraulic joints, Lap and butt joint, Zigzag and chain structure.

b) Couplings and pulleys: Solid and split muff couplings, Universal coupling, Flat pulleys, Stepped cone pulleys.

Module II (9 Hrs. - 1 Printouts, 2 Drawing sheets)

Preparation of Sketch & working drawings for:

a) Tolerances and Fits -Hole system and shaft system of tolerances, Indication of dimensional tolerances and fits on simple machine parts - Geometrical tolerances, Indication of geometrical tolerances on simple machine parts, Indication of surface finish on drawings - Preparation of shop floor drawings of simple machine parts.

b) Bearings - Solid journal bearings, Plummer block and footstep bearings.

Module III (15 Hrs. - 3 Printouts, 6 Drawing sheets)

Preparation of Sketch & assembly drawings for :

Stuffing boxes - cross heads, Eccentrics, Petrol Engine connecting rod - Piston assembly - Screws jacks - Machine Vices – Tailstock – Crane hook.

Steam stop valve - Spring loaded safety valve – Blow-off-cock - Gate valve- Glob valve- Ball valve- Non return valve.

Note:

- *University examination (3 Hours) shall be conducted by using drawing instruments only.*
- *All drawing exercises mentioned above are for class work. Additional exercises where ever necessary may be given as home assignments.*

Text Books:

1. N.D. Bhatt and Panchal, *Machine Drawing,Charator Publishing House.*

References:

1. GautamPohit&GautamGhosh, *Machine Drawing with AUTO CAD*, Pearson Education, New Delhi.
2. K.C. John, Machine *Drawing*, Jet Publications, Thrissur.
3. N.D.Junnarkar, *Machine Drawing,* Pearson Education, New Delhi.
4. P.I.Vargheese, *Machine Drawing, VIP Publishers, Thrissur*

Internal Assessment

Printouts = 10
Drawing sheets = 20
Tests = 15
Attendance and Regularity = 05
Total = 50

University examination pattern

Question I:

Answer any one question out of two questions of 25 marks each from (a) and (b) sections of module I.

1 x 25 = 25 marks

Question II: Answer any one question out of two questions of two questions of 30 marks each from (a) and (b) sections of module II.

1 x 30 = 30 marks

Question III: Answer any one question out of two questions of two questions of 45 marks each from (a) and (b) sections of module III.

1 x 45 = 45 marks

Total= 100 marks

ME14 308(P) Electrical Technology Lab

Teaching scheme **Credits: 2**
3 hours practical per week

Objectives

- *To familiarize various electrical measuring instruments*
- *To obtain the performance characteristics of DC and AC machines*

1. Determination of V-I characteristics of linear resistance and incandescent lamp
2. Calibration of 1-phase energy meter (Induction and Static type) by direct loading
3. Measurement of L,M & K of i) transformer windings and ii) air cored coil
4. OC & SC tests on single phase transformer
   a. Determine equivalent circuit parameters
   b. Predetermine efficiency & voltage regulation at various loads and different power factors
5. Load test on single phase transformer to determine efficiency & voltage regulation at various loads and unity power factor
6. Open circuit characteristics of dc shunt generator
   a. Plot OCC at rated speed
   b. Predetermine OCC for other speeds
   c. Determine critical field resistance for a specified speed
   d. Determine critical speed for a specified shunt field resistance
7. Load test on DC shunt generator
   a. Plot external characteristics
   b. Deduce internal characteristics
8. Brake test on DC series motor – plot performance characteristics
9. Brake test on 3-phase squirrel cage induction motor - plot the performance characteristics
10. No-load and blocked rotor tests on 3-phase slip ring induction motor
    a. Determine equivalent circuit parameters
    b. Predetermine the torque, line current and efficiency from equivalent circuit corresponding to a specified slip.
11. OC & SC tests on 3-phase alternator - Predetermine the voltage regulation at various loads and different power factors by EMF method

Internal Continuous Assessment *(Maximum Marks-50)*
60%-Laboratory practical and record
30%- Test/s
10%- Regularity in the class

Semester End Examination *(Maximum Marks-100)*
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

EN14 401A Engineering Mathematics IV

(Common for ME, CE, PE, CH, BT, PT, AM, and AN)

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objective

- *To provide a comprehensive introduction to those models and methods most likely to be encountered and used by students in their careers in engineering.*
- *To provide an introduction to some important partial differential equations*

Module I: Probability Distributions (12 hours)
Random variables – Mean and Variance of probability distributions – Binomial Distribution – Poisson Distribution – Poisson approximation to Binomial distribution – Hyper Geometric Distribution – Geometric Distribution – Probability densities – Normal Distribution – Uniform Distribution – Gamma Distribution.

Module II: Theory of Inference (14 hours)
Population and Samples – Sampling Distribution – Sampling distribution of Mean (σ known) – Sampling distribution of Mean (σ unknown) – Sampling distribution of Variance – Interval Estimation – Confidence interval for Mean – Null Hypothesis and Tests of Hypotheses – Hypotheses concerning one mean – Hypotheses concerning two means – Estimation of Variances – Hypotheses concerning one variance – Hypotheses concerning two variances – Test of Goodness of fit.

Module III: Series Solutions of Differential Equations (14 hours)
Power series method for solving ordinary differential equations – Frobenius method for solving ordinary differential equations – Bessel's equation – Bessel functions – Generating functions (No proof) – Relation between Bessel functions – Orthogonality property of Bessel functions (Proof not required).

Module IV: Partial Differential Equations (12 hours)
Introduction – Formation of PDE – Complete Solution – Equations solvable by direct integration – Linear PDE of First order, Legrange's Equation: $Pp + Qq = R$ – Non-Linear PDE of First Order, $F(p,q) = 0$, Clairaut's Form: $z = px + qv + F(p,q)$, $F(z,p,q) = 0$, $F_1(x,q) = F_2(y,q)$ – Classification of Linear PDE's – Derivation of one dimensional wave equation and one dimensional heat equation – Solution of these equation by the method of separation of variables.

Text Books

Module I: Richard A Johnson, CB Gupta, *Miller and Freund's Probability and statistics for Engineers, 7e,* Pearson Education- Sections: 4.1, 4.2, 4.3, 4.4, 4.6, 4.8, 5.1, 5.2, 5.5, 5.7

Module II: Richard A Johnson, CB Gupta, *Miller and Freund's Probability and statistics for Engineers, 7e,* Pearson Education- Sections: 6.1, 6.2, 6.3, 6.4, 7.2, 7.4, 7.5, 7.8, 8.1, 8.2, 8.3, 9.5

Module III: Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons, Inc.- Sections: 4.1, 4.4, 4.5

Module IV: N Bali, M Goyal, C Watkins, *Advanced Engineering Mathematics, A Computer Approach, 7e,* Infinity Science Press, Fire Wall Media- Sections: 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9 Erwin Kreysig, *Advanced Engineering Mathematics, 8e,* John Wiley and Sons, Inc. Sections: 11.2, 11.3, 9.8 Ex.3, 11.5

Reference books

1. J.S. Chandan, *Statisitcs for Business and Economics,* Vikas Publishing House.
2. Anthony Croft, Robert Davison, Martin Hargreaves, *Engineering Mathematics,* Pearson Education.
3. H Parthasarathy, *Engineering Mathematics, A Project & Problem based approach,* Ane Books India.
4. B V Ramana, *Higher Engineering Mathematics,* McGrawHill.
5. J K Sharma, *Business Mathematics, Theory and Applications,* Ane Books India.
6. John bird, *Higher Engineering Mathematics,* Elsevier, Newnes.

7. Wylie C.R and L.C. Barret, *Advanced Engineering Mathematics*, McGraw Hill.
8. V R Lakshmy Gorty, *Advanced Engineering Mathematics-Vol. I, II.*, Ane Books India.
9. Sastry S.S., *Advanced Engineering Mathematics-Vol. I and II.*, Prentice Hall of India.
10. Michael D Greenberg, *Advanced Engineering Mathematics*, Pearson Education.
11. Babu Ram, *Engineering Mathematics Vol.I & II*, Pearson Education.
12. S.Palaniammal, *Probability and Random Processes*, Prentice Hall of India.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: *Analytical/problem solving SHORT questions* — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

EN14 402 Environmental Science

(Common for all branches)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To understand the problems of pollution, loss of forest, solid waste disposal, degradation of environment, loss of biodiversity and other environmental issues*
- *To create awareness among the students to address these issues and conserve the environment in a better way.*

Module I (13hours)

The Multidisciplinary nature of environmental science. Definition-scope and importance-need for public awareness. Natural resources. Renewable and non-renewable resources: Natural resources and associated problems-forest resources: Use and over exploitation, deforestation, case studies. Timber extraction, mining, dams and their defects on forests and tribal people- water resources: Use and over utilization of surface and ground water, floods, drought , conflicts over water, dams-benefits and problems.- Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.- Food resources: World food problems, changes caused by agriculture over grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.-Energy resources: Growing energy needs, renewable and non-renewable energy resources, use of alternate energy resources, Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Module II (13 hours)

Ecosystems-Concept of an ecosystem-structure and function of an ecosystem – producers, consumers, decomposers-energy flow in the ecosystem-Ecological succession- Food chains, food webs and Ecological pyramids-Introduction, types, characteristics features, structure and function of the following ecosystem-Forest ecosystem- Grassland ecosystem –Desert ecosystem-Aquatic ecosystem(ponds, streams, lakes, rivers, oceans , estuaries)

Biodiversity and its consideration Introduction- Definition: genetic, species and ecosystem diversity-Bio-geographical; classification of India –value of biodiversity: consumptive use, productive use, social ethical , aesthetic and option values Biodiversity at Global, national , and local level-India at mega –diversity nation- Hot spot of biodiversity-Threats to biodiversity: habitat loss, poaching of wild life, man , wild life conflicts – Endangered and endemic species of India-Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Module III (13 hours)

Environmental pollution Definition-Causes, effects and control measures of Air pollution- Water pollution –soil pollution-Marine pollution-Noise pollution-Thermal pollution-Nuclear hazards-Solid waste management: Causes, effects and control measures of urban and industrial wastes-Role of an individual in prevention of pollution. Pollution case studies-Disaster management: floods , earth quake, cyclone and landslides-Environmental impact assessment

Module IV (13 hours)

Environment and sustainable development-Sustainable use of natural resources-Conversion of renewable energy resources into other forms-case studies-Problems related to energy and Energy auditing-Water conservation, rain water harvesting, water shed management-case studies-Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust-Waste land reclamation Consumerism and waste products-Reduce, reuse and recycling of products-Value education.

Text Books:

1. Daniels & Krishnaswamy, Environmental studies, Wiley India pvt ltd, 2009
2. Raman Sivakumar, Introduction to environmental science and engineering, 2nd edn, .Tata McGraw Hill, 2010
3. Anindita Basak, Environmental Studies, Pearson Education, 2009
4. Suresh K.D, Environmental Engineering and Management, Katson Books, 2007
5. Benny Joseph, Environmental studies, 2nd edn, McGraw Hill, 2009

References:

1. Raghavan Nambiar, A Text book of Environmental Studies, Scitech Publishers (India) Pvt. Ltd
2. S.P Misra, S.N Pandey, Essential Environmental studies, An e books, Pvt Ltd, 2009
3. P N Palanisamy, P Manikandan,A Geetha, Manjula Rani, Environmental Science, Pearson Education, 2012
4. D.L. Manjunath, Environmental Studies, Pearson Education, 2011

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

Note: Field work can be Visit to a local area to document environmental assets-river/forest/grass land/mountain or Visit to local polluted site-urban/rural/industrial/agricultural etc. or Study of common plants, insects, birds etc. or Study of simple ecosystems-pond, river, hill slopes etc. or mini project work on renewable energy and other natural resources , management of wastes etc.

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*
		Maximum Total Marks: 100

ME14 403 Thermodynamics

Teaching scheme **Credits: 4**
3 hours lecture and 1 hour tutorial per week

Objectives:

- *To impart the basic concepts of thermodynamics*

Note: Students are permitted to refer property tables and charts of liquids, steam, gases, refrigerants and compressibility chart for the University examination.

Module I (12 Hours)
Basic concepts and definitions – Macroscopic and microscopic approach, Continuum concept, system and control volume, properties, processes and cycles, Method of checking of properties, Quasi-static process, homogeneous and heterogeneous systems, thermodynamic equilibrium, Zeroth law of thermodynamics – measurement of temperature, Temperature scales, Concept of absolute temperature scale.
Different forms of energy- Stored energy and transition energy, work and heat, different types of work transfer, pdV work, Free expansion, First law of thermodynamics, Joule's experiment, First law applied for a cycle and change of state – internal energy and enthalpy, PMM1, first law applied for open system. Steady flow energy equation and applications.

Module II (14 Hours)
Second law of thermodynamics – thermal reservoir, heat engine, Kelvin – Plank and Clausius statement, Equivalence of two statements, PMM2, refrigerator and heat pump, reversibility and irreversibility, Causes of irreversibility, types of irreversibility, Carnot cycle, Carnot's theorem. Entropy, Clausius inequality, Entropy principle and its applications. Available energy, Law of degradation of energy, useful work, dead state, Availability, and irreversibility, Gibb's and Helmholtz function, Second law efficiency, Third law of thermodynamics.

Module III (14 Hours)
Properties of pure substances, p-v, p-T, T-s diagram for a pure substances, critical point and triple point, saturation states, liquid vapour mixtures, dry, wet and superheated steam. Use of steam table and Mollier diagram.
Properties of gases and mixtures – Avogadro's law, Equations of state – ideal gas equation, van der Waal's equation, Redlich Kwong equation, Beattie-Bridgeman equation, Viral expansions, simple problems, Law of corresponding states, Compressibility chart, Properties of mixtures of gases –
Dalton's law of partial pressures, Amagat Leduc law, mole fraction, Cp and Cv of the mixtures, simple problems.
Themodynamic relations – Maxwell's Equations, TdS equations, Joule Thomson effect, Clausius – Clapeyron equation

Module IV (12 Hours)

Thermodynamics of combustion – combustion reaction of common fuels – air-fuel ratio – exhaust gas composition – flue gas analysis – air-fuel ratio from exhaust gas composition – enthalpy of formation – application of first law of thermodynamics to chemically reacting systems – enthalpy and internal energy of combustion – adiabatic flame temperature, application of second law of thermodynamics to chemically reacting systems.

Text Books

1. P.K. Nag, *Thermodynamics*, Tata McGraw Hill, 4th edition
2. R. Yadav, *A Text book on Thermodynamics*, Central Publishing House

Reference Books

1. Sonntag, Van Wylen, *Fundamentals of Thermodynamics*, Sixth edn John Wiley & Sons
2. YunusCengel, *Thermodynamics an Engineering Approach*, Fourth Edition, McGraw Hill
3. Y V C Rao, *An Introduction To Thermodynamics*, Universities Press.
4. John Francis Lee, Francis Weston Sears , A Text book on thermodynamics,
5. Zemansky, A Text book on thermodynamics
6. Spalding &*Cole, Engineering thermodynamics*, ELBS

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 404 Advanced Mechanics of Solids

Teaching scheme **Credits: 4**
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart concepts of stress and strain analysis in a solid.*
- *To study the methodologies in theory of elasticity at a basic level.*
- *To acquaint with energy methods to solve structural problems.*

Module I (14 hours)

Basic equations of elasticity: Stress at a point with respect to a plane – normal and tangential components of stress – stress tensor – Cauchy's equations – stress transformation – principal stresses and planes – strain at a point - strain tensor – analogy between stress and strain tensors – constitutive equations – generalized Hooke's law – relation among elastic constants – equations of equilibrium – strain-displacement relations – compatibility conditions – boundary conditions – Saint Venant's principle for end effects – uniqueness condition.

Module II (12 hours)
2-D problems in elasticity:Plane stress and plane strain problems –Airy's stress function – solutions by polynomial method – solution for bending of a cantilever with an end load.
Equations in polar coordinates – Lame's problem - stress concentration problem of a small hole in a large plate.
Axisymmetric problems – thick cylinders – interference fit – rotating discs.

Module III (13 hours)
Special problems in bending: Unsymmetrical bending of straight beams – shear center of different sections.
Energy methods in elasticity: Strain energy of deformation – special cases of a body subjected to concentrated loads, due to axial force, shear force, bending moment and torque – reciprocal relation –Maxwell reciprocal theorem – Castigliano's first and second theorems – virtual work principle – minimum potential energy theorem - complementary energy.

Module IV (13 hours)
Torsion of non-circular bars: Saint Venant's theory – Prandtle's method - solutions for circular and elliptical cross-sections - membrane analogy - torsion of thin walled open and closed sections – shear flow.

Text Books

1. L. S. Sreenath, *Advanced Mechanics of Solids*, McGraw Hill
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill
3. Dr. L. Govindaraju&Dr. TG Sitharaman, Applied elasticity for Engineers, NPTEL

Reference Books

1. S. P. Timoshenko, J. N. Goodier, *Theory of elasticity*, McGraw Hill
2. J. P. Den Hartog, *Advance Strength of Materials*, McGraw Hill
3. C. K. Wang, *Applied Elasticity*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 405 Fluid Machinery

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives:

- *To impart the basic principles on the relationship between forces and its resulting motion of bodies due to impact of fluid jets.*
- *To understand the working and design principles of hydraulic turbines and pumps.*

Module I (12 Hours)

Vortex flow- Free and Forced vortex. Impact of jet: Integral form of continuity, energy, and momentum equations – impact of jet on flat plates and curved surfaces (stationary & moving) – impact of jet on hinged plate– concepts of relative velocity – velocity triangles – force, work done, and efficiency. Jet propulsion – classification of fluid machinery – performance indices like power and efficiency.

Dimensional analysis: Rayleigh's method – Buckingham's Π method – principles of modeling and similitude.

Module II (14 Hours)

Hydraulic turbines: Impulse and reaction turbines – Pelton wheel – geometry and working performance parameters – conditions for optimum operation – brief description of hydel power plant – surge tank – governing techniques. Radial flow turbine – geometry – working – velocity diagram – net head – draft tube – performance parameters. Axial flow reaction turbine – geometry – working – velocity diagram – net head – performance parameters – draft tube theory – cavitation –specific speed – design and selection criterions.

Module III (14 Hours)

Pumps: Rotodynamic pump - centrifugal pumps – geometry – working – velocity diagram at entry and exit of impellor – output and performance parameters – manometric head – manometric efficiency – overall efficiency – effect of blade angle on pump head – pump performance curves – cavitation – specific speed for pumps – net positive suction head – multistage pumps. Vertical pumps(only principle of operation)

Module IV (12 Hours)

Positive displacement pumps: Geometry – working – pump head – efficiency – discharge variation with crank angle – air vessels – indicator diagrams – theoretical and actual characteristics.

Rotary pumps: Gear pumps and its performance curves – rotary vane pump and its characteristics – screw pumps.

Miscellaneous devices – hydraulic ram, accumulator, intensifier, jet pump, air lift pump.

Text Books

1. R K Bensal, *Fluid mechanics andHydraulic machines,*
2. Jagadish Lal, *Hydraulic machines,*

Reference Books

1. J. F. Douglas, J. M. Gasiorek, J. A. Swaffield, *Fluid Mechanics,* Addison-Wesley.
2. S. L. Dixon, *Fluid Mechanics and Thermodynamics of Turbo Machinerys*, Butterworth and Hienemann.
3. D. G. Shepherd, *Principles of Turbo Machinery,* McMillan.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*
		Maximum Total Marks: 100

ME14 406 Casting and Joining

Teaching scheme Credits: 4
3 hours lecture and 1 hour tutorial per week

Objectives:

- *To provide knowledge on theory of solidification of metals*
- *To acquire knowledge on different casting processes*
- *To impart conception on various welding processes*
- *To understand fundamentals of soldering, brazing, adhesive bonding and ceramic joining.*

Module I (12 Hours)

Introduction- solidification of metals and alloys-homogeneous and heterogeneous nucleation-cast structures-casting alloys- foundries-furnaces and melting practices- pattern- pattern allowances- casting design- gating system design- risering - flow of molten metal in moulds.

Module II (14 Hours)

Casting processes- comparison-sand casting-shell moulding-CO_2 process-expended polystyrene process – plaster mould casting- ceramic mould casting-investment casting-permanent mould casting-slush casting-pressure casting-die casting-centrifugal casting-squeeze casting-semisolid casting- rapid solidification- casting of single crystal components- defects- inspection and testing of castings.

Module III (12 Hours)

Welding processes-classification-welding power source-Duty cycle - Arc characteristics- filler materials-Electrodes- Coding of the electrodes- Classification of electrodes-- metal transfer – solid state-solid liquid state process-OFW, SMAW, SAW, GMAW, FCAW, GTAW, PAW, ESW, EGW, RW, RSEW, HFRW, RPW, FW, SW, PEW, FOW, CW, USW, FRW, EXW, TW, EBW, LBW, DFW- Metallurgy of welding-HAZ-weld quality-weldability - welding defects- inspection and testing of welded joints.

Module IV (14 Hours)

Brazing, Soldering and Adhesive bonding –Physical aspects – Surface energy and contact angle – Capillary action - Theory of soldering and Brazing -Fluxes-Heat sources and heat transfer- Filler materials- Different types of brazing- Braze welding- Adhesives bonding- Contact adhesives- Polyester, polyamide and polyurethane melt adhesives- Toughened acrylic and epoxy adhesives- Silicone adhesives Joint design -Joining of Ceramics - Metal/ceramic joining and ceramic/ceramic joining-Diffusion bonding.

Text Books:

1. R K Jain, *Production technology,*
2. P C Sharma, *Manufacturing Technology.*

Reference Books:

1. C. Davies, *The Science and Practice of Welding*, Addison Wesley 2001
2. American welding society, *Welding Hand book, Welding, Brazing and Soldering*
3. Haine R W, Loper C R Jr.& Rosenthal P C, *Principles of metal casting*, Tata McGraw Hill
4. Lancaster. J.F, *The metallurgy of welding*, George Allen and Unwin Ltd.
5. P Khanna, *Welding Metallurgy*
6. R.S.Parmar, *Welding processes and Technology*, Khanna Publishers, New Delhi
7. Serope Kalpakjian, *Manufacturing Engineering and Technology*, Addison Wesley.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: *Analytical/problem solving SHORT questions* *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 407(P) Material Testing Lab

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

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

List of Experiments

1. Standard tension test on mild steel using Universal Testing Machines and suitable extensometers
2. Stress-strain characteristics of brittle materials – cast iron
3. Spring test – open and closed coiled springs – determination of spring stiffness and modulus of rigidity
4. Determination of modulus of rigidity of wires
5. Hardness tests – Brinnell hardness, Rockwell hardness (B S C scales), Rockwell superficial hardness (N & T scales), and Vickers hardness
6. Impact test – Izod and Charpy
7. Bending test on wooden beams
8. Fatigue testing – study of testing machine
9. Photo elastic method of stress measurements (two dimensional problems)
10. Torsion test on mild steel rod
11. Shear test on mild steel rod

Reference Books

1. G. E. Dieter, *Mechanical Metallurgy*, McGraw Hill.
2. J. W. Dally, W. P. Railey, *Experimental Stress Analysis*, McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-50)*

60%-Laboratory practical and Record *(30 marks)*
30%- Test/s *(15 marks)*
10%- Regularity in the class *(5 marks)*

Semester End Examination *(Maximum Marks-100)*

70% - Procedure, conducting experiment, results, tabulation, and inference (70 marks)
20% - Viva voce (20 marks)
10% - Fair record (10 marks)

ME14 408(P) Production Engineering Lab – I

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To acquaint with the basics of centre lathe and CNC lathe.*
- *To impart training on centre lathe and CNC lathe.*

Study of Machines

1. Study of machine tools and machining processes – specification of machine tools – power sources.
2. Study of centre lathe – general features, parts and functions – different machining operations on centre lathe – turning, taper turning, thread cutting, drilling, boring, reaming, tapping, profile turning, knurling.
3. Study of tolerances and surface finish – measuring tools and gauges.
4. Study of tolerances and surface finish – measuring tools and gauges.
5. Study of CNC lathe.

Exercises

1. Exercises on centre lathe requiring simple turning, taper turning, knurling, boring and thread cutting.
2. Exercises on centre lathe including multi-start thread, square thread, and internal thread.
3. Exercises on CNC lathe: Turning, step turning

Reference Books

1. W. A. J. Chapman, *Workshop Technology Part I*, ELBS & Edward Arnold Publishers.
2. R. Quesada, T. Jeyapoovan, *Computer Numerical Control*, Pearson Education
3. J. Anderson, *Shop Theory*, Tata McGraw Hill.
4. K. Venkata Reddy, *Workshop Practical*, Vipaka Publishers
5. E. D. Lawrence, *Manufacturing Processes & Materials for Engineers*, Prentice Hall

Internal Continuous Assessment *(Maximum Marks-50)*

60%-Workshop practical (models) and Record (30 marks)
30%- Test/s (15 marks)
10%- Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-100)*

70% - Making of models considering completion, dimensional accuracy, finishing, methods, choice of proper tools etc. (70 marks)
20% - Viva voce (20 marks)
10% - Fair record (10 marks)

ME14 501 Engineering Economics and Principles of Management

(Common for ME, AI, AM, PT, PE, CE, CS, EC, EE, BM and IC)

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Section 1 Engineering Economics
Teaching scheme **Credits:** 2
2 hour lecture per week

Objective

□ *The prime objective of the Engineering Economics course is to make students familiar with the economic way of thinking. This course provides the students with the foundations of economic theory, tools and techniques for use in the process of efficient economic decision-making in their engineering and managerial profession.*

Module1 (14 Hrs)

Introduction to Economics and Engineering Economics – Role of economics in engineering decision making- Basic economic problems-Factors of production- Circular Flow in an economy- Basic terms and concepts - Goods- utility- price-value-wealth
Technical efficiency, Economic efficiency. Law of supply and demand , Market equilibrium. Elasticity of demand –Markets (perfect competition, monopoly and monopolistc competition)
Money and banking-Functions of Money- Inflation and Deflation: Concepts and regulatory measures – Monetary policy and Fiscal policy. Commercial and central banking

Module II (12 Hrs)

National Income Concepts: GDP and GNP, Per capita income, Methods of measuring national income. Taxation-canons of taxation
Forms of business organizations proprietorship-partnership-joint-stock company-co-operative organisation
Indian Economy-Over view of post independence period-Role of agriculture and industry in economic development with reference to Indian economy - Economic policy reforms since 1991
Stages of economic development- Features of under development with reference to India.
International trade-Free trade Vs protection-Balance of payment

Text Books

1. Ruddar Datt, Indian Economy, S.Chand and Company Ltd.

2. K.K.Dewett, Modern Economic Theory, S.Chand and Company Ltd.

3. Panneer Selvam, R, "*Engineering Economics*", Prentice Hall of India Ltd, New Delhi, 2001.

References

1. Paul Samuelson, Economics, Tata McGraw Hill

2. Terence Byres, The Indian Economy, Oxford University Press

3. S.K.Ray, The Indian economy, Prentice Hall of India

4. Campbell McConnel, Economics, Tata McGraw Hill

5. Chan S. Park, "*Contemporary Engineering Economics*", Prentice Hall of India, 2002

Reference Books

1. Sullivan, W.G, Wicks, M.W., and Koelling. C.P., "*Engineering Economy 15/E*", Prentice Hall, New York, 2011.
2. Chan S. Park, "*Contemporary Engineering Economics*", Prentice Hall of India, 2002.
3. Prasanna Chandra, "*Financial Management: Theory & Practice, 8/E*", Tata-McGraw Hill, 2011.

Internal Continuous Assessment *(Maximum Marks-25)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern for Section 1

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer FOUR questions out of FIVE. There shall be minimum of TWO and maximum of THREE questions from each module with total FIVE questions.	*4x 5 marks=20 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*2 x 15 marks=30 marks*
		Maximum Total Marks: 50

Section 2 Principles of Management

Teaching scheme **Credits:** 2

1 hour lecture and 1 hour tutorial per week

Objective

- *To provide knowledge on principles of management, decision making techniques, accounting principles and basic management streams*

Module I (12 hours)

Principles of management – Evolution of management theory and functions of management Organizational structure – Principle and types. Decision making – Strategic, tactical & operational decisions, decision making under certainty, risk & uncertainty and multistage decisions & decision tree Human resource management – Basic concepts of job analysis, job evaluation, merit rating, wages, incentives, recruitment, training and industrial relations.

Module II (14 hours)

Financial management – Time value of money and comparison of alternative methods. Costing – Elements & components of cost, allocation of overheads, preparation of cost sheet, break even analysis. Basics of accounting – Principles of accounting, basic concepts of journal, ledger, trade, profit &loss account and balance sheet. Marketing management – Basic concepts of marketing environment, marketing mix, advertising and sales promotion. Project management – Phases, organisation, planning, estimating, planning using PERT & CPM .

Reference Books

1. F. Mazda, *Engineering management*, Addison Wesley, Longman Ltd., 1998
2. Lucy C Morse and Daniel L Babcock, *Managing engineering and technology*, Pearson, Prentice Hall
3. O. P. Khanna, *Industrial Engineering and Management*, Dhanpat Rai and Sons, Delhi, 2003.
4. P. Kotler, Keller, Koshy, Jha, *Marketing Management: Analysis, Planning, Implementation and Control*, Pearson, 13th Edition, 2013
5. Venkata Ratnam C.S & Srivastva B.K, *Personnel Management and Human Resources*, Tata McGraw Hill.
6. Prasanna Chandra, *Financial Management: Theory and Practice*, Tata McGraw Hill.
7. Bhattacharya A.K., *Principles and Practice of Cost Accounting*, Wheeler Publishing
8. Weist and Levy, *A Management guide to PERT and CPM*, Prantice Hall of India
9. Koontz H, O"Donnel C & Weihrich H, *Essentials of Management*, McGraw Hill.
10. Ramaswamy V.S & Namakumari S, *Marketing Management : Planning, Implementation*
11. Robbins S, Coulter M, Vohra N, *Management*, Pearson, 10th edition, 2013.

Internal Continuous Assessment *(Maximum Marks-25)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern for Section 2

PART A: *Analytical/problem solving SHORT questions* — *4x 5 marks=20 marks*

Candidates have to answer FOUR questions out of FIVE. There shall be minimum of TWO and maximum of THREE questions from each module with total FIVE questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* — *2 x 15 marks=30 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 50

Note: Section 1 and Section 2 are to be answered in separate answer books

Maximum 50 marks each for Section 1 and Section 2

ME14 502 Metal Cutting and Forming

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives:

- *To impart fundamental knowledge on theory of machine tools, metal cutting principles, advanced machining processes and press working operations.*

Module I (12Hours)

Metal cutting: cutting variables - mechanics of chip formation - types of chips produced - orthogonal and oblique cutting –velocity relationships - cutting forces – cutting power temperature in cutting – single point and multipoint tools – tool geometry - tool designation – tool wear and tool life – machinability – cutting tool materials - cutting fluids - economics of machining.

Module II (12 Hours)

Machining Process – tool-work motion – turning – parameters – lathes and lathe operations – material removal rate – cutting force – Milling – parameters – up milling and down milling – power - torque – cutting forces – drilling – drills – material removal rate – cutting forces – reaming – broaching – tapping – boring – planning – shaping – slotting – grinding – cylindrical and surface grinding- grinding wheels – wheel wear.

Module III (14 Hours)

Advanced Machining Processes: Electrical Discharge Machining - wire EDM – Electro Chemical machining – laser beam machining – abrasive jet machining – ultrasonic machining - electron beam machining – plasma arc machining – water jet machining – nano fabrication – micro machining – machining time - economics of advanced machining process.

Module IV (14 Hours)

Press working operations – types of presses – press selection – press working terminology – forming - principles – cutting forces – dies and punches –clearance – constructional features – simple, compound, combination & progressive dies – strippers - scrap strip layout – centre of pressure – press tonnage – drawing - drawing forces – blank holding pressure – bending force – die blank size estimation – forging – forgeability – open and closed die forging – forging force – grain flow – extrusion – explosive forming – electro hydraulic forming – electromagnetic forming. - rolling - extrusion.

Text books

1. SeropeKalpakjaian, Steven R. Schmid., *Manufacturing Engineering and Technology*, Pearson, New Delhi.
2. Sharma. P C, *A Text book of Production Engineering*, S. Chand & Co.
3. Jain .R K, *Production Technology*, Khanna Publishers.

Reference Books

1. HMT, *Production Technology*, Tata McGraw Hill Pvt. Ltd.
2. ASTME, *Fundamentals of Tool Design*, Prentice Hall of India

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 503 Heat and Mass Transfer

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of various modes of heat and mass transfer.*
- *To develop understanding about the method of determination of heat transfer rates in conduction, convection and radiation*

Module I (13 hours)

Conduction: Introduction - basic modes of heat transfer – conduction – general heat conduction equation in Cartesian, cylindrical and spherical coordinates – one dimensional steady state conduction with and without heat generation – critical thickness of insulation – extended surface heat transfer – fin performance – effect of variable thermal conductivity. Two dimensional steady state conduction through plane wall – conduction shape factor. Unsteady state conduction in one dimension – lumped heat capacity system – semi infinite solid with sudden and periodic change in surface temperature.

Module II (13 hours)

Convection: Newton's law – concept of boundary layer – significance of Prandtl number – boundary layer equations – flat plate heat transfer solutions by integral method – laminar and turbulent flow – Reynolds analogy – empirical relations in forced convection – internal flow – boundary conditions – laminar and turbulent flow – heat transfer coefficients – empirical correlations. Natural convection – heat transfer from vertical plate by integral method – empirical relation in free convection. Condensation and boiling heat transfer – film and drop wise condensation – film boiling and pool boiling – boiling curve – empirical relations for heat transfer with change of phase.

Module III (13 hours)

Radiation: Fundamentals of radiation – radiation spectrum – thermal radiation – concept of black body and grey body – monochromatic and total emissive power – absorptivity, reflectivity and transmissivity - laws of radiation – radiation between two surfaces – geometrical factors for simple configuration – radiation shields – electrical network method of solving problems.

Module IV (13 hours)

Heat exchangers: Classification – log mean temperature difference – overall heat transfer coefficient – fouling and scaling of heat exchangers – LMTD and NTU method of performance evaluation of heat exchangers. Introduction to mass transfer – Fick's law of diffusion – isothermal evaporation into air – mass transfer coefficients.

Text Books

1. F. P. Incropera, *Fundamentals of Heat and Mass Transfer*, John Wiley.
2. Sachdeva, *Heat and Mass Transfer,* New Age International.
3. Fundamentals of Heat& Mass Transfer, Sarit.K.Das, Alpha Science International Ltd

Reference Books

1. Holman, *Heat and Mass Transfer*, McGraw Hill.
2. Mahesh M Rathore, *Heat and mass transfer.*
3. P. K. Nag, *Heat Transfer*, Tata McGraw Hill.
4. D. S. Kumar, *Heat and Mass Transfer,* Prentice Hall of India
5. Younus A Cengel, Heat Transfer , Tata McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*
		Maximum Total Marks: 100

ME14 504 Mechanics of Machinery

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

To provide knowledge on kinematics of selected mechanisms, design of cams, Theory and Analysis of gears, Gear Trains and Synthesis of Mechanisms. These are the topics based on which the student will develop the design and practical problem solving skills in the area of Mechanisms in the future courses.

Module I (14 hours)

Introduction to kinematics and mechanisms - Various mechanisms, kinematic diagrams, degree of freedom- Grashof's criterion, inversions of four bar, single slider crank and double slider crank linkages, Coupler curves - straight line mechanisms exact, approximate – Ackerman Steering Mechanism – Hooke's joint – Intermittent motion mechanisms like ratchet mechanism, Geneva Mechanism - Mechanical advantage, Transmission angle - Instant centre –Kennedy's theorem - Displacement Velocity and Acceleration analysis - Relative motion – Relative velocity - Relative acceleration - Coriolis acceleration – Graphical and analytical methods – Complex number methods - Computer oriented methods

Module II (12 hours)

Cams - Classification of Cam and followers - Displacement diagrams, Velocity and Acceleration analysis of Simple Harmonic Motion, Uniform Velocity, Uniform acceleration, Cycloidal – Graphical Cam profile synthesis –Pressure angle- Analysis of Tangent cam with roller follower and Circular cam with flat follower- Introduction to Polynomial cams

Module III (14 hours)

Gears – Terminology of Spur gears – Law of Gearing - Involute spur gears - Involutometry – Contact ratio - Interference - Backlash - Gear standardization - Interchangeability - Non-standard gears Centre distance modification, Long and Short Addendum system. - Internal gears - Theory and details of bevel, helical and worm gearing - Gear trains - Simple and Compound gear trains - Planetary gear trains – Differential -Solution of planetary gear train problems - Applications

Module IV (12 hours)

Kinematic synthesis (Planar Mechanisms) - Tasks of kinematic synthesis – Type, Number and dimensional synthesis – Precision points - Graphical synthesis for motion - Path and prescribed timing - Function generator – 2 position and 3 position synthesis – Overlay Method - Analytical synthesis techniques Freudenstein's equation – Complex number methods - One case study in synthesis of mechanism

Text Books

1. J. E. Shigley, J. J. Uicker, *Theory of Machines and Mechanisms*, McGraw Hill
2. S. S. Rattan, *Theory of Machines*, 2nd Edition,, Tata McGraw Hill

Reference Books

1. C. E. Wilson, P. Sadler, *Kinematics and Dynamics of Machinery*, 3rd edition, Pearson Education.
2. Ghosh, A. K. Malik, *Theory of Mechanisms and Machines*, Affiliated East West Press
3. G. Erdman, G. N. Sandor, *Mechanism Design: Analysis and synthesis Vol I & II*, Prentice Hall of India
4. D. H. Myskza, *Machines and Mechanisms Applied Kinematic Analysis*, Pearson Education.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A: *Analytical/problem solving SHORT questions* — *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* — *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 505 Internal Combustion Engines

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

To provide knowledge on actual engine cycles, components of SI and CI engines, performance testing of IC engines , theory of combustion in IC engines, fundamental principles of air compressors.

Module I (13 hours)

Internal combustion engines – Engine classification and nomenclature - four stroke and two stroke - spark ignition and compression ignition - valve timing diagram - air standard cycles - Otto, Diesel and Duel combustion cycles –comparison between Otto, Diesel and Dual cycles- actual engine cycles - effect of dissociation - variable specific heats and heat losses - scavenging - objectives - effects and methods. Sterling Cycle, Atkinson Cycle.

Module II (14 hours)

Systems and components of I C engines - fuel systems - ignition systems - cooling - starting - lubrication - governing of IC engines - supercharging of SI and CI engines - turbocharging - exhaust emissions of IC engines - alternate potential engines - free piston engine - Wankel engine and stratified charged engine –
Modern concepts of IC engines – CRDI, MPFI, GDI, VVT.

Module III (12 hours)

Performance characteristics of SI and CI engines –constant speed and variable speed characteristics- heat balance test - Morse test - retardation test-volumetric efficiency-mean effective pressure-specific fuel consumption-fuel air ratio

Fuels-SI engine fuels-CI engine fuels-rating of fuels-Octane rating and Cetane rating-alternate fuels-alcohol-methanol-ethanol-hydrogen-natural gas-CNG-LPG-bio gas-producer gas and bio diesel.

Module IV (13 hours)

Combustion in SI engines - flame propagation - normal and abnormal combustion - detonation - pre ignition - after burning - fuel rating –Octane number- additives in petrol - combustion chambers of SI engines.

Combustion in CI engines - phase of normal combustion - diesel knock - effect of engine variables on diesel knock - Cetane number - additives in diesel - combustion chambers of CI engines-IC Engine exhaust emission control-standards.

Text Books

1. Ganesan V., *Internal Combustion Engines*, Tata McGraw Hill
2. Mathur and Sharma,*A Text book on Internal Combustion Engines.*
3. Obert, *A text book on Internal Combustion Engines and Air Pollution.*

Reference Books

1. Rogowsky, *Elements of Internal Combustion Engines*, Tata McGraw Hill
2. Gill, Smith, Ziurys, *Fundamentals of Internal Combustion Engines*, Oxford and IBH
3. Maleev, *Internal Combustion Engine Theory and Design*, McGraw Hill
4. Judge, *Modern Petrol Engines*, Chapman & Hall
5. Benson, Whitehouse, "Internal Combustion Engines" Vol. I & II, Pergamon press
6. Mathur, Mehta, *Thermodynamics and Heat Power Engineering*, Vol. I & II
7. John B.Heywood, Internal Combustion Engine Fundamentals, Tata McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: *Analytical/problem solving SHORT questions* — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 506 Computational Methods in Engineering

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of various numerical methods in engineering.*
- *To develop understanding about the method of applying numerical techniques with the help of computers for solving complex problems.*

Pre-requisites: *Basic knowledge of engineering mathematics*

Module I (13 hours)

Errors in numerical calculations: Sources of errors, significant digits and numerical instability – numerical solution of polynomial and transcendental equations – bisection method – method of false position – Newton-Raphson method – fixed-point iteration – rate of convergence of these methods – iteration based on second degree equation – the Muller's method – Chebyshev method – Graeffe's root squaring method for polynomial equations – Bairstow method for quadratic factors in the case of polynomial equations.

Module II (13 hours)

Solutions of system of linear algebraic equations: Direct methods – Gauss elimination and Gauss-Jordan methods – Crout's reduction method – error analysis – iterative methods – Jacobi's iteration – Gauss- Seidal iteration – relaxation method – convergence analysis – solution of system of nonlinear equations by Newton-Raphson method – power method for the determination of Eigen values – convergence of power method. Solution of tri-diagonal system – Thomas algorithm.

Module III (13 hours)

Polynomial interpolation: Lagrange's interpolation polynomial – divided differences – Newton's divided difference interpolation polynomial -- error of interpolation – finite difference operators – Gregory- Newton forward and backward interpolations – Stirling's interpolation formula – interpolation with a cubic spline – numerical differentiation – differential formula in the case of equally spaced points – numerical integration – trapezoidal and Simpson's rules – Gaussian integration – errors of integration formulae.

Module IV (13 hours)

Numerical solution of ordinary differential equations: Taylor series method – Euler and modified Euler methods – Runge-Kutta methods (2nd order and 4th order only) – multistep methods – Milne's predictor-corrector formulae – Adam-Bashforth and Adam-Moulton formula – solution of boundary value problems in ordinary differential equations – shooting method – finite difference methods for solving two dimensional Laplace's equation for a rectangular region – finite difference method of solving heat equation and wave equation with given initial and boundary conditions.

Text Books

1. Chapra and Canale, *Numerical methods for scientist and engineers,* McGraw Hill.
2. James B. Scarborough, *Numerical Mathematical Analysis*, Oxford and IBH Publishing.

Reference Books

1. Froberg, *Introduction to numerical analysis*, Addison Wesley.
2. Kandaswamy, *Numerical Analysis*, S Chand
3. Hildebrand, *Introduction to Numerical Analysis,* Tata McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*
		Maximum Total Marks: 100

ME14 507(P) Fluids Lab

Teaching scheme **Credits:** 2

3 hours lab per week

Objectives

- *To strengthen the knowledge on fluid mechanics principles, and hydraulic machinery through lab experiments.*
- *To equip the students to carry out independent experiments, and to train them to analyse, report and infer the results.*

List of Experiments

1. Study of plumbing tools and pipe fittings
2. Measurement of metacentric height and radius of gyration of floating bodies
3. Measurement of viscosity of fluids
4. Study of discharge measuring instruments
5. Measurement of pressure and velocity
6. Calibration of venturimeter, orifice meter, notches and weirs, nozzle meters, and rotameters
7. Pipe friction – minor losses in pipes - verification of Bernouli's theorem
8. Demonstration of laminar and turbulent flow in pipes – critical velocity
9. Experiment on flow through open channels – venturiflume
10. Demonstration of forces on curved and plane surfaces
11. Evaluation of torque & performance of turbines – main& operating characteristics – Muschel's curves
12. Performance of pumps: Centrifugal pumps, Reciprocating pumps, Gear pumps, Hydraulic ram, Torque converter.

Reference Books

1. H. Shames, *Fluid Mechanics*, 4th Edition, McGraw Hill
2. J. P. Holman, *Experimental methods for Engineers*, McGraw Hill
3. D. G. Shepherd, *Principles of Turbo Machinery*, McMillan

Internal Continuous Assessment *(Maximum Marks-50)*

60%-Laboratory practical and Record (30 marks)
30%- Test/s (15 marks)
10%- Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-100)*

70% - Procedure, conducting experiment, results, tabulation, and inference (70 marks)
20% - Viva voce (20 marks)
10% - Fair record (10 marks)

ME14 508(P) Production Engineering Lab-II

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To acquaint with basic machine tools.*
- *To impart training on shaper, slotting, milling and grinding machines.*

Introduction:

a) Limits, fits and tolerances.
b) Shaping machine – slotting machine – horizontal milling machine – surface, centreless and cylindrical grinding.
c) Spindle drives – milling cutter – indexing head.
d) Simple, compound, differential and angular indexing.

Study of machines:

a) Shaper
b) Planer
c) Slotting machine
d) Drilling machine
e) Milling machine
f) Grinding machine
g) Power saws

Exercises:

1. Exercises on shaper and slotting machines – cube with V-groove, slot and guide ways.
2. Exercise on milling machine – spur gear and helical gear milling by simple and differential indexing, surface milling, slot and key way milling.
3. Exercise on grinding and tool grinding

Reference Books

1. HMT, *Production Technology,* Tata McGraw Hill.
2. ASTME, *Tool Engineers Hand Book.*
3. Burghardt, Asilered, Anderson, *Machine Tool Operations I & II*, McGraw Hill.
4. W. A. J. Chapman, *Workshop Technology: Part 2*, CBS Publishers.
5. R. V. Rao, *Metal Cutting and Machine Tools*, S K Kataria& Sons

Internal Continuous Assessment	*(Maximum Marks-50)*
60%-Workshop practical (models) and Record	(30 marks)
30%- Test/s	(15 marks)
10%- Regularity in the class	(5 marks)

Semester End Examination	*(Maximum Marks-100)*
70% - Making of models considering completion, dimensional accuracy, finishing, methods, choice of proper tools etc.	(70 marks)
20% - Viva voce	(20 marks)
10% - Fair record	(10 marks)

ME14 601 Gas Dynamics & Jet Propulsion

Teaching scheme **Credits: 4**

3 hours lecture and 1 hour tutorial per week

Objectives:

- *To impart concept of compressible fluid flow and flow through duct and nozzle under various conditions.*
- *To provide knowledge on jet propulsion and rocket propulsion.*

Note: Students are permitted to refer gas tables/charts for the University examination.

Module I (13 hours)

Introduction to compressible flow – continuity, momentum and energy equations for compressible flow – equation for acoustic velocity – Mach number – flow regimes – Mach angle – Mach cone – wave propagation in incompressible, subsonic, sonic and supersonic flows.

One dimensional isentropic flow with variable area – stagnation properties – reference velocities – dimensionless Mach number M*- Compressibility factor & effect of Mach number on compressibility – impulse function and thrust – area velocity relation – chocking – mass flow rate for chocked flow – operation of convergent and convergent-divergent nozzle under varying pressure ratio – over expanded and under expanded mode.

Module II (13 hours)

Flow with normal shock waves – Prandtl-Mayer relation - Rankine-Hugoniot equations – change of entropy across normal shock – impossibility of a shock in subsonic flow.

Flow with oblique shock waves – nature of flow through oblique shock waves – Prandtl's equation - Rankine-Hugoniot equations – change of entropy across oblique shock – oblique shock relations from the normal shock equations – θβm curves – shock polar diagram.

Module III (13 hours)

Adiabatic flow through constant area duct with friction – equation of fanno line – illustration of fanno line on h-s diagram – chocking due to friction, effect of friction on flow parameters

Isothermal flow with friction-governing equations.

Flow through constant area duct with heat transfer – equation of Rayleigh line – illustration of Rayleigh line on h-s diagram – condition for maximum heat transfer - thermal chocking, effect of heat transfer on flow parameters.

Module IV (13 hours)

Aircraft propulsion – types of aircraft engines – turbo-prop engine – turbojet engine – turbofan engine – aircraft propulsion theory – propeller thrust and jet thrust – propulsive, thermal and overall efficiencies – specific fuel consumption, specific thrust and impulse - ramjet engine – pulsejet engine.

Rocket propulsion – types of rocket engines – liquid propellant rocket engines - solid propellant rocket motors – rocket propulsion theory – rocket applications.

Text books

1. S.M. Yahya, Fundamentals of compressible fluid flow with aircraft and rocket propulsion, New Age International publishers

Reference books

1. P. Balachandran, fundamentals of compressible fluid dynamics, PHI learning pvt. Ltd.
2. John d. Anderson,jr., modern compressible flow with historical perspective, Mcgraw-hill publishing company
3. A. H. Shapiro, dynamics and thermodynamics of compressible flow, ronald press
4. M.j. Zucro&d.h. Holfman, gas dynamics, Mcgraw-hill publishing company
5. V. Babu, fundamentals of gas dynamics, ane books pvt. Ltd.
6. E. Radhakrishnan, gas dynamics, prentice hall of indiapvt. Ltd.
7. ZoebHussain, Gas Dynamics

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern
PART A: Analytical/problem solving SHORT questions — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 602 Metrology & Instrumentation

Teaching scheme Credits: 4
3 hours lecture and 1 hour tutorial per week

Objectives
- *To provide the fundamental concepts and principles of metrology and instrumentation*
- *To impart the various methods of measurement of physical and mechanical quantities*

Module I (13 hours)
Mechanical measurement – direct comparison and indirect comparison –classification – Generalized Measurement system – types of input quantities – measurement standards – calibration – uncertainty – classifications of errors
Static performance characteristics– introduction to uncertainty – propagating uncertainty Kline and Mclintock approach – Zero, First and Second order instruments –Response of Zero, First & Second order instruments to Step, Ramp and Sinusoidal inputs-methods of correcting for spurious inputs – inherent insensitivity – high gain feedback – signal filtering and opposing inputs.

Module II (13 hours)
Sensors – loading error – primary and secondary transducers – variable resistance transducers - sliding contact devices – variable inductance elements – self-inductance and mutual inductance elements – differential transformer – construction and characteristics – rotary differential transformer –variable reluctance transducer – capacitance transducers – active and passive transducers – piezo electric transducers – photoelectric sensors – Hall Effect transducers – Resistance wire strain gages – types – theory of metallic strain gauges — calibration of strain gauges – application of strain gauges-load cells

Module III (13hours)
Measurement of temperature – liquid in glass thermometer – partial and total immersion thermometers – resistance thermometers – constructional details – resistance thermometer circuits – lead wire compensation for resistance thermometers – thermistors – constructional details – Thermo electric thermometers – laws of thermocouples – industrial thermocouples and their ranges – making of thermocouple junctions – ambient temperature compensation- use of extension wires. Pyrometers – optical, total radiation and photo electric pyrometers – linear Quartz thermometer
Measurement of flow – need for flow metering – rotameter – theory and constructional details – magnetic flow meters – hotwire anemometers –Measurement of low pressure – McLeod gauge – thermal conductivity gauge – measurement of high pressure – bulk modulus gauge

Module IV (13 hours)

Linear and angular measurement: Spring calipers, Vernier calipers and micrometers – slip gauges - Measurement of angles – sine bar – sine center – Sources of error – angle gauges – optical instruments for angular measurement- auto collimator – applications – straightness and squareness –angle dekkor – precision spirit levels – Clinometers

Measurement of surface roughness – surface texture – primary texture – secondary texture and the lay specification for surface textures – methods of measuring surface finish . The Talysurf instrument – the profilograph – Tomlinson surface meter – Tracer type profilograph – Measurement of screw thread profiles – errors in pitch– microscopic method – measurement of internal thread – measurement of effective diameter – two wire and three wire method – measurement of root diameter – gear tooth measurement – measurement of gear profile – tooth thickness – tooth spacing – pitch circle diameter – Parkinson"s gear tester.

The coordinate measuring machine construction – operation and programming – Machine vision

Image acquisition and digitization - image processing and analysis

Text Books

1. Ernest O. Doebelin, *Measurement Systems Application and Design*, McGraw-Hill Publishing Company
2. Thomas G Beckwith, Roy D M, John H L, *Mechanical Measurements*, 6/E , Pearson Prenticé Hall
3. Jain R.K., *Engineering Metrology*, Khanna Publishers, Delhi
4. Holman J.P., *Experimental Methods for Engineers*, McGraw Hill Co

Reference Books

1. R K Jain, *Mechancial& Industrial Measurements*, Khanna Publishers, Delhi
2. D S Kumar, *Mechanical Measurements*, Prentice Hall of India.
3. A.K. Thayal; *Instrumentation and mechanical measurements*
4. Figliola, Richard S, & Beasley, Donald E, "*Theory and Design for Mechanical Measurements*", Third edition, John Wiley & Sons Inc
5. Collett, CV, & Hope, AD, "*Engineering Measurements*", Second edition, ELBS/Longman.
6. R.K. Rajput; *Mechanical Measurement and Instrumentation*; S.K. Kataria and Sons
7. RegaRajendra; *Principles of Engineering Metrology*; Jaico Publication
8. R.K. Rajput; *Engineering Metrology and Instrumentation*; S.K. Kataria and Sons
9. I. C. Gupta, *A text book of Engineering Metrology*; DhanpatRai Publications
10. ASME, *Hand book of Industrial Metrology*

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

8x 5 marks=40 marks

PART A: Analytical/problem solving SHORT questions
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

4 x 15 marks=60 marks

PART B: Analytical/Problem solving DESCRIPTIVE questions
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 603 Dynamics of Machinery

Teaching scheme **Credits: 4**

3 hours lecture and 1hour tutorial per week

Objectives

- *To impart knowledge on Force analysis of machinery, balancing go f rotating and reciprocating masses, Gyroscopes, Energy fluctuation in Machines. This forms the second part of the basic needed in the area of Mechanisms for Design courses in future.*
- *To introduce the fundamentals in Vibration, Vibration analysis of Single degree and multi degree freedom systems.*
- *To impart knowledge required to understand the physical significance and design parameters related to vibration in mechanical systems.*

Module I (12 hours)

Static Force analysis of plane motion mechanisms – Conditions of equilibrium - Graphical method – Static force analysis with friction – Friction circle - Force Analysis of Spur, Helical, Bevel and Worm gear –Analytical methods like Matrix methods, method of virtual work and Superposition principle

Dynamic force analysis of plane motion mechanisms- D'Alembert's principle-Determination of inertia forces –Graphical method-Complex number method-shaking forces-Dynamics of reciprocating engines- Turning moment on the crank shaft-effect of inertia of the piston, crank and connecting road in turning moment- Equivalent system of the connecting rod-Graphical analysis using Klein's construction

Module II (14 hours)

Balancing – static and dynamic balancing –balancing of masses rotating in several planes – Balancing of reciprocating masses – Analytical conditions for the balancing of reciprocating engines-Primary forces and secondary forces – primary moments and secondary moments-Partial balancing of locomotives-balancing of multi-cylinder in-line engines, V-engines-radial engines – Concept of direct crank and reverse crank– balancing machines.

Gyroscope – Gyroscopic action and reaction couples – Effect of gyroscopic couple on bearing reactions- Effect of gyroscopic couple on wheel reactions of two wheeled and four wheeled vehicles-- Gyroscopic Stabilization of ships and aeroplanes Fly wheel analysis –Coefficient of fluctuation of speed- Calculation of the flywheel mass.

Module III (12 hours)

Introduction to vibrations – Undamped free vibrations of single degree freedom systems – Energy Method – Single degree freedom torsional Systems - Damped free vibrations – Viscous damping – Critical Damping – Logarithmic Decrement – Coulomb damping

Harmonically excited vibrations – Response of Undamped and Damped system -Vibration due to unbalance - Analysis of vibration due to support motion -Transmissibility and isolation – whirling of shafts (only undamped system) – Critical speed.

Module IV (14 hours)

Free vibrations of undamped two degree of freedom systems – Generalized coordinates-Frequency equations - Lagrange's equation of motion – Beat phenomenon - Coordinate coupling - Equations of Motion for Forced Vibration – Dynamic vibration absorbers

Torsionally equivalent shaft - Free vibration of two and three rotor systems – Geared system-Determination of Mode shape-Fundamental natural frequency of loaded beams through Dunkerley's Empirical equation-Rayleigh's rule.

Vibration measurement - accelerometer – seismometer – vibration exciters- Vibration control-Vibration nomograph and Vibration criteria-Vibration Isolation

TextBooks

1. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, Mc Graw Hill
2. Singiresu S. Rao, "Mechanical Vibrations", Pearson Education, Fourth Edition, 2004

ReferenceBooks

1. S. S. Rattan,Theory of Machines, 2nd Edition,TataMcGrawHill
2. JP Den Hartog- Mechanical Vibrations, McGraw Hill Pub.
3. W. T. Thompson, Theory of Vibrations with Applications, Prentice Hall of India.
4. Charles E. Wilson and J. Peter Sadler, Kinematics and Dynamics of Machinery, 3rd Edition, Pearson Education, 2008.
5. A. Ghosh, A. K. Malik,Theory of Mechanisms and Machines, Affiliated East West Press
6. William W. Seto, "Theory and Problems of Mechanical Vibrations", McGraw-Hill International Editions (Schaum's Outline Series), Singapore, 1983

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions — *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions — *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 604 Machine Design - I

Teaching scheme: **Credits:4**
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide basic knowledge on the design considerations and methodology of various machine elements.*

Module I (13 Hours)

System design cycle - Different phases in design process – design factors and considerations – standardization – selection of materials – stress concentration – Methods to reduce stress concentration - theoretical stress concentration factor - theories of failure – Guest"s theory – Rankine"s theory – St. Venant"s theory – Haigh"s theory – Von Mises & Hencky theory - shock and impact loads – fatigue loading – endurance limit stress- Factors affecting endurance limit - Factor of safety.

Module II (13 Hours)

Threaded joints – thread standards- thread nomenclature - stresses in screw threads- bolted joints- preloading of bolts- eccentric loading- gasketed joints- power screws - design of riveted joints- Failure of riveted joints and efficiency of joint -boiler and tank joints- structural joints- cotter and knuckle joints

Module III (13 Hours)
Design of welded joints- Representation of welds - stresses in fillet and butt welds- design for static loads - bending and torsion in welded joints- eccentrically loaded welds - design of welds for variable loads. Springs- stresses and deflection of helical springs with axial loading – curvature effect – resilience - design of spring for static and fatigue loading- surging- critical frequency- stress analysis and design of leaf springs- nipping.

Module IV (13 Hours)
Shafts and axles design- stresses- causes of failure in shafts - design based on strength, rigidity and critical speed- design for static and fatigue loads- repeated loading- reversed bending-design of couplings- rigid and flexible couplings-design of keys and pins.

Note: The following data books are permitted for reference in the final examination:

1. PSG Design Data, DPV Printers, Coimbatore.
2. Prof. Narayanalyengar B.R &DrLingaiah K, Machine Design Data Handbook, Vol I & II
3. K. Mahadevan, K.Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors.

Text Books

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill Book Company.
2. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education.

Reference Books

1. Juvinall R.C &Marshek K.M., Fundamentals of Machine Component Design, John Wiley
2. S.Md. Jalaludeen, *Machine Dsign*, Anuradha Publications, 2006
3. TV SundararajaMoorthy, Machine Design, Anuradha Publications, Chennai.

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, design etc. At least one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern **4 x 25 = 100**
There will be total of EIGHT questions - TWO questions from each module with choice to answer one question. Each main question carries 25 marks. This will enable to have the freedom of setting lengthy, design question or combination of short answer/problems/ essay/design in each main question.
Maximum Total Marks: 100

ME14 605 Operations Research

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week
Objectives
- *To impart knowledge on linear programming, transportation problem, assignment problem, game theory and queuing theory.*

Module I (13 hours)
Review of the properties of matrices and matrix operations - Lines and hyper planes – linear inequalities – convex sets – extreme points – fundamental theorem of linear programming - Development of OR – Phases of OR – Scope of OR – Advantages and limitations of OR.
Formulation and application of linear programming to production, marketing, finance and other areas – Concepts of Solution space, convex region, basic feasible solution, optimal solution – Solving LPP by graphical method

Module II (13 hours)
Solving LPP by Simplex method– slack and surplus variables – basic feasible solutions – reduction of a feasible solution to a basic feasible solution – artificial variables – optimality conditions – unbounded solutions –big M method- two phase method- degeneracy – duality.

Module III (13 hours)
Transportation problem – coefficient matrix and its properties – basic set of column vectors – linear combination of basic vectors – tableau format – stepping stone algorithm – UV method – inequality constraints – degeneration in transportation problems Assignment problem as a maximally degenerate transportation problem – Koning"s method

Module IV (15 hours)
Game theory –Two person zero sum games– saddle points – pure and mixed strategies - dominance – graphical solutions Basic structure of queuing models – exponential and Poisson distributions - queuing models based on Poisson inputs and exponential service times – basic model with constant arrival rate and service rate – Poisson-exponential single server model, infinite population– Poisson-exponential single server model, finite population - Poisson-exponential multiple server model, infinite population Dynamic programming – Bellman's principle of optimality – formulation and solution of simple problems

Text Books

1. Vohra N. D. *Quantitative Techniques for Management,* Tata McGraw Hill, New Delhi
2. J.K.sharma, Operations Research, Macmillan India Limited

Reference Books

1. Ravindran A., Phillips D. T., Solberg J. J., *Operations Research Principles and Practice*, John Wiley
2. Hadley G., *Linear Programming* , Addison Wesley
3. Hillier F. S., Lieberman G.J. *Introduction to Operations Research* , McGraw Hill
4. Taha H. A., *Operations Research, An introduction* , P.H.I.
5. Wagner H.M., *Principles of Operations Research with Application to Managerial Decision.*
6. R. Panneerselvam, "*Operations Research*", PHI (2002).
7. S. D. Sharma, *Operation Research*, Kedarnath and Rannalt Pub.
8. Hira and Gupta, *Operation Research*, S. Chand and Co.

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A: *Analytical/problem solving SHORT questions* — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 606 Automobile Engineering

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To develop understanding about various automobile components and systems*
- *To impart concepts modern automotive controls and safety features*

Pre-Requisites

- *Knowledge of theory of IC engines and power transmission by belt, chain, pulleys and gears*

Module I (13 hours)

Introduction – classification of automobiles- automobile terminology. Modern energy systems for automotive application -Electric vehicles – hybrid vehicles – LPG and CNG fueled vehicles – hydrogen fueled vehicles. (basics only)

Chassis and body – body parts, functions, types, material and construction. Engines - component details and modern materials for cylinder head, cylinder block, piston, piston rings , connecting rod, crank shaft, valve actuating mechanism, VVT(Variable Valve Timing).

Modern Fuel systems: Working and advantages of: Petrol injection – MPFI (Multi Point Fuel Injection), GDI (Gasoline Direct Injection), High pressure pump &Injectors, Diesel Injection- CRDI (Common Rail Direct Injection), Electronic Diesel Control (EDC).

Module II (13 hours)

Transmission: Clutch – functions – types - single plate, multi-plate, diaphragm and cone clutch– hydraulic clutch - centrifugal clutch – electromagnetic clutch - eddy current clutch and electronic clutch.

Gear boxes – functions - types – sliding mesh, constant mesh, synchromesh - semi-automatic and automatic transmission – torque converter - overdrive. Propeller shaft – Hotchkiss drive – torque tube drive. Differential – function and working, Front axle and rear axle – functions and classes.

Brake system – functions and classification - band brake - shoe brake and disc brake – Working of mechanical brake, hydraulic brake, air brake, power assisted brakes, regenerative brake, anti-lock braking system (ABS), Electronic brake force distribution system (EBFD) - brake drum and shoes, brake lining - brake effectiveness.

Module III (13 hours)

Steering system – steering principle – functions – steering mechanisms – system components – steering gear box – types – steering ratio, power steering – hydraulic and electronic. Steering geometry – camber, caster, king pin inclination, toe-in and toe-out. Function and need of wheel alignment and wheel balancing.

Suspension system – objectives – types – rigid – independent – MacPherson strut – torsion bar – leaf spring, coil spring and shock absorber – air suspension – Electronic control of suspension.

Wheels and tyres – pressed wheel, cast wheel and wire-spoked wheel. Tyres – tyre with tube and tubeless tyres - aspect ratio –tyre specification – tyre construction – plies. Auto-electric system- circuit and working of lighting circuit – indicating devices – starter mechanism – solenoid switch – bendix drives. Function and working of alternator, Battery charging circuit. Storage battery - types.

Module IV (13 hours)

Heating ventilation and air conditioning – ventilation – heating – air conditioning – climatic control.

Automotive safety and driver assisting systems – air bags – inflation mechanism, seat belt – types – working, electronic stability control systems(ECS), GPS, side impact protection system (SIPS), alternative controls – steer by wire and drive by wire – anti-collision systems – visibility assistance – head up display (HUD), advanced frontline system (AFS), night vision system (NVS), cruise control system-(Basics Only).

Emission control norms-Need of Euro and Bharat emission norms, effective methods for reducing pollution for petrol and diesel vehicles- Exhaust system – muffler/silencer – types, Catalytic convetors, NOx-Reducing Catalysts, "DENOx" , Exhaust Gas Recirculation (EGR) Particulate Traps. Modern diagnostic tools for analyzing troubles and its need- OBD II (On Board Diagnostics), Engine Scanner -(Basics Only).

Text Book.

1. Kripal Singh, *Automobile Engineering- Vol. I and II, Standard Publishers Distributors, Delhi, 12th Edition, 2011.*
2. Kamaraju Ramakrisna, *Automobile Engineering*, PHI Learning Private Ltd.
3. James D. Halderman, Automotive Technology, 4/e,Pearson, 2013.

Reference Books

1. *Bosch Automotive Hand Book, Bentley Publishers; 8th Edition, 2011.*
2. G B S Narang, *Automobile Engineering, Khanna publishers, 12th Edition,Delhi, 2005.*
3. *K. M. Gupta, Automobile Engineering- Vol I and II, Umesh Publications, 2007*
4. Ulrich W. Seiffert, Hans Hermann Braess, *Handbook of Automotive Engineering*, SAE International
5. R.K. Rajputh, *A Text Book of Automobile Engineering*, Laksmi Publications
6. M.D. Arafat Rahman, *A Text Book Of Automobile Engineering*, Publisher: Vdm Verlag
7. K. M. Moeed, *Automobile Engineering*, S. K. Kataria & Sons
8. R. K. Singal, *Automobile Engineering*, S. K. Kataria & Sons
9. Amithosh De, *Automobile Engineering Rev. Edition*, Galgotia
10. Gupta, *Automobile Engineering*, Satya Prakashan
11. Rudolf Limpert, *Brake Design and Safety Third Edition*, SAE International
12. Donald E. Malen, Fundamental of Automotive Body Structure Design, SAE International

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions — *8x 5 marks=40 marks*

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions — *4 x 15 marks=60 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 607(P) Thermal Lab – I

Teaching scheme **Credits:** 2

3 hours lab per week

Objectives

- *To strengthen the knowledge on heat engine, and heat transfer principles through lab Experiments.*
- *To equip the students to carry out independent experiments, and to train them to analyse, Report and infer the results.*

List of Experiments

1. Study of systems of modern petrol and diesel engines, automotive parts, heat transfer equipments
2. Determination of performance characteristics of carbureted engines and diesel engines.
3. Valve timing diagram

4. Determination of Flash and Fire point.
5. Determination of Calorific Value.

Heat transfer experiments:

6. Experimental study on natural convection heat transfer
7. Experimental determination on Stefan Boltzmann Constant
8. Emissivity measurement of a radiating surface
9. Measurement of solar radiation
10. Thermal conductivity of a metal rod
11. Measurement of unsteady state conduction heat transfer
12. Experimental study on forced convection heat transfer

Reference Books

1. P. L. Bellani, *Thermal Engineering*, Khanna Publishers
2. J. P. Holman, *Heat Transfer*, McGraw Hill
3. Obert, *Internal Combustion Engines*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*

60%-Laboratory practical and Record (30 marks)
30%- Test/s (15 marks)
10%- Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-100)*

70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

ME14 608 (P) Instrumentation Lab

Teaching scheme Credits: 2

3 hours practical per week

Objectives

- *To provide knowledge of uncertainties involved in any measurement.*
- *To train the students in the calibration and use of different measuring instruments.*

List of Experiments

I. (a) Determination of uncertainties in computed quantities such as the following

i. Volume of a rectangular block or cylinder computed from measurements of length, width, height and diameter.
ii. Water power computed from measurements of density, local acceleration due to gravity, volumetric flow rate and head.
iii. Shaft power computed from measurements of speed and torque.
iv. Electrical power computed from measurements of "number of rotations of energy meter disk", time taken and "energy meter constant"

(b) Selection of instruments for computing quantities with desired uncertainties

II. Determination of bias and random error of the following instruments by calibrating them using proper standards

a)Load cells such as strain-gauge-load cells, strain-gauge-beam transducer etc.
b) Rotameter
c) Bourdon-tube pressure gauge
d) LVDT
e) Thermocouples
f) Tachometers
g) Constant area flow meters

III. Preparation of a Psychrometric chart for the laboratory and determination of Psychrometric properties of atmospheric air - use of Sling psychrometer

a. Analysis of exhaust gases and flue gases with the help of orsats apparatus,

Gas chromatograph, paramagnetic oxygen analyser, smoke meter etc.

b. Acoustic measurements: sound level meter-octave band filter- preparation of noise contours

c. Plotting of velocity profiles using pitot tubes and hot wire anemometers

IV. Study of and making measurements with: Water meter, velometers, pH meter, slip gauges, comparators, planimeter, pyrometers, RTDs, thermistors, CRO, multimeters, linear capacitance meters & LDR (light depended resistance)

V. Determination of static and dynamic characteristics of zero, first and second order instruments

Reference Books

1. E. O. Doblin, *Mechanical Measurements- Application and Design,* McGraw Hill.
2. J.P. Holman, *Experimental Methods for Engineers*, McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Practicals and Record (30 marks)
30% - Test /s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-100)*

70% - Procedure, modelling steps, analysis, results, and inference (70 marks)
20% - Viva voce (20 marks)
10% - Fair record (10 marks)

ME14 701 Refrigeration and Air Conditioning

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of the basic principles, working, scientific analysis and system components of different types of refrigeration and air conditioning systems.*
- *To impart the knowledge of various types of refrigerants, their properties, selection criteria and environmental aspects*

Pre-requisites: *Fundamentals of thermodynamics, heat & mass transfer*

Note: Students are permitted to refer refrigeration tables/charts and Psychrometric charts for the University examination.

Module I (13 hours)

Introduction to refrigeration: Brief history and applications – methods of refrigeration – natural and artificial methods – unit of refrigeration - C.O.P. Ideal refrigeration cycles – Carnot refrigeration cycle – limitations of reversed Carnot cycle, air refrigeration cycles: Bell Coleman cycle and Reversed Brayton cycle - open and dense air systems – actual air refrigeration systems – simple numerical problems - Air craft refrigeration. Steam Jet Refrigeration System–working principle and basic components. Principle of thermoelectric refrigeration, adiabatic demagnetization refrigeration and Vortex tube or Hilsch tube refrigeration.

Module II (13 hours)

Vapour compression refrigeration – working principle and essential components- simple vapour compression refrigeration cycle – representation of cycle on T-S and p-h charts – thermodynamic analysis - effect of operating parameters on the performance – liquid vapour regenerative heat exchanger - actual cycle – performance of simple VC systems - numerical problems. Multi stage systems – multi stage compression and multi stage evaporator systems – flash inter cooling and flash gas removal – liquid sub-cooling. Vapour Absorption System – working principle - calculation of max COP – description and working of NH_3 – water and Li Br –water systems - comparison with vapour compression system. Three fluid absorption system. Refrigerants and their properties – designation of refrigerants - selection of refrigerants – environmental aspects.

Module III (13 hours)

Introduction to air conditioning - comfort and industrial air conditioning. Psychrometric properties and processes – Psychrometric chart - adiabatic mixing – sensible heating and cooling, – humidifying dehumidifying and

combinations – sensible heat factor – bypass factor – ADP – concept of RSHF and GSHF – simple problems. Comfort Air conditioning – requirements of human comfort and concept of effective temperature- comfort charts. Air conditioning systems – window air conditioner – split systems – packaged systems – centralized systems - all air and chilled water systems. Summer, winter and year round air conditioning systems. Air conditioning loads – characterization of sensible heat, latent heat and total loads – ESHF - need for ventilation and ventilation load. Clean rooms – conventional flow – laminar flow and cross flow clean rooms.

Module IV (13 hours)

Refrigeration system components: Compressors – types of compressors used in refrigeration systems – reciprocating and rotary compressors-comparison – advantages and disadvantages. Condensers - heat rejection ratio – classification — air cooled, water cooled and evaporative condensers. Evaporators – classification – flooded, direct expansion coil, shell and tube and finned evaporators. Expansion devices – types – capillary tube, automatic expansion valve, thermostatic expansion valve, float type and electronic expansion valves.
Air conditioning system components – heat pumps, filters, grille – grille accessories – dampers, diffusers, registers, fans and blowers, AHUs. AC system controls – thermostat and humidistat.

Text Books

1. C. P. Arora ,*Refrigeration and Air Conditioning,* Tata McGraw-Hill Publishing Company Ltd.
2. Manohar Prasad, *Refrigeration and Air Conditioning*, New Age
3. Domkundwar and Domkundwar, *Refrigeration and Airconditioning data book,* DhanpaRai& Co.

Reference Books

1. R.C Arora, *Refrigeration and Air conditioning*, PHI Learning Pvt. Ltd
2. S. C. Arora, Domkundwar, *A Course in Refrigeration and Air conditioning*, Dhanpatrai.
3. W. F. Stoecker, *Refrigeration and air conditioning*, Tata McGraw-Hill Publishing Company Ltd.
4. R.C. Jordan, G. B. Priester, *Refrigeration and Air conditioning*, Second Edition, Prentice Hall of India, New Delhi, 1981.
5. Ananthanarayanan, *Basic Refrigeration and Air-Conditioning*, Tata McGraw-Hill Publishing Company Ltd
6. Norman C. Harris, *Modern Air Conditioning Practice*, McGraw Hill
7. ASHRAE *Handbook.*
8. Carrier Air conditioning Company (Corporate author), Hand Book of Air Conditioning System Design, McGraw Hill, New York

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 702 Machine Design-II

Teaching scheme: Credits: 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide basic design skill with regard to clutches, brakes, belt drives, bearings, gears and connecting rod.*

Module I (13 Hrs)

Clutches – friction clutches- design considerations-multiple disc clutches-cone clutch- centrifugal clutch - Brakes- Block brake- band brake- band and block brake-internal expanding shoe brake - Design of Flat belt- materials for belts- slip of the belts- creep - centrifugal tension - Design of V-belt drives- Advantages and limitations of V-belt drive- selection of roller chains- power rating of roller chains- galling of roller chains- polygonal action- silent chain.

Module II (13 Hrs)

Design of bearings – Types – Selection of a bearing type - bearing life – Rolling contact bearings – static and dynamic load capacity – axial and radial loads – selection of bearings – dynamic equivalent load - lubrication and lubricants – viscosity – Journal bearings – hydrodynamic theory – design considerations – heat balance – bearing characteristic number – hydrostatic bearings.

Module III (13 Hrs)

Gears- classification- Gear nomenclature – Tooth profiles – Materials of gears - design of spur, helical, bevel gears and worm & worm wheel - Law of gearing - 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.

Module IV (13 Hrs)

Connecting road – Material – connecting rod shank – small end – big end – connecting rod bolts – inertia bending stress. Design recommendations for Forgings- castings and welded products- rolled sections- turned parts- screw machined products- Parts produced on milling machines.

Note: The following data books are permitted for reference in the final examination:

1. PSG Design Data, DPV Printers, Coimbatore.
2. Prof. Narayanalyengar B.R &DrLingaiah K, Machine Design Data Handbook, Vol I & II
3. K. Mahadevan, K.Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors.

Text Books

1.J. E. Shigley, Mechanical Engineering Design, McGraw Hill Book Company.
2.M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education.

Reference Books

1. Juvinall R.C &Marshek K.M., Fundamentals of Machine Component Design, John Wiley
2. S. Md. Jalaludeen, *Machine Dsign*, Anuradha Publications, 2006
3. TV SundararajaMoorthy, Machine Design, Anuradha Publications, Chennai.
4. Doughtie V.L, &Vallance A.V., Design of Machine Elements, McGraw Hill Book Company.
5. Siegel, Maleev& Hartman, Mechanical Design of Machines, International Book Company.
6. James Bralla, *Design for Manufacturability Handbook*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, design etc. Atleast one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern **(4 x 25 = 100)**

There will be total of EIGHT questions - TWO questions from each module with choice to answer one question. Each main question carries 25 marks. This will enable to have the freedom of setting lengthy, design question or combination of short answer/problems/ essay/design in each main question.

Maximum Total Marks: 100

ME14 703 Computer Integrated Manufacturing

Teaching scheme **Credits: 4**

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart fundamental knowledge of Numerical Control, NC part programming, Controls in CIM, material handling systems.*
- *To acquire comprehensive idea on FMS and Robotics.*

Module I (13 hours)

Introduction- fundamentals of numerical control- advantages of NC system - classification of NC system - NC and CNC - open loop and closed loop systems - features of NC machine tools - fundamentals of machining- design considerations of NC machine tools- methods of improving machine accuracy and productivity- special tool holders.

Module II (13 hours)

NC part programming - manual programming- part programming examples- point to point programming and contour programming- computer aided programming concepts - post processor - program languages- APT- programming - part programming examples.

Module III (13 hours)

Controls in CIM- material handling in CIM- AGV- Vehicle guidance- vehicle management and safety automated storage systems- ASRS components and operations- features of ASRS- automatic data capture- barcode technology- magnetic strips- optical character recognition- group technology- part family- part classification and coding - features OPITZ classification and multi class coding system.

Module IV (13 hours)

Flexible manufacturing system- types of FMS- components of FMS- FMS workstations- material handling and storage systems- FMS layout- configurations- computer control systems in FMS applications and benefits of FMS- industrial robotics- robot anatomy- configurations- joints- drive systems- robot control systems- end effectors- sensors in robots- industrial robot applications- robot programming- on line and off line programming.

Text Books

1. Yoram Koran, *Computer control of manufacturing systems*, McGraw Hill IntI. Book Co., John Wiley & Sons, N. Y., 2002
2. Mickel. P. Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, Pearson Education

Reference Books

1. H.M.T, *Mechatronics,* Tata McGraw Hill
2. Mickel. P. Groover, *Industrial Robotics Technology, Programming and Applications*, Mc Graw Hill.
3. Radhakrishnan P., *Computer Numerical Control Machines*, New Central Book Agency.
4. Radhakrishnan P., Subramanian S., *CAD/CAM and CIM*, Wiley Eastern, 1994.
5. Nagpal G.R. , *Machine Tool Engineering*, Khanna Publishers, 2000

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 704(A) Financial Management

Teaching scheme Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on financial management of organisations*

Module I (13 hours)

Scope of financial management- Investment financing and asset management decisions.
Type of business organisations- sole proprietorship, partnership, private company and public company. Goals of the firm: Profit maximization, wealth maximization - management verses owners, social responsibility. Major financial decision areas: Investment financing and dividend decisions. Basic factors influencing financial decisions-internal and external factors.

Module II (13 hours)
Capital budgeting- meaning, importance, difficulties and rationale .Data requirement: Cash flow patterns Tax effect, effect on other projects, effect of depreciation and effect of indirect expenses. Method of appraisal: traditional techniques: Average rate of return (ARR) method-Pay back method. Discounted cash flow techniques: present value, net present value, internal rate of return. Terminal value and profitability index methods.

Module III (13 hours)
Working capital management: Need for working capital, classification of working capital-Source of fixed and variable working capital. Components of working capital: Positive and negative working capital-estimation of working capital requirement-Liquidity profitability tangle.

Module IV (13 hours)
Sources of company finance: Long term sources-other sources-Retained earnings-Capital market-short term sources- External and internal sources- Merger of companies-reasons-impact type of mergers. Lease financing: Concept and classification-Significance and limitations.

Reference Books

1. James C Van Horne, *Fundamentals of financial management.*
2. Ezera Solomon, *Theory of financial management.*
3. H Beeman Jr. And S. Smdidi, *Capital budgeting decisions*
4. Prasanna Chandra, *Financial management theory and practice*
5. M Y Khan & P K Jain, *Financial management*
6. S K R Paul, *Financial management.*

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A: *Analytical/problem solving SHORT questions* — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 704(B) Industrial Safety Engineering

Teaching scheme Credits: 4
3 hours lecture and 1 hour tutorial per week
Objectives
□ *To provide on concept of safety in industry, principle of accident prevention, major hazards, consequences and concept of reliability.*
Pre-requisites: *Nil*

Module I (13 Hours)
Introduction to the concept of safety-Need-safety provisions in the factory Act-Laws related to the industrial safety-Measurement of safety performance, Safety Audit, Work permit system, injury and accidents-Definitions-Unsafe act –unsafe condition- causes, investigations and prevention of accidents, hazards, type of industrial hazards-nature, causes and control measures, hazard identifications and control techniques-HAZOP, FMEA,FMECA etc.
Module II (13 Hours)
Concept of Industrial hygiene, programmes-Recognition –Evaluation- Control, Noise- source –effects and noise control, exposure limits –standards, Hearing conservation programmes, Fire –fire load-control and industrial fire protection systems, Fire Hydrant and extinguishers, Electrical Hazards, protection and interlock-Discharge rod and earthling device, safety in the use of portable tools.

Module III (13 Hours)
Logics of consequence analysis-Estimation-Toxic release and toxic effects-Threshold limit values, Emergency planning and preparedness, Air pollution-classification- Dispersion modeling –pollution source and effects- - control method and equipments-Gravitational settling chambers-cyclone separators- Fabric filter systems-scrubbers etc.
Module IV (13 Hours)
Concept of reliability-Definition-Failure rate and Hazard function, System reliability models-series, parallel systems, reliability hazard function for distribution functions-exponential-normal –log normal weibull and gamma distribution.

Text books

1. Thomas J. Anton, *Occupational Safety and Health Management*, McGraw Hill
2. Ian T.Cameron & Raghu Raman, *Process Systems Risk Management*, ELSEVIER Academic press.
3. C.S.Rao, *Environmental Pollution Control Engineering*, New Age International Limited
4. L. S. Srinath, *Reliability Engineering*, East west Press, New Delhi.

Reference books

1. Frank E. Mc Erloy, P.E; C.S.P, *Accident Prevention Manual for Industrial Operations*, NSC Chicago.
2. Lees F.P, *Loss Prevention in Process Industries*, Butterworths, New Delhi.
3. BHEL, *Occupational Safety Manual*, Tiruchirappalli.
4. Dr. A.K. Gupta, *Reliability, Maintenance and Safety Engineering*, Laxmi Publications, New Delhi.

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 704 (C) Renewable Energy Technology

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Module I – (13 Hours)

Solar energy – The Sun – Production and transfer of solar energy – Sun-Earth angles – Availability and limitations of solar energy – Measuring techniques and estimation of solar radiation – Solar thermal collectors – General description and characteristics – Flat plate collectors – Heat transfer processes – Short term and long term collector performance – Solar concentrators.

Module II – (13 Hours)

Energy storage – Sensible heat storage – Liquid media storage – Solid media storage – Dual media storage – Phase change energy storage – Storage capacity – Other storage methods – Solar dehumidification – Design, performance and applications – Combined solar heating and cooling systems – Performance and cost calculations.

Module III- (13 Hours)

Energy from biomass – Sources of biomass – Different species – Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion – Properties of biomass – Biogas plants – Types of plants – Design and operation – Properties and characteristics of biogas.

Module IV – (13 Hours)

Wind energy – Principles of wind energy conversion – Site selection considerations – Wind power plant design – Types of wind power conversion systems – Operation, maintenance and economics – Geothermal energy – Availability, system development and limitations – Ocean thermal energy conversion – Wave and tidal energy – Scope and economics – Introduction to integrated energy systems.

Text Books

1. Chetan Singh Solanki , Renewable Energy Technologies: Practical Guide For Beginners, PHI, 2009
2. K. Sukhatme, Suhas P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage Tata McGraw-Hill Education, 1996
3. G.N. Tiwari, *Solar Energy-Fundamentals, Design, Modeling and Applications*, Narosa Publishers, 2002.
4. K.M. Mittal, Non-*conventional Energy Systems-Principles, Progress and Prospects*, Wheeler Publications, 1997

References:

1. J.A. Duffie and W.A. Beckman, *Solar Energy thermal processes*, J. Wiley, 1994.
2. A.A.M. Saigh (Ed), *Solar Energy Engineering*, Academic Press, 1977.
3. F. Kreith and J.F. Kreider, *Principles of Solar Engineering*, McGraw Hill, 1978.
4. Ahmed, *Wind energy Theory and Practice*, PHI, Eastern Economy Edition, 2012
5. H.P. Garg, S.C. Mullick and A.K. Bhargava, *Solar Thermal Energy Storage*, 1985.

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 704 (D) Energy Conservation in Thermal Systems

Teaching scheme Credits: 4
3 hours lecture and 1 hour tutorial per week

Module I – (13 Hours)
Definition of energy management – Energy conservation schemes – Optimizing steam usage – Waste heat management – Insulation – Optimum selection of pipe size – energy conservation in space conditioning – Energy and cost indices – Energy diagrams – Energy auditing – Thermodynamic availability analysis – Thermodynamic efficiencies – first law and second law efficiency.

Module II – (13 Hours)
Thermodynamics and economics – Systematic approach to steam pricing – Pricing other utilities – Investment optimization – Limits of current technology – Process improvements – Characterizing energy use – Optimum performance of existing facilities – Steam trap principles – Effective management of energy use – Overall site interactions – Total site cogeneration potential.

Module III – (13 Hours)
Thermodynamic analysis of common unit operations – Heat exchanger – Expansion – Pressure let down – Mixing – Distillation – Combustion air pre-heating – Systematic design methods – Process synthesis – Application to cogeneration system – Thermo-economics – Systematic optimization – Improving process operations – chemical reactions – Separation – Heat transfer – process machinery – System interaction and economics.

Module IV – (13 Hours)
Potential for waste heat recovery – Direct utilization of waste heat boilers – Use of heat pumps – Improving boiler efficiency – Industrial boiler inventory – Potential for energy conservation – Power economics – General economic problems – Load curves – Selections of plants – Specific economic energy problems – Energy rates.

Text Book:

1. A.P.E. Thummann, *Fundamentals of Energy Engineering*, Prentice Hall, 1984

References:

1. W.F. Kenney Energy Conservation in the Process Industries, Academic press, 1984.
2. M.H. Chiogioji: Industrial energy Conservation, Marcel Dekker, 1979.
3. A.P.E. Thummann, Plant Engineers and Managers Guide to Energy Conservation, van Nostrand, 1977.
4. W.R. Murphy and G. Mckay: Energy Management, Butterworth-Heinemann, 2001.
5. F.B. Dubin: Energy Conservation Standards, McGraw Hill, 1978.

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*
		Maximum Total Marks: 100

ME14 704 (E) Industrial Automation

Teaching scheme Credits: 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on basics of automation, sensors, robots and its application*

Module I (13 hours)
Introduction to automation: basic motions and definitions, technical and economic requisites. Automation as a means of control and inspection- basic control system concepts - control system analysis, systems of automatic control.

Module II (13 hours)
Sensors: sensory equipment, range sensing - proximity sensing - touch sensing - force and torque sensing - signal conditioning equipment.
Introduction to machine vision, sensing and digitizing - image processing and analysis - applications.
Introduction to robots: definition of robot - basic concepts - robot configurations - types of robot drives - basic robot motions - point to point control - continuous path control.

Module III (13 hours)
Components and operations: basic actuation mechanisms - robot actuation and feedback, manipulators –director and inverse kinematics, coordinate transformation - brief robot dynamics. Types of robot and effectors - grippers - tools as end effectors – robot end - effort interface.
Robot programming: methods - languages - capabilities and limitation - Artificial Intelligence – Knowledge representation – search techniques - AI and robotics.

Module IV (13 hours)
Industrial applications: application of robots in machining - welding - assembly - material handling – loading and unloading - CIM - hostile and remote environments. Parts handling automation, products inspection automation, machine tool automation, in-plant transport automation, automatic transfer machines, assembly automation.

Text books:

1. K. S. Fu., R. C. Gonalez, c. S. G. Lee, *robotics control sensing, vision and intelligence*, McGraw hill international edition, 1987.

Refernce books:

1. Michelle p. Grover, Mitchell Weiss, *industrial robotics, technology, programming, and Applications*, megraw hill international editions, 1986.
2. Richard d. Klafter, Thomas a. Chmielewski, Michael negin, *robotic engineering - an Integrated approach*, prentice hall inc, englewoods cliffs, nj, usa, 1989.
3. Yu.kozyrev, *industrial robots*,
4. V. Tergan, i. Andreev, b. Liberman, *fundamentals of industrial automation*

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*
		Maximum Total Marks: 100

ME14 704 (F) Combustion Engineering

Teaching scheme Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of principles of combustion.*
- *To develop understanding about principles of thermodynamics of combustion.*

Pre-requisites: *Basic knowledge of thermodynamics and heat transfer.*

Module I (13 hours)

Thermodynamics of reactive mixtures: Bond energy – heat of formation, heat of combustion – adiabatic flame temperature. Entropy change for reacting mixtures – chemical equilibrium – equilibrium criteria – evaluation of equilibrium constant and equilibrium composition – simple numerical problems.

Module II (13 hours)

Elements of chemical kinetics: Laws of mass action – order and molecularity of reaction – rate equation – Arrhenius law – activation energy – collision theory of reaction rates. General theory of chain reactions – kinetics of chemical chain reactions – reaction of hydrogen with oxygen.

Module III (13 hours)

Laminar flame propagation: Structure of a laminar flame – concentration and temperature profile flames in tubes – theories of laminar flame propagation – thermal and diffusion theories. Determination of burning velocity – flat flame burner method – tube method.

Module IV (13 hours)

Flame stabilization: Stability diagrams for open flames – mechanism of flame stabilisation – critical boundary velocity gradient – stabilisation by eddies bluff body stabilisation.

Miscellaneous topics: Droplet combustion – fluidized bed combustion – air pollution.

Text Books

1. S. P. Sharma, *Fuels and Combustion*, Tata McGraw Hill

Reference Books

1. Roger A. Strehlow, *Fundamentals of Combustion*, McGraw-Hill, 1984
2. Dudley Brian Spalding, Some *Fundamentals of Combustion*, Academic Press
3. Joseph Lionel Latham, A. E. Burgess, *Elementary reaction kinetics*, Butterworths

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 704(G) Finite Element Methods

Teaching scheme **Credits: 4**

3 hours lecture and 1 hour tutorial per week

Objectives

1. To acquaint with basic concepts of finite element formulation methods.
2. To practice finite element methodologies through simple structural and heat transfer problems.

Module 0 (2 hours)

Review: Matrices and matrix operations solution of system of linear equations Gauss elimination. Basic equations of elasticity strain-displacement relations compatibility - stress-strain relationship boundary condition St. Venant's principle - theorem of minimum potential energy principle of virtual work. Steady state heat conduction equation Fourier's law boundary conditions. (No direct questions from the above part)

Module I (13 hours)

Introduction:Finite element method as a numerical tool for design basic concepts formulation procedures historical development.

FE modelling Direct approach: 1-D bar element element stiffness assembly of elements properties of [K] matrix treatment of boundary conditions temperature effects stress computation support reaction simple problems. Analogous (1-D) problems of torsion, heat conduction and laminar pipe flow.

Beam element:Beam relationships 1-D beam element FE formulation - element stiffness matrix load considerations boundary conditions member end forces.

Module II (13 hours)

FE modelling Direct approach : Plane truss element formulation coordinate transformation local and global coordinates element matrices assembly of elements treatment of boundary conditions stress calculation simple problems - band width of the stiffness matrix node numbering to exploit matrix sparsity conservation of computer memory.

Interpolation shape function Lagrange interpolation - 1D linear and quadratic, 2D linear triangle and bilinear rectangular elements.

FE formulation from virtual work principle B-matrix element matrices for bar and CST elements load considerations consistent nodal loads simple problems.

Module III (13 hours)

Variational methods : Functionals weak and strong form essential and non- essential boundary conditions - Principle of stationary potential energy Rayleigh-Ritz method simple examples.

FE formulation from a functional: 2-D steady state heat conduction element matrices for a triangular element boundary conditions simple problems. FE formulation for 2-D stress analysis from potential energy - element matrices - plane bilinear element.

Convergence requirements modelling aspects symmetry element size and shape sources of error.

Module IV (13 hours)

Weighted residual methods: Galerkin FE formulation axially loaded bar heat flow in a bar. Isoparametric formulation: Natural coordinates linear and quadratic bar element linear triangle and plane bilinear elements for scalar fields jacobian matrix element matrices - Gauss quadrature requirements for isoparametric elements accuracy and mesh distortion.

Text Books

1. T. R. Chandrupatla, Finite Element Analysis for Engineering and Technology, University Press
2. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, Concepts & Applications of Finite Element
3. Analysis, John Wiley & Sons
4. P. Seshu, Text Book of Finite Element Analysis, PHI Learning Pvt. Ltd.

Reference Books

1. J. N. Reddy, An Introduction to the Finite Element Method, McGraw Hill International Edition
2. S. S. Rao, The Finite Element Method in Engineering, Butterworth Heinemann
3. K. J. Bathe, Finite Element Procedures in Engineering Analysis, Prentice Hall of India O. C. Zienkiewics, R. L. Taylor, The Finite Element Method, Vol I & II, McGraw Hill

Internal Continuous Assessment (Maximum Marks-50)

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks = 40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 705(A) Logistics and Supply Chain Management

Teaching scheme **Credits: 4**

3 hours lecture and 1 hour tutorial per week

Objectives

- *To visualize the major issues in supply chain domain*
- *To understand how the environment affects the design, implementation and management of supply chains*
- *To develop competence in distribution and logistics management*

Pre-requisites: *nil*

Module I (13 hours)

Concept of Supply Chain –Value Chain for supply chain management, Integrated Supply chain, Drivers for supply chain management, Growth of supply chain, Major trends in supply chain management, Strategic decisions in supply chain, Supply Chain flows - Supply Chain and competitive performance – performance measures of Supply Chain –Strategic fit – Drivers and Obstacles

Module II (13 hours)

Managing supply, Managing demand and Managing variability – Inventory Management in Supply Chain – Uncertainties of demand, Inventory related costs, Types of inventory, Demand, Tools and techniques in inventory management, Managing supply chain inventory: Pitfalls and opportunities.

Module III (13 hours)

Sourcing decisions in Supply Chain – management, Buyers perspective to supply chain management, Suppliers perspective to supply chain management, Buyer supplier relations, Supplier relations in managing faster supply chain, Pricing and revenue management in Supply Chain – Coordination in Supply Chain – IT and Supply Chain

Module IV (13 hours)

Logistics Management – Definition of Logistics and concept of Logistics – Logistic activities –Functions of Logistics system – Transportation in Supply Chain – Design options for a transportation network – Trade offs in transportation design – Designing distribution network

Text Books

1. Dr.R..P Mohanty and Dr.S.G.Deshmukh Essentials of Supply Chain Management, Jaico Publishing.
2. Chopra S. &Meindl P., Supply Chain Management: Strategy, Planning, and Operation, Pearson Education, South Asia, 2005

Reference Books

1. Janat Shah, *Supply Chain Management: Text and Cases,* Pearson Education South Asia, 2009
2. Ronald H Ballou and Samir K Srivastava, *Business Logistics/ Supply Chain Management,* Pearson Education South Asia, 2007
3. HaraldDyckhoff et al, *Supply Chain Management and Reverse Logistic,* Springer, 2004.
4. Christopher M., *Logistics and Supply Chain Management*, Pitman Publishing Company.
5. John Mortimer (Editor), *Logistics in Manufacturing: An IFS Executive Briefing* , IFS Publications, U.K. & Springer-Verlag.
6. Raghuram G. &Rangaraj N., *Logistics and Supply Chain Management: Cases and Concepts* , Macmillan India Limited.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*
		Maximum Total Marks: 100

ME14 705(B) Design of Heat Transfer Equipments

Teaching scheme Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concepts of design of heat transfer equipments.*
- *To develop understanding about design of various heat exchangers*

Pre-requisites: Basic knowledge of fluid mechanics and heat transfer

Module I (13 hours)

Heat exchangers - classification – selection – heat transfer and flow friction characteristics – pressure drop analysis – basic thermal design – theory of heat exchangers – E-NTU, P-NTU and MTD method - F-factor for various configurations - applications to design.

Module II (13 hours)

Shell and tube heat exchanger – construction and thermal features – thermal design procedure – kern method – Bell Delaware method – flow stream analysis method – flow induced vibration in shell and tube heat exchanger.

Module III (13 hours)

Thermal design of double pipe heat exchanger – design of air-cooled heat exchanger – design variables, preliminary sizing – heat transfer and pressure loss calculations – detailed design. Thermal design of regenerators – classifications – governing equations – design parameters.

Module IV (13 hours)

Design of compact heat exchangers – plate and fin, fin-tube and plate and frame heat exchangers – fouling and corrosion in heat exchanger – sizing and cost estimation of heat exchanger.

Text Books

1. Hewitt., *Process Heat Transfer*, CRC Press
2. Saunders, *Heat Exchanger – selection, design and construction*, Longman Scientific and Technical, U. K.

Reference Books

1. R. K. Shah, *Fundamental of Heat Exchanger Design*, John Wiley & Sons

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: *Analytical/problem solving SHORT questions* — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 705 (C) – Advanced Fluid Mechanics

Teaching scheme **Credits: 4**
3 hours lecture and 1 hour tutorial per week

Module I (13 hours)
Basic equations of fluid flow: Reynolds transport equation - integral and differential formulations - integral form of the equations of continuity - momentum and energy equations - use of the integral equations - differential form of these equations - Stokes postulates and constitutive equations - Navier-Stokes equations and energy equations for Newtonian fluids
Non-dimensionalisation of the equations of motion and order of magnitude analysis: Choice of characteristic quantities - identification of the non-dimensional parameters - classification of flows based on the characteristic Reynolds number - approximate equations for low Re and high Re flows and boundary layer equations - boundary conditions

Module II (13 hours)
Some exact solutions of the Navier-Stokes equations: Couette flows - plane Poisseuille flow - flow between rotating cylinders - Stokes problems - fully developed flow through circular and non-circular pipes
Approximate solutions: Creeping flow past a sphere - theory of hydrodynamic lubrication - boundary layer on a flat plate - Blassius solution and use of momentum integral equation

Module III (13 hours)
Potential flows: Velocity potential and stream function in rectangular and plane polar coordinates - Uniform stream at an angle – Circulation. Line source or sink at the origin – Line irrotational vortex. Superposition – Source plus an equal sink, Sink plus a vortex at the origin, uniform stream plus a source at the origin (The Rankine half body). Superposition of plane flow solutions – Graphical Method of super position – Boundary layer separation on a Half Body –Flow past a vortex – An infinite row of vortices – the vortex sheet – The doublet. Plane flow past closed body shapes - The Rankine oval – Flow past a circular cylinder with circulation. Kutta – Joukowski Lift theorem – Kelvin oval – Potential Flow Analogs. Uniform stream at an angle of attack – Line source at a point – Line vortex at a point – Flow around a corner at an arbitrary angle – flow normal to a plate – Images.

Module IV (13 hours)
Turbulence: Some characteristics of Turbulence flows – Randomness, non-linearity, diffusivity, vorticity and dissipation. Averages – correlations. Averaged equations of motions – mean continuity equation – mean momentum equation – Reynolds stress – Reynolds stress tensor – Mean heat equation – Kinetic energy budjet of mean flow – Kinetic energy budget of Turbulent flow – shear production, buoyant production, viscous dissipation – turbulent production and cascade –Kolmogorove micro scale. Wall free shear flow – entrainment, self-preservation – Turbulent Kinetic energy budget in a jet. Wall bounded shear flow – Inner layer – Law of the wall, outer layer – velocity defect law and overlap layer – Logarithmic law. Eddy viscosity and mixing length.

Text:
1. Frank M White, *Fluid Mechanics* (in SI units), McGraw Hill, Seventh edition
2. Pijush K Kundu, Ira M Cohen, *Fluid Mechanics,* Elsevier Third edition
3. Muralidhar K. &Biswas G., *Advanced Engineering Fluid Mechanics,* Narosa Publishing House

Reference:
1. Gupta V. & Gupta S., *Fluid Mechanics and its Applications,* Wiley Eastern Ltd
2. Frank M White, *Viscous Fluid Flow,* McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 705 (D) Designs of Jigs & Fixtures

Teaching scheme Credits: 4
3 hours lecture and I hour tutorial per week

Objectives
- *To provide knowledge on design of different cutting tools*
- *To develop comprehensive idea on design of jigs and fixtures*

Pre-requisites: *Metal cutting and Forming*

Module I (13 Hours)
Location – method of location - Principles of location – 3-2-1 principle – types of location – plane surface – six point – profile – cylindrical – conical – vee – redundant – nest locator – radial – extreme locations.

Module II (13 Hours)
Clamping – principles of clamping - Design and methods of clamping - types of clamps – screw – strap – swing – wedge – multiple – magnetic – latch – self locking – toggle clamps - hydraulic and power clamping.

Module III (13 Hours)
Jigs - Classification of Jigs - Principles of design of Jigs – elements of jig – types of drill jigs – template – sandwich – leaf – box – indexing - drilling and reaming jigs - guide bushings - Simple design for drill Jigs.

Module IV (13 Hours)
Fixtures - Elements of fixture – standard work holding devices - machine vices – mandrels – collets – chucks – magnetic and vacuum chucks - face plates – turning fixture – milling fixture – indexing fixture– grinding fixture – welding and assembly fixtures - modular fixtures - design & sketching of fixtures for turning & milling of simple components.

Text books:
1. Cyril Donaldson, *Tool Design*, Tata McGraw Hill
2. Sharma. P C, *A Text book of Production Engineering*, S. Chand & Co.
3. Jain .R K, *Production Technology*, Khanna Publishers.
4. P H Joshi, *Jigs & Fixtures*, Tata McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 705(E) Fracture Mechanics

Teaching scheme Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on linear elastic fracture mechanics, crack tip plasticity, Elastic – Plastic Fracture Mechanics, Fatigue crack growth and application of fracture mechanics concepts to design*

Module I (13 hours)

Introduction: Introduction to conventional and fracture mechanics approaches to design – significance of defects in materials – brittle fracture experienced in the past – the effect of material properties on fracture. Linear elastic fracture mechanics (LEFM): Atomic view of fracture - stress concentration effect of flaws - Griffith"s energy balance - energy release rate - criterion for crack growth. Stress analysis of cracks - Expressions for stresses and strains in the crack tip region (derivation not required) – stress intensity factor (SIF) – Relationship between K and G – critical stress intensity factor – principle of superposition – SIF solutions for simple cases.

Module II (13 hours)

Crack tip plasticity: Plastic zone size – Irwin plastic zone correction – the Dugdale approach – effective crack length – Plastic zone shapes according to Mises criterion - K as a failure criterion – Effect of specimen dimensions – limits to the validity of LEFM - measurement of fracture toughness. Introduction to dynamic fracture mechanics: Crack speed and kinetic energy – dynamic stress intensity and elastic energy release rate – dynamic fracture toughness – crack branching – crack arrest.

Module III (13 hours)

Elastic – Plastic Fracture Mechanics (EPFM) : Fracture beyond general yield – crack tip opening displacement (CTOD) – determination and use of CTOD – critical CTOD – J integral – HRR singularity - measurement of J – relation between J integral and CTOD - crack growth resistance curves – tearing modulus stable and unstable crack growth – J-controlled fracture for stationary and growing cracks – effect of specimen dimensions – fracture mechanisms in metals.

Module IV (13 hours)

Fatigue crack growth: Fatigue cracking criteria (constant amplitude only) – crack growth and stress intensity factor – crack closure and fatigue threshold - factors affecting crack growth - growth of small cracks – measurement of fatigue crack growth. Application of fracture mechanics concepts to design: Means to provide fail safety and damage tolerance – application to pressure vessel and pipelines – Leak before break criterion – material selection – use of fatigue crack growth parameters and its application to design.

Text Books

1. Prashant Kumar, *Elements of fracture mechanics*, Wheeler publishing
2. D. Broek, *Elementary engineering fracture mechanics*, Sijthoff &Noordhoff International publishers.

Reference Books

1. T. L. Anderson, *Fracture Mechanics: Fundamentals and Applications*, CRC Press, USA
2. K. Hellan K, Introduction to fracture mechanics, McGraw Hill Book company
3. Edwalds H L &Wanhill RJH, *Fracture mechanics*, Edward Arnold Edition.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A: *Analytical/problem solving SHORT questions* *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: *Analytical/Problem solving DESCRIPTIVE questions* *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 705(F) Composite Materials

Teaching scheme **Credits: 4**
3 hours lecture and I hour tutorial per week

Objectives

- *To provide knowledge on characteristics of composites, manufacturing and testing methods, mechanical behavior, recent trends and its application.*

Pre-requisites: *Basic knowledge of material science and mechanics of solids*

Module I (13 hours)
Introduction to composites: Characteristics and classifications of composites – study of fibers, flake and particulate composites. Manufacturing methods: Production of various fibers – matrix materials and surface treatments – fabrication of composites – fabrication of thermosetting resin matrix composites – fabrication of thermoplastic resin matrix composites – short fiber composites – fabrication of metal matrix and ceramic matrix composites.

Module II (13 hours)
Testing aspects of composites: Experimental characterisation of composites – uniaxial tension, compression and shear tests – determination of interlaminar fracture toughness – damage identification through non-destructive evaluation techniques – ultrasonic, acoustic emission and X-radiography.

Module III (13 hours)
Mechanical behaviour of UD composites: Longitudinal strength and stiffness – transverse strength and stiffness – failure modes – analysis of laminated composites – stress-strain variation in a laminate.

Module IV (13 hours)
Special laminates: Symmetric laminates, uni-directional, cross-ply and angle-ply laminates, quasiisotropic laminates. Recent trends in composite materials – carbon-carbon composites, Bucky Papee. Application of composite materials in aerospace, automotive, defence and industry.

Text Books

1. B. D. Agarwal, L. J. Broutman, *Analysis and Performance of Fiber Composites*, John Wiley.

Reference Books

1. R. F. Gibson, *Principle of Composite Material Mechanics*, McGraw Hill
2. M. M. Schwartz, *Composite Materials Handbook*, McGraw Hill. Inc.
3. R. M. Jones, *Mechanics of Composite Materials*, McGraw Hill. Inc
4. S. W. Tsai, *Introduction to Composite Materials*, Technomic Publishing Company.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 705 (G): Entrepreneurship

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To give an idea on entrepreneurial perspectives*

Module I (13 hours)

Entrepreneurial perspectives- understanding of entrepreneurship process- entrepreneurial decision process- entrepreneurship and economic development- characteristics of entrepreneur- entrepreneurial competencies- managerial functions for enterprise.

Module II (13 hours)

Process of business opportunity identification and evaluation- industrial policy- environment- market survey and market assessment- project report preparation-study of feasibility and viability of a project assessment of risk in the industry

Module III (13 hours)

Process and strategies for starting venture- stages of small business growth- entrepreneurship in international environment- entrepreneurship- achievement motivation- time management creativity and innovation structure of the enterprise- planning, implementation and growth

Module IV (13 hours)

Technology acquisition for small units- formalities to be completed for setting up a small scale unit forms of organizations for small scale units-financing of project and working capital-venture capital and other equity assistance available- break even analysis and economic ratios technology transfer and business incubation

Text Books

1. Harold Koontz & Heinz Weihrich, *Essentials of Management*, McGraw hill International
2. Roy R., *Entrepreneurship, Oxford University Press, 2nd Edition, 2013.*
3 Hirich R.D. &Peters Irwin M.P., *Entrepreneurship*, McGraw Hill
4. Rao T.V., Deshpande M.V., Prayag Mehta &Manohar S. Nadakarni, *Developing Entrepreneurship a Hand Book*, Learning systems
5. Donald Kurado & Hodgelts R.M., *Entrepreneurship A contemporary Approach*, The Dryden Press
6. Dr. Patel V.G., *Seven Business Crisis*, Tata McGraw hill
7. Timmons J.A., *New venture Creation- Entrepreneurship for 21st century*, McGraw Hill International
8. Patel J.B., Noid S.S., *A manual on Business Oppurnity Identification*, selections, EDII
9. Rao C.R., *Finance for small scale Industries*
10. Pandey G.W., *A complete Guide to successful Entrepreneurship*, Vikas Publishing

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions — *8x 5 marks=40 marks*
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions — *4 x 15 marks=60 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 706(P) Thermal Lab II

Teaching scheme Credits: 2
3 hours practical per week
Objectives

- *To strengthen the knowledge on heat engines and heat transfer principles through experiments.*
- *To equip the students to carry out independent experiments, and to train them to analyse, report and infer the results.*

List of Experiments

1. Test on IC engines:
   i. Variable speed performance test on modern Multi Point Fuel Injection (MPFI) petrol engine and Direct Injection (DI)/Common Rail Direct Injection (CRDI) diesel engines.
   ii. Determination of friction power – retardation test and Morse test
   iii. Study of the effect of cooling water on engine performance
   iv. Heat balance test
   v. Analysis of the exhaust gas of IC engines
2. Heat transfer experiments:
   i. Performance studies on a shell and tube heat exchanger
   ii. Performance studies on parallel and counter flow arrangements in a concentric pipe heat exchanger
3. Performance tests on air compressor and blower
4. Performance test on refrigeration plant

Reference Books

1. P. L. Bellaney, *Thermal Engineering*, Khanna Publishers
2. J. P. Holman, *Heat Transfer*, McGraw Hill
3. Obert, *Internal Combustion Engines*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Practical and Record (30 marks)
30% - Test /s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-100)*
70% - Procedure, conducting experiment, results, tabulation, and inference (70 marks)
20% - Viva voce (20 marks)
10% - Fair record (10 marks)

ME14 707(P) CAD/CAM Lab

Teaching scheme **Credits: 2**
3 hour practical per week
Objectives

- *To train the students in solid modeling*
- *To practice static and dynamic analyses using FEM*
- *To practice computer controlled manufacturing methods*

1. Exercises on solid modeling (12 hours)
Introduction to computer graphics - viewing transformations, curves and surfaces generation, curve fitting and curve fairing techniques - 2D, wire frame, 3D shading - familiarity with Boolean operations - sweep, revolve, loft, extrude, filleting, chamfer, splines etc. - windowing, view point, clipping, scaling and rotation transformations using commercial solid modeling packages

2. Exercises on finite element analysis (12 hours)
Introduction to FEM - 1D, 2D and 3D elements - shape functions - preprocessing - boundary conditions, structured and free mesh generation - analysis - linear and non linear analysis - static and dynamic analysis - post processing - display, animation, extraction of nodal data - exercises on heat conduction and elasticity may be given using commercial FEM packages

3. Assembly and mechanism design (6 hours)
Assembling of various parts and tolerance analysis - synthesis and design of mechanisms - animations - exercises on various mechanisms like four bar linkages and its variations - cam and follower - two and four stroke engines

4. Computer aided manufacturing (9 hours)
Part programming fundamentals - manual part programming and computer aided part programming - hands on training in computer controlled turning and milling operations - familiarity with windows based software packages - tool path generation and simulation - exercises on CNC lathe and machining center/milling machines

5. Programming of industrial robots (6 hours)
Introduction to robotics - structure, workspace analysis and various components - actuators - sensors - encoders - end effectors - applications - hands on training on industrial robots - manual and programmed path planning

6. Computer aided inspection and quality control (3 hours)
Introduction to CMM - classification - structure - components - familiarity with measurement software packages and its modules - demonstration of the capability of coordinate measuring machine using a sample component e.g.: engine block - concepts of reverse engineering and rapid prototyping technology

Reference Books

1. D. F. Rogers, J. A. Adams, *Mathematical Elements for Computer Graphics*, mcgraw Hill
2. F. R. David, *Procedural Elements for Computer Graphics*, Mc Graw Hill
3. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, *Concepts & Applications of Finite Element Analysis*, John Wiley & Sons
4. K. Yoram, *Computer Control of Manufacturing Systems*, Mc Graw Hill
5. K. Rao, Tewari, *Numerical Control and Computer Aided Manufacturing*, Tata Mc Graw Hill
6. V. Ramamurthy, *Computer Aided Mechanical Design*, Tata Mc Graw Hill
7. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, *Robotics: Control, Sensing, Vision and Intelligence*, Mc Graw Hill
8. K. Yoram, *Robotics for Engineers*, Mc Graw Hill
9. J. A. Bosch, *Coordinate Measuring Machines and Systems*, Marcel Decker Inc.

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Practical and Record (30 marks)
30% - Test(s) (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-100)*
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

ME14 708(P) Project

Teaching scheme **Credits:4**
4 hours practical per week

Objectives

- *To judge the capacity of the students in converting the theoretical knowledge into practical systems/investigative analysis.*

Project work is for duration of two semesters and is expected to be completed in the eighth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. Project evaluation committee consisting of the guide and three/four faculty members specialised in the above field shall perform the screening and evaluation of the projects.
Each project group should submit project synopsis within three weeks from start of seventh semester. Project evaluation committee shall study the feasibility of each project work before giving consent. Literature survey and 40% of the work has to be completed in the seventh semester.
Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.
Each student has to submit an interim report of the project at the end of the 7th semester. Members of the group will present the project details and progress of the project before the committee at the end of the 7th semester.
50% of the mark is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment
20% - Technical relevance of the project
40% - Literature survey and data collection
20% - Progress of the project and presentation
10% - Report
10% - Regularity in the class

ME14 801 Mechatronics

Teaching scheme Credits: 4
3 hours lecture and 1 hour tutorial per week

Course Objectives:

- *To impart knowledge on the fundamentals of the following*
  - *i. Control systems*
  - *ii. Controls in NC machine*
  - *iii. Fluidic Controls and*
  - *iv. Process control Pneumatics.*

Course Outcome

- *The students will become familiar with the different aspects of mechatronic engineering.*
- *They will have working knowledge to handle problems involving mechatronic and control elements.*

Module I (13 Hours)

Introduction - multidisciplinary scenario - evolution of mechatronics - scope of Mechatronics - measurement systems - control systems - servomechanisms and regulators - control system fundamentals - block diagrams and block diagram reduction.

Module II (13 Hours)

Mechartonic elements - data presentation systems - displays - analog and digital indicators - analogous chart recorders - visual display units - CRO - printers - magnetic recorders – light indicators - liquid crystal display units - alarm indicators data loggers - computers with plug in boards-data acquisition systems.

Module III (13 Hours)

Process control pneumatics - signals and standards - the flapper nozzle - volume booster – air relay and force balance - pneumatic controllers - proportional pneumatic control - proportional plus integral pneumatic control - proportional plus integral plus derivative pneumatic control - PI and IP convertors.

Module IV (13 Hours)

Controls in NC Machines and fluidic control

Controls in NC Machines-hydraulic systems - direct current motors - stepping motors - feedback devices-encoders - resolvers - inductosyn – tacho generators - principles of fluid logic control -Coanda effect - basic fluidic devices - fluidic logic gates - bistable – flip flop - OR and NOR gates - exclusive OR gates - fluidic sensors - backpressure sensor - cone jet proximity sensor -interruptible jet senor.

Text books

1. W Boltson , „*Mechatronics*", Pearson Education third edition 2007.
2. Anthony Esposito, „*Fluid Power with applications, 6/E*', Pearson Education, 2009
3. Andrew Parr, „*Hydraulics and Pneumatics*', Jaico Publishing House ,Mumbai 2006.
4. Kuo ,Automatic Control Systems, Asian student Edition, Prentice Hall of India, 2005.

Reference Books:

1. MahalikNitaigour, Premehand, „*Mechatronics*", TataMc.Graw Hill Publishers, New Delhi 2005.
2. Ogata Katsuhiko , „*Modern Control Engineering*", Printice Hall of India , 2005.
3. YoranKoren, „*Computer control of Manufacturing Systems*", Tata McGraw Hill Publishers, New Delhi, 2005.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 802 Power Plant Engineering

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of power plant technology.*
- *To develop understanding about power plant cycles, power generation devices, and power plant economics.*

Module I (14 hours)

Analysis of vapor power cycle- Rankine cycle-deviation of actual cycle from ideal cycle. ideal reheat and regenerative cycles- open and closed feed water heaters –second law analysis of vapor power cycles. Cogeneration- binary vapor cycle.

Analysis of Gas turbine cycles - open and closed cycles - regeneration - reheating – inter cooling - efficiency and performance of gas turbines- combined gas power cycle.

Module II (12 hours)

Modern high pressure boilers- Sub critical and super critical steam generation-rating of boilers-boiler efficiency- equivalent evaporation-boiler draught types and its calculations. Guidelines for selection of boilers for steam power plants. Boiler testing and trials-inspection and safety regulations (simple problems).

Thermal power plant systems- fuel handling and ash handling systems-combustion equipments-super heaters, economizers, air-pre heaters and feed water heaters

Module III (14 hours)

Steam nozzles- mass flow relations- area ratio- critical pressure ratio- effect of back pressure – supersaturated flow in nozzles

Steam turbines-velocity diagrams-efficiencies-turbine performance and governing

Power plant condensers- Classification, selection and Performance. Counter flow and cross flow – evaporative cooling Towers - selection of cooling towers.

Pollution from thermal power plant- pollution control

Module IV (12 hours)

Gas turbine power plants -combustion chambers of gas turbines - cylindrical - annular and industrial type combustion chamber - combustion efficiency - axial flow turbines - design of nozzles and blades for turbines - limiting factors in turbine design

Nuclear power plants- pressurized water reactors-boiling water reactors-gas cooled reactors-fast breeder reactors –pollution

Economics of power plant-terms and definitions-types of load-typical load curves-- fixed cost- operating cost-variable load operation-economics of load sharing and power generation. Cost of electricity and energy Tariffs.

Text Books

1. R. K. Rajput *A Text Book of Power Plant Engineering* Laxmi Publications
2. S. C. Arora, S. Domkundwar, *A Course in Power Plant Engineering*, DhanpatRai
3. V. GANESAN, *GAS TURBINES 3E,* Tata McGraw Hill

Reference Books

1. E. L. Wakil, *Power Plant Technology*, McGraw Hill.
2. P.K. Nag ,*A Text Book of Power Plant Engineering,* Tata McGraw Hill.
3. P. C. Sharma, *Power Plant Engineering*, S.K Kataria and Sons
4. C. P. Kothandaraman, S. Domkundwar, Basic *Power Plant Engineering*, DhanpatRai
5. Cohen, Rogers, *Gas Turbine Theory*, Longmans

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 803 Operations Management

Teaching scheme Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on production, planning and control functions, method study, materials management, inventory models, maintenance management and project management*

Module I (13 hours)

Operations Management – An overview: Nature and scope of production and Operations Management – Productivity and factors affecting productivity – Types of production systems- product life cycle Forecasting technique – Causal, Time series and Qualitative methods – Regression, Moving average-Trend and seasonality-Exponential smoothing and Delphi technique Product design and development – principles of good product design- quality and cost consideration –standardization – simplification

Module II (13 hours)

Process design and planning – Types – Fixed, Product, process, hybrid and FMS, Facility location and layout – Influencing factors and evaluation methods – Layout design process –Computerised layout planning - Assembly line balancing – Material handling systems Work system design – Method study – Recording techniques- micro

motion study – work measurement Aggregate production planning – Master production scheduling – Material requirement planning – Manufacturing resource planning

Module III (13 hours)

Materials Management: Purchase Management- Stores Management Inventory: Functions – Costs – classifications – Deterministic and Probabilistic Inventory models-Quantity discount – Safety stock Operations scheduling: Strategy and guidelines – charts and methods – sequencing – Johnson's rules for sequencing, Dispatching, progress reporting and expediting functions

Module IV (13 hours)

Maintenance and replacement – Preventive and breakdown maintenance – Economic aspects –Replacement of equipment – methods, Network techniques for Project management – Time estimates – Time- Cost tradeoffs-Crashing –Shortest route problem – Minimal Spanning tree problem –Maximal flow in capacitated network

Text Book

1.R. Paneerselvam, *Production and Operations Management* Third Edition, PHI learning Private Limited

Reference Books

1. Mahadevan B. *Operations Management Theory and Practice*, Pearson education, Second impression 2007
2. William, J. *Operations Management*, Stevenson 8th 2005 edition
3. Chase Richard B, *Operations Management*, 11th edition Tata McGrawhil
4. Ashwathappa. K, Sridhar Bhat. K, *Production and Operations Management*, Himalaya Publications
5. Monks, Joseph G. *Operations Management*, McGrawhil
6. Riggs J.L, *Economic Decision Models for Engineers and Managers*, McGraw Hill International Student Edition
7. Weist and Levy, *A Managemnt Guide to Pert and CPM*, Prentice Hall of India
8. Samuel Eilon, *Production Planning and Control*, Universal Book Corporation
9. Francis and White, *Facility Layout and Location*, Prentice Hall Inc
10. Hillier and Liberman, *Introduction to Operations Research*, Holden Day Inc
11. Biegel, *Production Control*, Prentice Hall of India
12. James Moore, *Plant Layout and Design*, The MacMillan Company

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 804(A) Marketing Management

Teaching scheme Credits: 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on fundamentals of marketing, marketing environment market oriented strategic planning, marketing research and marketing communications.*

Pre-requisites: *Basic knowledge of principles of management*

Module I (13 hours)

Introduction to marketing : Defining marketing for the twenty first century, marketing – scope, tasks, concept of market and marketing, company orientations towards the market place – production , product, selling, marketing, customer and societal marketing concepts.
Marketing environment : Controllable factors, identifying and responding to the major macro environment – uncontrollable factors – demographic, economic, natural technological, political- legal and social – cultural environment.

Module II (13 hours)

Market Oriented strategic planning – key areas, organizational levels, corporate and division strategic planning – corporate mission, strategic business units, The Boston consulting group approach, The general electric model, Planning new businesses – Growth – Intensive, integrative, diversification, Marketing mix – variables, marketing-mix strategy. Market-segmentation – levels, patterns, procedure, effectiveness. Market targeting – Evaluation, target market selection.

Module III (13 hours)

Marketing research – Need, scope – Marketing research process. Consumer behaviour – factors influencing buyer behaviour – Cultural, social personal, psychological factors.Defining customer value and satisfaction.Product life cycles – marketing strategies for different stages of product life cycle.

Module IV (13 hours)

Marketing communications – process – developing effective communications – Identification of the target audience, determination of communication objectives, Designing the message, select the communication channels, establishing the total marketing communications budget – Deciding on the marketing communications mix – promotional tools an over view – advertising, sales promotion, public relations and publicity, sales force and direct marketing- developing and managing an advertising program – setting objectives, deciding budget, choosing message – an overview on measuring effectiveness of a media – sales promotion – purpose, major decisions.

Text Books

1. P. Kotler, *Marketing Management*, 14th Edition – Pearson Eductation (India) Pvt Ltd, New Delhi (2013)
2. Baines P., Fill C., Page K., Marketing, Oxford University Press, 2013.

Reference Books

1. V. S. Ramaswamy, S. Namkumari, *Marketing Management*, McMillan India Ltd, New Delhi (1997)
2. Saxena. *Marketing Management*, 2nd Edition, Tata McGraw Hill (2002).

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 804(B) Aerospace Engineering

Teaching scheme **Credits: 4**

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concepts of aerospace engineering.*
- *To develop understanding about aerofoil theory and airplane performance.*

Pre-requisites: *Basic knowledge of fluid mechanics and gas dynamics*

Module I (13 hours)

Review of gas dynamics: Control volume analysis, continuity, momentum and energy equations. Static, dynamic and stagnation conditions. Phenomena in supersonic flow – aerostatics – international standard atmosphere – pressure, temperature and density variation in international standard atmosphere.

Module II (13 hours)

Equations for incompressible inviscid flows: Circulation and vorticity – kelvin's theorem – velocity potential and stream function. Elementary flow patterns and their superposition.Blasius theorem. Flow past a cylinder, magnus effect, kutta condition, vortex theory of lift. Conformal transformation, Jowkowski transformation.

Module III (13 hours)

Theory of aerofoil: Application of dimensional analysis to viscous flow over bodies – aerofoil geometry – lift, drag and moment equations, characteristic curves, low theory, symmetric aerofoil, tear drop theory. wave drag of aerofoil – The NACA aerofoils. Theory of propeller – momentum and blade element theory, propeller characteristics.

Module IV (13 hours)

Straight and level flight – stalling speed, minimum drag and maximum power conditions, performance curves. Gliding – gliding angle and speed of fastest glide. Climbing – rate of climb, take off and landing performance, length of runway required. Circling flight, banked flight, range and endurance of airplanes.aircraft instruments – airspeed indicators – calculation of true airspeed, altimeters, rate of climb meter, gyro compass.

Text Books

1. J. D. Anderson Jr., *Fundamentals of Aerodynamics*, McGraw Hill

Reference Books

1 Dommasch, *Airplane Aerodynamics*,

2 A. C. Kermode, *Mechanics of Flight*,

3 Houghton, Brock, *Aerodynamics for Engineering Students*

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 804(C) Energy Engineering and Management

Teaching scheme Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on energy conservation and management.*
- *To impart the basics of renewable energy technology*

Module I (13 hours)

Energy and environment: Introduction – fossil fuel reserves – world energy consumption – green house effect – global warming – renewable energy sources – environmental aspects utilization – energy prices – energy policies

Module II (13 hours)

Energy conservation: Industrial energy use – energy surveying and auditing – energy index – energy cost – energy conservation in engineering and process industry, in thermal systems, in buildings and non conventional energy resources schemes.

Module III (13 hours)

Energy technologies: Fluidized bed combustion – fluidized bed boilers – waste heat recovery systems – heat pump and refrigerators – wind energy collectors and storage systems – insulated pipe work systems.

Module IV (13 hours)

Energy management: Energy management principles – energy resources management – energy management information systems – computerized energy management. Costing techniques – cost optimization – optimal target investment schedule – financial appraisal and profitability.

Text Books

1. W. R. Murphy, G. Mc Kay, *Energy Management*, Butterworths, London

Reference Books

1. O. Callaghn, *Design and Management for energy conservation*, Pergamon Press, Oxford
2. D. Merick, *Energy - Present and Future Options*, vol 1 and 2, John Wiley and Sons
3. N. A. Chaigier, *Energy Consumption and Environment*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 804(D) Cryogenic Engineering

Teaching scheme Credits: 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on basics of low temperature production and applications*

Pre-requisites: *Basic knowledge of thermodynamics and refrigeration*

Module I (13 hours)

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.

Module II (13 hours)

Liquefaction systems: ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers.

Gas liquefaction systems: Introduction - Production of low temperatures- General Liquefaction systems- Liquefaction systems for Neon. Hydrogen and Helium – Critical components of Liquefaction systems.

Module III (13 hours)

Cryogenic Refrigeration systems: Ideal Refrigeration systems- Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media, cryogenic fluid storage and transfer systems:

Module IV (13 hours)

Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems, Pressure flow-level and temperature measurements – Types of heat exchangers used in cryogenic systems. Cryopumping Applications.

Text Books

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

Reference Books

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

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 804(E) Control System Engineering

Teaching scheme Credits: 4
3 hours lecture and 1 hour tutorial per week

Objectives

To provide knowledge on basics of control system

Pre-requisites: *Basic mathematics*

Module I (13 hours)

Mathematical modelling –block diagrams-modelling in state space-mechanical, electrical, liquid level and thermal systems- functions, Set point- Identification of plat Characteristics- First order proportional and second order proportional elements.

Module II (13 hours)

Classification of control systems-Transient response analysis-first and second order representations- Derivation of Transfer functions.

Module III (13 hours)

Dynamic response –stability of control systems- Routh – Hurvitz criterion- Nyquist criterion. Bode plots - root locus method-lead ,lag , lead –lag compensations-introduction to instrument design.

Module IV (13 hours)

Mat : lab fundamentals- linear and non linear systems –matrix, tensor representations of control systems – solutions by mat lab (simple examples).

Reference Books

1. R. K. Jain, *Mechanical and Industrial Measurements*
2. D. M. Considine, *Process Instrument and Control Hand Book*
3. E. O. Doeblin, *Measurements System, Application and Design*
4. K. Ogatta, *Modern control systems,*
5. B. Kuo, *Control Systems, Prentice Hall*

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 804 (F) Industrial Tribology

Teaching scheme **Credits: 4**

3 hours lecture and 1 hour tutorial per week

Objectives

To impart knowledge on theory of lubrication, finite journal and thrust bearings, hydrodynamic gas bearing and theory of friction and wear

Pre-requisites: *Basics of material science and mechanics*

Module I (13 Hours)

Introduction – viscosity and its temperature dependents – models of visco elastic materials – Navier-Stoke"s equations – derivation of Reynold's equation from Navier-Stoke's equation – one dimensional journal bearing – infinitely long bearing – infinitely short bearing - one dimensional thrust bearing.

Module II (13 Hours)

Finite journal and thrust bearings – journal bearing work – axial and circumferential feeding – journal bearing solutions – centrally loaded partial bearings – axial groove bearings – non circular bearings – finite thrust bearings – step bearings.

Module III (13 Hours)

Hydrodynamic gas bearing – general equations – limiting characteristics – infinitely long slider bearings – parallel, plane, inclined, slider, step slider – finite slider bearings – infinitely long journal bearings – journal bearings with inertia considered – journal bearings with inertia neglected – finite journal bearings – perturbation and numerical solutions.

Module IV (13 Hours)

Friction and wear – mixed friction theory of sliding friction – boundary friction – extreme pressure lubrications – surface layer – extreme pressure additives – thick boundary film thickness – scuffing boundary friction – stick – slip- wear- adhesive wear – mild and sever wear – abrasive wear – fatigue and corrosive wear- delaminations – measurement of friction and wear.

Text books:

1. B. C. Majumdar, *Introductin to Tribology*, A H Wheeler, Bangalore.

Refernce Books:

1. Pinkus and Sternilincht, *Theory of hydrodynamic lubrication*, John Wiley and Son, Newyork
2. D. F. Moore, *Principle and Application of Tribology*, Pergamon Press, Newyork
3. E. Rabinnowizc, *Friction & Wear of Metals*, John Wiley & Sons , Newyork
4. K. L. Johnson, *Contact Mechanics*, Cambridge University Press.
5. T. R. Thomas, *Rough Surfaces*, Longman Inc.

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 804 (G) Wind Energy and its Utilization

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Module I – (13 Hours)
Historical developments, latest developments, state of art of wind energy technology, turbine rating, cost of energy, wind power plant economics, installation and operation costs, decommissioning, Indian scenario and worldwide developments, present status and future trends.
Nature of atmospheric winds; wind resource characteristics and assessment; anemometry; wind statistics; speed frequency distribution, effect of height, wind rose, Weibull distribution, atmospheric turbulence, gust wind speed, effect of topography.

Module II – (13 Hours)
Aerodynamics of aerofoil; lift; drag; stall; effect of Reynold's number; actuator disc; momentum theory and Betz coefficient; design of wind turbine blade; effect of stall and blade pitch on coefficient of power vs tip speed ratio and cut-out wind speeds, blade materials. Vertical and horizontal axis turbines, design characteristics, multiple stream tube theory, vortex wake structure; tip losses; rotational sampling, wind turbine design programs, aerodynamic loads, tower shadow, wind shear, blade coning, gyroscopic, transient and extreme loads. Aerodynamic damping and stability, teetering motion, stiff and soft towers, Power train dynamics.

Module III – (13 Hours)
Pitch control, yaw control, Electrical and Mechanical aerodynamic braking, teeter mechanism. Wind turbine dynamics with DC and AC generators: induction and synchronous generators, variable speed operation, effect of wind turbulence. Power electronics Converter and Inverter interfaces for wind energy utilization system for isolated and grid connected system.

Module IV – (13 Hours)
Wind farm electrical design, Planning of wind farms, special application for developing countries, maintenance and operation, wind farm management, site selection. Environmental assessment; noise, visual impact etc. Instrumentation, data loggers, remote monitoring and control.

Text Book:
1. Paul Gipe, *Wind Energy Comes of Age*, John Wiley & Sons Inc.
2. L.L. Freris, *Wind Energy Conversion System*, Prentice Hall.

References:

1. Tony Burton et al, *Wind energy Hand Book*, John Wiley & Sons Inc.
2. *Directory, Indian Windpower 2004*, CECL, Bhopal.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 805(A) Quality Engineering and Management

Teaching scheme Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To analyse key definitions of quality, focusing on a customer-centric approach.*
- *To provide knowledge on the managerial tools and techniques on quality*
- *To analyze the relationship of statistics to a process and to use the statistical tools*
- *To analyze and generate acceptance sampling plans*
- *To provide knowledge on the reliability and life testing of components and systems*

Module I (13 hours)

Concepts of quality: Quality control – Quality assurance – Quality management- Quality costs, Total Quality Management: Axioms – Management commitment- Deming's approach – Quality council,– Customer satisfaction and retention – Employee involvement and empowerment – Suggestion system –Quality circle – Continuous process improvement – Juran's trilogy – PDSA cycle – Kaizen – Six-sigma Crosby's quality treatment

Module II (13 hours)

Management tools and techniques: Benchmarking – ISO quality management systems – Quality function deployment – Quality by design – Failure mode and effect analysis – Affinity diagram – Block diagram –Pareto chart – Fish bone diagram – Flow chart – Run chart – Scatter diagram – Tree diagram – Matrix diagram

Module III (13 hours)

Statistical tools Control charts: Basic concepts - Attributes and variables - Random and assignable causes of variations- Patterns of variation - Measures of central tendency and dispersion – Probability distributions: Binomial, Poisson and Normal Control charts for variables, X , R and sigma charts – Details of construction and uses Control charts for attributes: p, np, c and u charts – Details of construction and uses (Numerical problems included)

Module IV (13 hours)

Statistical tools 2- Acceptance sampling, Reliability and Life testing: Sampling Vs inspection - OC curve - Single and double sampling plans - ATI - AOQL - Life testing - Bathtub curve – MTBF - OC curve for Life testing - System reliability (Numerical problems included)

Reference Books

1. M Mahajan, Statistical Quality Control, DhanpathRai& Co
2. Bester Field, Dale H, Carol Boeterfreld – Muchna, Glen H, BoeterfreldMeryBoeterfeld-Scare, 2003, *Total Quality Management*, 3rd edition, Pearson, Education, New Delhi.
3. Logethetis, N. (1992), *Managing for Total Quality*, Prentice Hall International, Englewood Cliffs, NJ.,
4. Grant.E.L., *Stastical Quality Control*, McGraw Hill
5. Juran J.M, Gryna I.M., *Quality Planning and Analysis*, Tata McGraw Hill Publishing Company
6. Montgomery, Douglas C, 2001, *Introduction to Statistical Quality Control*, Fourth edition, John Wiley and Sons, Inc, New Delhi
7. Gerals M Smith- 2004, *Statistical Process Control and Quality Improvement*- 5th edition

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 805(D) Computerised Materials Management

Teaching scheme Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on basics of advances in materials management*

Pre-requisites: *Basic knowledge of management principles*

Module I (13 hours)

Introduction to Materials management – Importance of material management and its role in industries. The need for the integrated approach in Material management Demand forecasting – Various qualitative and quantitative methods of demand forecasting – Different type of averaging, Exponentially weighed smoothening, Correction for fluctuations, Time series analysis, Delphi and other Group techniques. Development of simple Computer Programme for forecasting.

Module II (13 hours)

Inventory control – Basic methods in Inventory – Assumptions used in deriving models. Inventory costs and EOQ model.Price breaks and quantities – Effects of variations in lead-time and demand. Effects of shortage cost on EOQ. Systems of Inventory control, Design of Inventory control systems. Development of Computer Programme for forecasting.

Module III (13 hours)
Classification systems and selective Inventory control – ABC, VED, FSN, HML, and MUSIC, 3-D approaches, Coverage analysis in Material management. Development of Computer Programme for ABC analysis – Codification and standardization Systems and Techniques, Effects in Cost.Vendor rating and source selection.Techniques and materials.Use of Indian Standards for Vendor rating. Make or buy decisions – Materials Requirements Planning Concept, methods and illustration examples.

Module IV (13 hours)
Introduction to JIT philosophy – Features and impact in Materials Management. Purchasing – Purchase organization – legal aspects of buying – Purchase Procedure. Store and Material control – Receipts and issues – Stores Record. Methods and principles of Storing and retrieving items. Material handling devices used in stores – Application of Computers in Material handling – Design of informatics systems for procurement and storage using computer.

Reference Books
1. Bnchan, Kbenigsberg, *Scientific Inventory Management*
2. Starr, Miller, *Inventory Management*
3. R. M. Shah, *Materials Management*
4. P.Gopalakrishnan, *Integrated Material management*
5. Tershine, *Principles of Inventory management*

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 805 (E) Design of Pressure Vessels and Piping

Teaching scheme Credits: 4
3 hours lecture and I hour tutorial per week
Objectives
To provide knowledge on design of pressure vessels and piping
Pre-requisites: *Basic knowledge of solid mechanics*

Module I (13 Hours)
Methods for determining stresses - terminology and ligament efficiency - applications.
Stresses in pressure vessels: Stresses in a circular ring, cyclinder - membrane stress analysis of vessel shell - components - cylindrical shells, spherical shells, torispherical heads, conical heads – thermal stresses - discontinuity of stresses in pressure vessels.

Module II (13 Hours)
Design of vessels: Design of tall cylindrical self supporting process columns - supports for short vertical vessels – stress concentration - at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of reinforcement - pressure vessel design.

Module III (13 Hours)
Buckling and fracture analysis in vessels : Buckling phenomenon - elastic Buckling of circular ring and cylinders under external pressure - collapse of thick walled cylinders or tubes under external pressure - effect of supports - elastic buckling of cylinders - buckling under combined external pressure and axial loading
Module IV (13 Hours)
Fracture mechanics based design: LEFM - stress intensity factor – fracture toughness – fracture criterion – fatigue – fatigue crack growth – fail safety criterion – leak before brake - control and significance of fracture mechanics in vessels - FEM application. Piping: Introduction - flow diagram - Piping layout and piping stress analysis.

Text book

1. J. F. Harvey, *Theory and Design of Pressure Vessels*, CBS Publishers and Distributors, 1987.

Reference books

1. Henry H. Bedner, *Pressure Vessels, Design Hand Book* , CBS Publishers and Distributors, 1987.
2. Stanley, M. Wales, *Chemical Process Equipment, Selection and Design*, Buterworths series in Chemical Engineering, 1988.
3. D. Broek, *Elementary Engineering Fracture Mechanics*, Sijthoff&Noordhoff International publishers.
4. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, *Concepts & Applications of Finite Element Analysis*, John Wiley & Sons

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 805 (F) Industrial Maintenance

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week
Objectives
- *To provide knowledge on basic concepts of maintenance, vibration monitoring, non destructive testing and concepts of reliability*

Module I (13 hours)
Basic concepts purpose and functions of maintenance – types of maintenance – condition monitoring – principles and method –Transducers for vibration measurement.

Module II (13 hours)
Elementary problem diagrams – misalignment – unbalance – vibration monitoring and analysis – Vibration analysis – proximity analysis – frequency analysis – spectral analysis – real time analysis vibration limits vibration severity criteria vibration severity charts – shock pulse analysis application to condition monitoring of ball and roller bearings - vibration signature analysis.

Module III (13 hours)
Ferrography – spectral oil analysis procedure – non destructive testing – liquid penetrant testing – radio graphic inspection – ultra sonic testing acoustic emission corrosion monitoring – resistance techniques – technique providing information on plant regarding corrosion monitoring

Module IV (13 hours)
Reliability: Basic concepts – reliability , maintainability and availability – failure rate – mean time between failures – system reliability – reliability of series and parallel systems – reliability estimation using exponential distribution function.

Text Books

1. L. S. Sreenath, *Vibration spectrum analysis A practical approach*, Steve Goldman Industrial Press Inc.

Reference Books

1. Miller, Blood, *Modern Maintenance Management*, D B Tarapur.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 805 (G) Tool Engineering and Design

Teaching scheme **Credits: 4**
3 hours lecture and 1 hour tutorial per week
Objectives
- *To impart knowledge on basic concepts of tool design.*

Module I (13 hours)
Design of chips forming tool, chip removal process, principle, classification of tools, tool geometry – tool materials – multi point tools – milling cutter, drills, reamer, taps, broaches, Machining time estimation for milling, drilling, cutting power estimation in milling, drilling operations, boring bar, vibration damping of bar boring.
Module II (13 hours)
Power presses, types, die cutting operation, press tonnage calculations – scrap-strip layout, compound & progressive dyes, design of dies for simple components, drawing dies, blank development, press tonnage and blank holding pressure, draw dies for simple components.

Module III (13 hours)
Design of thermoplastic injection moulds: Plastic materials, classes of plastics, injection moulds, specifications, injection moulding machine and its influence in mould design, phases of moulding cycle, parting surfaces, feed systems – sprue, runner and gate systems, mould casting, ejection methods, shrinkage, mould tool materials.
Module IV (13 hours)
Design of work holders: Purpose of work holders, function, principle of location and clamping, locators, toll forces, design of work holder for tapping, fixture components, work holders for round work pieces – mandrels, collets.

Reference Books

1. Bhattacharya, *Metal cutting theory and practice*, Central Book Publishers.
2. ASTME, *Fundamentals of tool design*, Prentice Hall.
3. G. R. Nappel, *Machine Tool Engineering, Khanna Publishers*
4. P. S. Cracknell, R. W. Dysor, *Handbook of thermoplastic injection mould design*, Blackie Academic and Professional, Glasgow.
5. HMT, *Production Technology*, Tata McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Attendance and Regularity in the class

University Examination Pattern

PART A:	*Analytical/problem solving SHORT questions* Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.	*8x 5 marks=40 marks*
PART B:	*Analytical/Problem solving DESCRIPTIVE questions* Two questions from each module with choice to answer one question.	*4 x 15 marks=60 marks*

Maximum Total Marks: 100

ME14 806(P) Seminar

Teaching scheme **Credits:** 2
3 hours practical per week

Objectives
- *To assess the ability of the student to study and present a seminar on a topic of current relevance in the field of Mechanical Engineering or allied areas*

It enables the students to gain knowledge in any of the technically relevant current topics and acquire the confidence in presenting the topic. The student will undertake a detailed study on the chosen topic under the supervision of a faculty member, by referring papers published in reputed journals and conferences. Each student has to submit a seminar report, based on these papers; the report must not be reproduction of any original paper. A committee consisting of three/four faculty members will evaluate the seminar.

Internal Continuous Assessment (Max. Marks : 100)
20% - Relevance of the topic and literature survey
50% - Presentation and discussion
20% - Report
10% - Regularity in the class and Participation in the seminar

ME14 807(P) Project

Teaching scheme **Credits: 4**
7 hours practical per week

Objectives

- *To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model or a system.*

This project work is the continuation of the project initiated in seventh semester. The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation committee through progress seminars and demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc. There shall be at least an Interim Evaluation and a final evaluation of the project in the 8th semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation.
Each project group should complete the project work in the 8th semester. Each student is expected to prepare a report in the prescribed format, based on the project work. Members of the group will present the relevance, design, implementation, and results of the project before the project evaluation committee comprising of the guide, and three/four faculty members specialised in different streams in Mechanical Engineering i.e. Thermal Sciences/ Manufacturing/ Design/ Management. etc.
50% of the mark is to be awarded by the guide and 50% by the evaluation committee.

Internal Continuous Assessment *(Maximum Marks - 100)*
40% - Design and development/Simulation and analysis
30% - Presentation & demonstration of results
20% - Report
10% - Regularity in the class

ME14 808(P) Viva Voce

Credits: 4

Objectives

- *To examine the knowledge acquired by the student during the B.Tech. course, through an oral examination*

The students shall prepare for the oral examination based on the theory and laboratory subjects studied in the B.Tech. course, seminar, and project. There is only university examination for viva-voce. University will appoint two external examiners and an internal examiner for viva-voce. These examiners shall be senior faculty members having minimum five years teaching experience at engineering degree level.
For final viva-voce, candidates should produce certified reports of mini project, seminar, and project. If he/she has undergone industrial training/industrial visit/educational tour or presented a paper in any conference, the certified report/technical paper shall also be brought for the viva-voce.
Allotment of marks for viva-voce shall be as given below.

Assessment in Viva-voce *(Maximum marks – 100)*
40% - Subjects
30% - Project
20% - Seminar
10% - Industrial training/industrial visit/educational tour or Paper presented at National-level

25/11/14

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97 & Chairman, BoS (ME)

ME14 805 (B) Heating, Ventilation and Air-conditioning Design

Teaching scheme: Credits: 4

3 hours lecture and I hour tutorial per week

Objectives

1 .To impart knowledge on principles of refrigeration, cooling and heating load calculation, design of air conditioning system and selected systems in comfort engineering

Pre-requisites: Basics of thermodynamics, fluid mechanics, and heat transfer

Module I (14 Hours)

Principles of refrigeration and psychrometry. Psychrometric properties and processes. Air conditioning systems and its applications Psychrometric chart- various process-sensible cooling and heating - adiabatic saturation - use & absorbent or adsorbent - Heating and humidification - cooling and dehumidification - mixing of air streams - use of psychrometric chart for air conditioning various process - S.H.F, G..S.H.F, E.S.H.F Etc.

Module II (13 Hours)

Cooling and heating load calculation - selection of design temperatures - sources of heat load-heat transfer through structures - solar radiation - Infilteration and ventilation- Heat generation inside the conditioned space - heat storage, Diversity and stratification.

Module III (13 Hours)

Design of air conditioning system. Continuty equation, Bernoulli's equation, pressure losses, Duct design - pressure drop in ducts, pressure drop by graphical method- method of duct design- Arrangements of ducts, fan design, thermal insulation

Module IV (14 Hours)

Heating systems-warm air systems-hot water systems steam heating systems-panel and central heating systems-heat pump circuit. Applications - comfort air conditioning-effective temperature-thermal analysis of human body- Air conditioning systems- evaporate cooling- low humidity applications Automobile and Train car air conditioning.

Text Book

1. Faye C. McQuiston , Jerald D. Parker , Jeffrey D. Spitler, Heating, ventilating, and air conditioning: analysis and design, John Wiley & Sons, 2005
2. Thomas H. Kuehn, James W. Ramsey , James L. Threlkeld, Thermal environmental engineering, Prentice Hall, 1998
3. ASHARE handbook

Refernce Books:

1. C. P. Arora, Refrigeration and Air Conditioning.
2. Manohar Prasad, Refrigeration and Air Conditioning.
3. W. P. Jones, Air-conditioning Engineering
4. Carriers Handbook system design of Air Conditioning
5. R. G. Jordan, G. B. Priester, Refrigeration and Air conditioning.

Internal Continuous Assessment (Maximum Marks-50)

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks = 40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

ME14 805(C) Computational Fluid Dynamics

Teaching scheme Credits: 4

3 hours lecture and 1 hour tutorial per week

Objectives:

1. To impart the concept of computational methods in fluid flow and heat transfer
2. To develop understanding about principles of fluid flow modelling.

Pre-requisites: Basic knowledge of fluid mechanics and heat transfer

Module I (14 hours)

Classification of partial differential equations - system of first and second-order partial differential equations - initial and boundary conditions - finite difference formulations - finite difference equations simple applications in steady state conduction and convection.

Module II (13 hours)

Elliptic partial differential equations relaxation method. Parabolic partial differential equations - explicit and implicit method ADE and ADI method. Hyperbolic partial differential equations method of characteristics - explicit and implicit method. Consistency, errors and stability analysis.

Module III (14 hours)

Fundamentals of fluid flow modelling upwind scheme artificial viscosity hybrid scheme. Solution of viscous incompressible flows by the stream function vorticity formulation. Solution of Navier- Stokes equations for incompressible flows using MAC and SIMPLE algorithms stability considerations.

Module IV (13 hours)

Introduction to finite volume method regular finite volume approximations in the discretization technique discretization procedure semi-explicit method implementation of boundary conditions (only elementary theory and no direct problems).

Text Books

1. T. Sundararajan, Computational fluid flow and heat transfer, Narosa publishing House

Reference Books

1. Hoffmann Klaus, Computational Fluid Dynamics for Engineers - Volume I, Engineering Education System, Wichita
2. V. PatankarSuhas, Numerical Heat Transfer and Fluid Flow, Taylor & Francis
3. J. Fletcher, Computational Techniques for Fluid Dynamics I, Springer Verlag

Internal Continuous Assessment (Maximum Marks-50)

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Attendance and Regularity in the class

University Examination Pattern

PART A: Analytical/problem solving SHORT questions 8x 5 marks = 40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100