BMS COLLEGE OF ENGINEERING, BENGALURU

Autonomous College under VTU

VISION

Promoting Prosperity of mankind by augmenting human resource capital through Quality Technical Education & Training

MISSION

Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society

DEPARTMENT OF MECHANICAL ENGINEERING

SECOND YEAR SYLLABUS BOOK

With effect from A. Y. 2015 – 16

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DEPARTMENT OF MECHANICAL ENGINEERING

Scheme & Syllabus for UG Programme - III & IV Semesters

DEPARTMENT VISION

To become a center of excellence in educating students to become successful Mechanical Engineers

DEPARTMENT MISSION

- To empower the students with the fundamentals for a successful career in the field of Mechanical engineering.
- To continue their education through post-graduation, Research & Development.
- To provide service to the society.

PROGRAM EDUCATIONAL OBJECTIVES

1. PEO1 -Graduates shall have successful careers as Mechanical Engineers, lead & manage teams.
2. PEO2 - Graduates shall be professional in engineering practice and socially responsible
3. PEO3 - Graduates shall be pursuing advanced education, research and engage in the process of life-long learning.

PROGRAM OUTCOMES

PO 1	Ability to apply knowledge of mathematics, science, and Mechanical engineering fundamentals to solve complex problems in engineering
PO 2	Ability to analyze mechanical engineering problems, interpret data and arrive at meaningful conclusions involving mathematical inferences
PO 3	Ability to design a mechanical system, component, or process to meet desired needs considering public health and safety, and the cultural, societal, and environmental considerations.
PO 4	Ability to understand and solve complex mechanical engineering problems by conducting experimental investigations.
PO 5	Ability to apply appropriate tools and techniques and understand utilization of resources appropriately to complex mechanical engineering activities.
PO 6	Ability to understand the effect of mechanical engineering solutions on legal, cultural, social and public health and safety aspects.
PO 7	Ability to develop sustainable solutions and understand their effect on society and environment.
PO 8	Ability to apply ethical principles to engineering practices and professional responsibilities.
PO 9	Ability to work as a member of a team, to plan and to integrate knowledge of various engineering disciplines and to lead teams in multidisciplinary settings.
PO 10	Ability to make effective oral presentations and communicate technical ideas to a broad audience using written and oral means
PO 11	Ability to lead and manage multidisciplinary teams by applying engineering and management principles.
PO 12	Ability to adapt to the changes and advancements in technology and engage in independent and life-long learning

DEPARTMENT OF MECHANICAL ENGINEERING

Scheme & Syllabus for UG Programme - III & IV Semesters

SCHEME OF INSTRUCTION FOR THIRD SEMESTER

Sl. No.	Code	Course Title	Credits				
			L	T	P	S	Total
1	**15MA3GC MAT**	ENGINEERING MATHEMATICS-3	3	0	0	0	**3**
2	**15ME3DC MSM**	MATERIAL SCIENCE & METALLURGY	3	0	0	0	**3**
3	**15ME3DC SOM**	STRENGTH OF MATERIALS	3	0	1	2	**6**
4	**15ME3DC FWT**	FOUNDRY AND WELDING TECHNOLOGY	3	0	1	0	**4**
5	**15ME3DC BTD**	BASIC THERMODYNAMICS	3	0	0	0	**3**
6	**15ME3DC FME**	FLUID MECHANICS	3	0	1	2	**6**
		Total	**18**	**0**	**3**	**4**	**25**

SCHEME OF INSTRUCTION FOR FOURTH SEMESTER

Sl. No.	Code	Course Title	Credits				
			L	T	P	S	Total
1	**15MA4GC MAT**	ENGINEERING MATHEMATICS-4	3	0	0	0	**3**
2	**15ME4DC ATD**	APPLIED THERMODYNAMICS	3	0	0	0	**3**
3	**15ME4DC KOM**	KINEMATICS OF MACHINES	3	0	0	1	**4**
4	**15 ME4DC DM1**	DESIGN OF MACHINE ELEMENTS-I	3	1	0	0	**4**
5	**15ME4DC MTM**	MACHINE TOOLS & MACHINING	3	0	1	2	**6**
6	**15ME4DC MMM**	MECHANICAL MEASUREMENTS & METROLOGY	3	0	1	1	**5**
		Total	**18**	**1**	**2**	**4**	**25**

NOTATIONS

AY	Academic Year
AAT	Alternative Assessment Tools
BOE	Board of Examiners
BOS	Board of Studies
CBCS	Choice Based Credit System
CGPA	Cumulative Grade Point Averages
CIE	Continuous Internal Evaluation
CO	Course Outcomes
DC	Departmental Core
GC	Group Core
HSS	Humanity and Social Science courses
IC	Institutional Core
IE	Institutional Elective
IL	Institutional Lab
LTPS	Lecture-Tutorial-Practical-Self Study
NFTE	Not Fit for Technical Education
PCC	Professional Core Courses
PEC	Professional Elective Courses
PEO	Program Educational Objectives
PO	Program Outcomes
SEE	Semester End Examination
SGPA	Semester Grade Point Average
ST	Studio

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class tests, homework assignments, problem solving, group discussions, quiz, seminar, mini- project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE) - A written examination for theory courses and practical/design examination with built-in oral part (Viva-Voce).

Both CIE and SEE have equal (50:50) weightage. The Student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

Breakup of CIE Components for Courses in General:

Component	Test-1	Test-2	Quiz-1/AAT	Quiz-2/AAT	Total Marks
Maximum Marks	40	40	10	10	100

Breakup of CIE Components for Integrated Courses:

Component	Theory			Practical			Total Marks
	Test-1	Test-2	Quiz/ AAT	Records & Performance	Lab Test	Viva-Voce	
Maximum Marks	20	20	10	20	20	10	100

Breakup of CIE Components for Comprehensive Courses:

Component	Theory			Practical		Self-Study	Total Marks
	Test-1	Test-2	Quiz /AAT	Lab Performance / Record	Lab Test		
Maximum Marks	20	20	10	20	10	20	100

Note:

Alternate Assessment Tools, if any, will be announced by concerned Faculty at the beginning of the semester.

In case of Alternative Assessment Tools (such as term papers, assignments, problem solving, micro-projects, seminars, MOOCs etc.,) being used by a faculty for a particular course, a maximum of 40% of the total CIE marks can be utilized.

III Semester Syllabus

Course		Credits : 03				Marks	
Name	**Engineering Mathematics - 3**	**L**	**T**	**P**	**S**	**CIE**	**SEE**
Code	**15MA3GCMAT**	**3**	**0**	**0**	**0**	**100**	**100**

PRE-REQUISITES: Basic concepts of Trigonometry, Trigonometric formulas, methods of differentiation, methods of integration, partial derivatives, solution to ordinary differential equations.

SYLLABUS:

UNIT-1

Matrices

Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of a system of linear equations and solution. Solution of a system of non-homogenous equations: Gauss elimination method, LU decomposition method, Gauss-Seidel method. Eigenvalues and eigenvectors of matrices, reduction of a matrix to diagonal form.

Suggested Reading: Inverse of a matrix using Gauss-Jordan method. Largest eigenvalue and corresponding eigenvector using Rayleigh power method.

8 hours

UNIT-2

Fourier Series

Introduction: Periodic function, Dirichlet's condition, statement of Fourier Theorem, Fourier series of a periodic function of period 2l, Fourier series of functions having points of discontinuity.

Applications: Fourier series of typical waveforms-saw toothed waveform, triangular waveform, square waveform, half-wave rectifier, full wave rectifier and modified saw tooth waveform. Practical harmonic analysis.

Suggested Reading: half range Fourier series, Fourier series of discrete functions, Complex Fourier series. **7 hours**

UNIT-3

Partial Differential Equations

Formation of Partial differential equations-elimination of arbitrary constants, elimination of arbitrary functions. Equations of first order- The linear equation P p + Q q = R (Lagrange's partial differential equation).

Applications: One-dimensional heat equation and wave equation (without proof), various possible solutions of these by the method of separation of variables.

Suggested Reading: Direct integration method, method of separation of variables, D'Alembert's solution of wave equation. **7 hours**

UNIT-4

Fourier Transforms

Concept of finite Fourier Transform. Infinite Fourier transform, Fourier Sine and Cosine transforms, properties, Inverse transforms, Fourier transforms of the derivatives. Solution to boundary value problems using Fourier transforms.

Suggested Reading: Convolution theorem, Parseval's identities and physical significance of Parseval's identities. **8 hours**

UNIT-5

Calculus of Variations

Variation of a functional, Euler's equation, variational problems.
Applications: Hanging cable problem, Geodesics of a right circular cylinder, Brachistochrone problem.
Isoperimetric problems.

Suggested Reading: Minimal surface of revolution, Geodesics of a right circular cone and sphere. **7 hours**

Mathematics Lab

- Solution of system of algebraic equations using Gauss Seidel method
- LU decomposition of matrices.
- Eigenvalues and eigenvectors of matrices.
- Largest eigenvalue, smallest eigenvalue and corresponding eigenvectors of a matrix.

REFERENCES:

Text Books

1. Higher Engineering Mathematics, B.S. Grewal, 43th edition, 2013, Khanna Publishers.
2. Advanced Engineering Mathematics, Dennis G. Zill and Cullen, 4th edition, 2011, Jones and Bartlett India Pvt. Ltd.

Reference Books

1. Higher Engineering Mathematics, B.V. Ramana, 7th reprint, 2009, Tata McGraw Hill.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 10th edition Vol.1 and Vol.2, 2014, Wiley-India.

E-Books / Web References

1. Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001
http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.

2. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
3. http://ocw.mit.edu/courses/mathematics/ (online course material)

MOOCs

1. http://nptel.ac.in/courses.php?disciplineId=111
2. https://www.khanacademy.org/
3. https://www.class-central.com/subject/math (MOOCS)
4. E-learning: www.vtu.ac.in

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Compute solution of a system of algebraic equations.
CO 2	Demonstrate an understanding to Fourier series and Fourier transforms.
CO 3	Formulate boundary value problems involving one dimensional heat and wave equation.
CO 4	Employ analytical techniques to solve partial differential equations with appropriate boundary conditions.
CO 5	Obtain the extremal of a functional.

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

To set one question each from units 1, 2, 5 and two questions each from units 3 & 4.

Course		Credits : 03				Marks	
Name	**Material Science & Metallurgy**	**L**	**T**	**P**	**S**	**CIE**	**SEE**
Code	**15ME3DCMSM**	**3**	**0**	**0**	**0**	**100**	**100**

PRE-REQUISITES:

Concepts of unit cell, space lattice, Unit cells for cubic crystals (Simple cubic, BCC & FCC) and HCP structure and calculations of radius, Coordination Number and Atomic Packing Factor. Miller indices, Point, line, surface defects and volume defects.

SYLLABUS:

UNIT – 1

Mechanical behaviour: Stress strain diagram for ductile and brittle materials, linear and non-linear elastic properties, properties in plastic range, engineering stress-strain and true stress & strain with problems

Plastic deformation: Slip & twinning, critically resolved shear stress, strain hardening, Bauschinger's effect, strain ageing, recovery, recrystallization and grain growth.

Diffusion in solids: Diffusion Mechanism, Fick's laws of diffusion, Factors affecting diffusion **06 Hours**

Fracture: Brittle and ductile facture, Griffith's criterion.

Creep: Creep curve, creep mechanism, factors affecting creep and creep test.

Fatigue: Fatigue cycles, Fatigue test, SN curve, Fatigue mechanism, Factors affecting fatigue life**.** **05 Hours**

UNIT – 2

Solidification - Nucleation and grain growth in pure metals and alloys during freezing.

Solid solutions: Types of solids solutions, Rules for governing the formation of solid solutions and intermediate phases

Cooling curves and phase diagrams: Construction of phase diagrams, Gibbs phase rule and Lever rule, Phase diagrams of Isomorphous, Eutectic, Eutectoid, Peritectic and Peritectoid systems. Problems on Isomorphous and Eutectic systems. **06 Hours**

UNIT – 3

Iron- Iron carbide equilibrium diagram: Equilibrium phases, invariant reactions, critical temperatures, slow cooling of steels (hypo, hyper and eutectoid steels).

TTT diagram: Construction of TTT diagram, TTT diagram for eutectoid, hypo and hyper eutectoid steels, continuous cooling curves, Effect of

alloying elements on steels **06 Hours**

UNIT – 4

Heat treatment processes: Annealing and its types, normalizing, hardening, tempering, martempering, austempering, surface heat treatment methods and heat treatment of Non-ferrous materials (dispersion hardening and precipitation hardening) **05 Hours**

Classification of materials, **Ferrous materials:** Composition, properties and applications of low, medium and high carbon steels, alloy steels, stainless steels and designation of steels.
Cast irons: Types, Composition, Properties and applications of Grey, Malleable, Nodular and White cast irons.
Non-ferrous materials: Aluminium and its alloys, Copper and its alloys, Titanium and its alloys
Polymers: Properties, types and applications
Ceramics: Properties, types and applications **06 Hours**

UNIT – 5

Composite Materials: Definition, classification, properties and applications of FRP composites, MMCs and Ceramic composites.
Production methods of FRP Composites (Pultrusion, filament winding, hand lay-up, Autoclave/ Vacuum bag processes and Spray forming processes) and MMCs (Powder metallurgy, Stir casting, Squeeze casting and In-situ methods. **05 Hours**

REFERENCES:

Text Books

1. Materials Science & Engineering- An Introduction William D.Callister Jr. Wiley India Pvt. Ltd.
2. Foundation of Material Science and Engineering, Smith, McGraw Hill

Reference Books

1. Introduction to Material Science for Engineering, James F. Shackel ford. Pearson, Prentice Hall.
2. Materials Science & Engineering", V.Raghavan, Prentice Hall.
3. Mechanical Metallurgy, George.E.Dieter, McGraw Hill.
4. Material Science and Metallurgy, O P Khanna, Dhanpat Rai publications.
5. Physical Metallurgy Principles, Robert. E. Reed-Hill.

E-Books / Web References

1. Material Science, R.D. Rawlings, CRC Press, 2004 (http://link.springer.com/book/10.1007%2F978-1-4899-6826-5)
2. Material Science and Engineering, V. Raghavan, PHI, 2004. (http://phindia.com/bookdetails/materials-science-and-engineering-raghavan-v--isbn-978-81-203-5092-2)
3. http://nptel.ac.in/courses/Webcourse-contents/IIScBANG/Material%20Science/New_index1.html
4. http://www.intechopen.com/books/materials-science-advanced-topics
5. Material Science, S. L Kakani, Amit Kakani, New Age International Publishers (https://iimtstudies.files.wordpress.com/2014/03/material-sciencekakani-2004.pdf)

MOOCs

1. https://legacy.saylor.org/me203/Intro/
2. https://courses.edx.org/courses/MITx/3.032x/3T2014/courseware/fa156567e80a483ab833f2b1a581923c/8a344b60a6c04f8da5ebda9a0a7c402e/

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Analyse the concepts of mechanical behaviour of materials and their testing.
CO 2	Apply the concepts of solid solutions, cooling curves and phase diagrams.
CO 3	Understand the concepts of Iron- Iron carbide equilibrium diagram and TTT diagrams.
CO 4	List and Discuss ferrous and non-ferrous materials and their heat treatment processes.
CO 5	Understand the various types, properties, applications and production methods of Composite materials.

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

To set one question each from units 2, 3 and 5 and two questions each from units 1 and 4.

Course		Credits : 06				Marks	
Name	**Strength Of Materials**	**L**	**T**	**P**	**S**	**CIE**	**SEE**
Code	**15ME3DCSOM**	**3**	**0**	**1**	**2**	**100**	**100**

PRE-REQUISITES:

1. Engineering Mechanics - Statics
2. Engineering Mathematics - Calculus

SYLLABUS:

UNIT – 1

Simple stress and strain: Introduction, stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain behaviour in Tension for Mild steel and non-ferrous metals. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Principle of super position. Elongation due to self-weight for constant cross section, simple shear stress, shears strain, elastic constants and their relations. Stress in composite section subjected to external loads and temperature change, volumetric strain. **06 Hours**

Compound stresses: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Graphical Method - Mohr's circle for plane stress. **03 Hours**

UNIT – 2

Bending moment and Shear forces in beams: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, couple of different types of beams. **05 Hours**

UNIT -3

Bending and shear stresses in beams: Introduction, theory of simple bending, assumptions in simple bending, relationship between bending stresses, radius of curvature and bending moment, moment carrying capacity of a section, shearing stresses in beams, shear stress across rectangular, circular. **05 Hours**

Deflection of beams: Introduction, differential equation for deflection, equations for deflections, slope and moments, double integration method for cantilever and simply supported beams for point loads, UDL and Couple, Macaulay's method. **05 Hours**

UNIT - 4

Torsion of circular shafts: Introduction, pure torsion, assumptions,

derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts**.**

05 Hours

UNIT - 5

Thick and Thin cylinders: Stresses in thin cylinders, Lame's equation for thick cylinders subjected to internal and external pressures, Changes in dimensions of cylinder (diameter, length and volume), Simple Numericals. **05 Hours**

Columns and Struts: Introduction, Euler's formula for critical load of columns for different end conditions, limitations of Euler's theory, Rankine's formula. Simple Numericals. **05 Hours**

Self-Study: Students have to learn on their own, concepts related to the course suggested by course-faculty**.** Students' work will be assessed by a committee for CIE.

REFERENCES:

Text Books

1. Engineering Mechanics of Solids, Egor.P.Popov, Pearson Edu.India, 2nd Ed 1998
2. Mechanics of Materials, K.V.Rao, G.C.Raju, Subhash Stores, First Edition, 2007

Reference Books

1. Mechanics of Solids, Mubeen, Pearson Edu.India, 2002
2. Strength of Materials, W.A.Nash, Schaum's Outline Series, Fourth Edition-2007
3. Mechanics of Materials, S.I.Units, Ferdinand Beer & Russell Johnstan, TATA McGrawHill-2003
4. Strength of Materials, S.S.Bhavikatti, Vikas pub.House-Pvt.Ltd., 2nd Ed.2006
5. Mechanics of Materials F.P.Beer, E.R. Johnston, J.T.DeWolf and D.F. Mazurek, McGraw Hill, ISBN: 978-0-07-339823-5
6. Mechanics of Materials, R.C.Hibbeler, Printice Hall, Pearson Edu., 2005

E-Books / Web References

1. Statics and Strength of Materials, Shehata, 2nd edition, 1994. (http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/TESTEVAL/PAGES/JTE12637J.htm)
2. A Text book of Strength of Materials, R. K. Bansal, Laxmi Publications, 2010.
3. http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/TESTEVAL/PAGES/JTE12637J.htm
4. http://www.freeengineeringbooks.com/Civil/Strength-of-MaterialBooks.php

MOOCs

1. https://www.edx.org/course/mechanical-behavior-materials-mitx-3-032x
2. https://mitopencourseware.wordpress.com/2013/02/27/new-mitx-mooc-2-01x-elements-of-structures/

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

Two questions each to be set from Units 1 and 3 and one question from units 2, 4, and 5.

STRENGTH OF MATERIALS LAB

List of Experiments

PART-A

1. Tensile, Shear and Compression tests of metallic specimen using Universal Testing Machine
2. Torsion test, Bending test on metallic specimen
3. Izod and Charpy test on various specimens
4. Brinell and Vicker's hardness test on various specimens

PART-B

1. Examination of different engineering materials. Identification of microstructures of Plain Carbon Steel, Tool Steel, Gray Cast Iron, SG Iron, Brass, Bronze, Aluminium alloys and composites (Preparation of specimen-demo).
2. Heat treatment: Annealing, Normalizing, Hardening and tempering of steel. Hardness studies of heat treated samples (Demo).
3. Demo on Non-destructive tests such as: Magnetic crack detection and Dye penetration testing to study the defects of casted and welded specimens.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Understand the basic concepts of stress and strain.
CO 2	Investigate various structural members subjected to different loading conditions.
CO 3	Evaluate cylindrical shafts subjected to torsional loads.
CO 4	Analyse cylindrical pressure vessels under various loadings.
CO 5	Determine mechanical properties of materials related to tensile, compression, torsion, impact, bending and hardness.
CO 6	Identify and evaluate microstructures of different materials.
CO 7	Understand heat treatment and Non Destructive Testing concepts.

Course		Credits : 04				Marks	
Name	Foundry and Welding Technology	L	T	P	S	CIE	SEE
Code	15ME3DCFWT	3	0	1	0	100	100

PRE-REQUISITES:

1. Elements of Mechanical Engineering
2. Engineering Physics

SYLLABUS:

UNIT-1

Manufacturing process: Introduction to basic manufacturing, Classification of manufacturing process, Applications.

Metal Casting: Introduction about metal casting, steps involved in making casting, Advantages and limitations, Applications.

Pattern making: Functions of pattern, Classification of pattern, Different pattern materials, various pattern allowances in design of pattern, Simple problems in design of pattern.

Mould making: Types of moulds, Mould making, Desirable properties of Sand mould.

Core making: Functions of cores, important factors in core design and making. **9 Hours**

UNIT-2

Moulding sand ingredients: Types of base sand, Properties of base sand, Types of binders and its functions, various types of additives and its functions.

Gating system: Concept of gating system, different types of gating systems, gating system design, risering design, numericals on gating and risering design.

Solidification: Solidification of pure metal and alloy, Mechanisms of solidification, types of nucleation, grain structures. Progressive and directional solidification, solidification variables. Methods of achieving directional solidification

Defects in casting: Introduction, types of defects, causes and remedies.

11 Hours

UNIT- 3

Special casting processes: Shell moulding, investment casting, Gravity die casting, Pressure die casting, Centrifugal casting, Slush casting, Continuous casting, Injection moulding.

Melting Furnaces: Types of furnaces, constructional features & working of Cupola, Resistance furnace, Electric Arc furnace, Induction furnace.

7 Hours

UNIT-4

Welding: Weldability, Different types of weld joints, TIG Welding & MIG Welding, Laser Beam Welding, Friction stir welding, Explosive welding, Resistance welding, Thermit welding.

Metallurgical aspect of Welding: Metallurgical effects of welding, weld metal solidification, formation of different weld zones, Weld cracking, Corrosion of weld, defects in welding & remedies. **7 Hours**

UNIT-5

Powder Metallurgy: Introduction to powder metallurgy, Preparation of powders (Atomization, Electrolysis, and Granulation Process, Mechanical Alloying), Powder Blending, Powder Compaction, Sintering. Finishing operations, application of powder metallurgy products, advantages and limitations. **5 Hours**

REFERENCES:

Text books

1. Foundry Technology, O.P. Khanna, Dhanpat rai publications (P)-2003 reprint.
2. Manufacturing Technology: Foundry, Forming and Welding, P N Rao, 2nd Edition Tata Mc Graw-Hill publishing company Limited.

References

1. Manufacturing technology, Swaroop Kalpak Jain, Steuen R. Schmid, Pearson Education Asia, 5th Ed.2006.
2. Principles of metal casting, Richard W Heine ,Carl R Loper, Philip C Rosenthal, Tata McGraw-Hill, 2002.
3. Workshop Technology, Vol-1, H.K Hajara Choudhary, 12th Edition, MPP Publisher, 2001.
4. Welding Technology, O.P Khanna, Dhanpat Rai, 2001.
5. Manufacturing Process-1, K Radhakrishana, Sapna.

E-Books / Web References

1. Principles of foundry technology, 4th edition,P L Jain, Tata McGraw Hill, 2006.
   (https://books.google.co.in/books?id=NOotk64Grx0C&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false)
2. Advanced Welding Processes technology and process control, John Norrish, Wood Head Publishing, 2006.
   (http://www.elcoweld.com/files/editor/downloads/elmi/AWP1.pdf)
3. http://www.astm.org/DIGITAL_LIBRARY/STP/SOURCE_PAGES/STP494.htm

4. http://efoundry.iitb.ac.in/Academy/index.jsp
5. http://nptel.ac.in/courses/112107145/

Foundry and Sand Testing Lab component:

a) Lab exercises in Sand Testing Lab
b) One Model involving Sand Casting

Scheme of Examination (SEE):

SEE: Answer five full questions selecting one from each unit.

Two questions each to be set from unit 1 & 2 and One question each from unit 3, 4 & 5

Foundry and Sand Testing Lab
List of Experiments of lab component

Part A:

Testing of molding sand and core sand

1. Compression, shear and permeability tests on green sand specimen
2. Tension and bending tests on core sand specimen
3. Sieve analysis to find grain fineness number of base sand
4. Clay content test

Part B:

1. Use of foundry tools and other equipments
2. Preparation of moulds using two moulding boxes with and without Patterns (Split pattern, Core boxes)
3. Production of metal component using sand casting

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Understand fundamentals of foundry.
CO 2	Understand sand moulding processes and the design of gating systems and risering.
CO 3	Understand melting concepts and welding fundamentals.
CO 4	Understand metallurgical aspects of welding and fundamentals of powder metallurgy.
CO 5	Understand the importance of different test carried out on moulding sand and prepare casted component.

Course		Credits : 04				Marks	
Name	**Basic Thermodynamics**	**L**	**T**	**P**	**S**	**CIE**	**SEE**
Code	**15ME3DCBTD**	**3**	**1**	**0**	**0**	**100**	**100**

PRE-REQUISITES:

1. Engineering Mathematics
2. Engineering Physics
3. Engineering Chemistry

SYLLABUS:

UNIT - 1

Introduction: Macroscopic and Microscopic approaches, Thermodynamic system: control volume and control mass, properties, process and cycles, Homogeneous & Heterogeneous systems, Thermodynamic Equilibrium, Quasi-static process, pure substance, Concept of continuum.

Temperature: Zeroth Law of Thermodynamics, Measurement of Temperature, Reference points, Ideal gas Temperature, Celsius Temperature scale and International Practical Temperature scale.

Work & Heat: Work transfer, $p\mathrm{d}V$-work or displacement work, different forms of work transfer, Net work done by a system, Heat transfer-A path function, Specific heat and Latent heat. **10 hours**

UNIT – 2

First Law of Thermodynamics: For a process, applied to closed and open systems undergoing a cycle, Steady Flow Energy Equation (SFEE). Enthalpy, Specific heat at constant volume, and at constant pressure, Energy of an isolated system, PMM1 and Limitations of the First Law. **06 hours**

UNIT – 3

Second Law of Thermodynamics: Cyclic Heat engine, Kelvin-Planck and Clausius statements, Refrigerator and Heat pump, Equivalence of Kelvin-Planck and Clausius statements, Reversibility and Irreversibility, Causes for Irreversibility, Reversed Heat engine, Carnot's Theorem, Absolute Thermodynamic Temperature scale, Efficiency of the Reversible heat engine, Equality of Ideal gas Temperature & Kelvin Temperature. **06 hours**

Entropy: Introduction, Two reversible adiabatic paths cannot interact each other, Clausius Theorem, The property of Entropy, Principle of Caratheodory, Clausius Inequality, Entropy change in reversible and Irreversible process, Entropy principle, Entropy generation in a closed system and open system, First & Second Laws combined relations, Reversible adiabatic work in a steady flow system. **05 hours**

UNIT – 4

Real and ideal gases: Introduction; Vander Waal's Equation and its constants in terms of critical properties, law of corresponding states, compressibility factor and chart. Ideal gas; equation of state, internal energy and enthalpy as functions of Temperature, universal and particular gas constants, specific heats, perfect and semi-perfect gases. Evaluation of heat, work, change in internal energy, enthalpy and entropy in various quasi-static processes. **07 hours**

UNIT – 5

Exergy Analysis: Available and unavailable energy, concept of availability, availability of heat source at constant and variable Temperatures, Availability for non-flow and steady flow systems, Helmholtz and Gibbs function, irreversibility and second law efficiency. **05 hours**

REFERENCES:

Text Books

1. Basic and Applied Thermodynamics, P. K. Nag, 2nd Edition, Tata McGraw Hill, 2009
2. Thermodynamics: An Engineering Approach, Yunus A. Cengel and Michael A. Boles, 7th Edition, Tata-McGraw hill Pub, 2011.

Reference Books

1. Fundamentals of Thermodynamics, Gordon J. VanWylan & Richard E. Sonntagg, 7th Edition, Wiley Eastern Ltd, 2009.
2. Engineering Thermodynamics, Rajput, 4th Edition, Laxmi Publications, 2010
3. Engineering Thermodynamics, J.B. Jones and G.A. Hawkins, John Wiley and Sons.
4. Thermo Dynamics, S.C.Gupta, 1st Edition, Pearson Edu.Pvt.Ltd., 2005.
5. Engineering Thermodynamics, Auchutan, 2nd Edition, Phi Learning publications, 2009.
6. Elements of heat Engines (Vol. I, II, III), R.C. Patel and C.J. Karamchandani, Acharya Publications, 2010,

E-Books / Web References

1. Engineering Thermodynamics, Achuthan, 2nd Edition, Phi Learning, 2009
2. Fundamentals of Engineering Thermodynamics, Rathakrishnan, 2nd Edition, Phi Learning, 2005

3. http://nptel.ac.in/courses/112104113/
4. http://nptel.ac.in/courses/112108148/
5. http://nptel.ac.in/courses/112105123/

MOOCs

1. https://www.coursera.org/course/introthermodynamics
2. https://www.iitbombayx.in/courses/IITBombayX/ME209xA15/2015_T1/about
3. https://legacy.saylor.org/me103/Intro/

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Understand the fundamentals concepts of system, control volume, property, state, process & cycle.
CO 2	Understand and analyse the concept of work, heat and the relationship between them.
CO 3	Understand feasibility of the process using Second law and Entropy.
CO 4	Understand and analyse the role of Real and Ideal gases in Energy exchanges.
CO 5	Understand the concept of Availability & Irreversibility.

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

Two questions each to be set from units 1 & 3 and one question each from units 2, 4 & 5.

Course		Credits : 06				Marks	
Name	Fluid Mechanics	L	T	P	S	CIE	SEE
Code	15ME3DCFME	3	0	1	2	100	100

PRE-REQUISITES:

1. Vector Calculus
2. Engineering Mechanics

SYLLABUS:

UNIT – 1

Fluid Pressure and its Measurements: Concept of continuum, Newton's law of viscosity, Pascal's law, hydrostatic Law, manometry (simple, differential, inverted and inclined manometers). **04 Hours**

UNIT - 2

Hydrostatic Forces on surfaces: Concepts of center of pressure along a horizontal plane, vertical plane and inclined plane surface submerged in static fluid.

Buoyancy and Flotation: Buoyancy, center of buoyancy, meta center and meta centric height (analytical method). **04 Hours**

UNIT -3

Fluid Kinematics: Types of flows, Eulerian and Lagrangian representation, velocity and acceleration fields, stream lines, streak lines, time line and path lines, material derivative, linear motion and deformation, angular deformation, vorticity, strain rate. **06 Hours**

Fluid Dynamics: Continuity equation in 3D (cartesian coordinate only), Newton's second law along a streamline and normal to streamline, Euler equation of motion and reduction to Bernoulli equation, venturi meter, orifice meter and pitot tube, Navier stokes equation. **08 Hours**

UNIT 4

Impact of jets: Force exerted on stationary and moving plates- vertical, inclined and curved (symmetrical and unsymmetrical) **06 Hours**

Viscous flow through pipes: Major and minor losses, Hagen poiseuille equation **07 Hours**

UNIT – 5

Dimensional Analysis: Rayleigh's method, Buckingham Π theorem, dimensionless numbers (Reynolds Number, Mach number, Froude Number, Weber's Number, Knudsen Number. **04 Hours**

Self-Study: Students have to learn on their own, concepts related to the course suggested by course-faculty**.** Students' work will be assessed by a committee for CIE.

REFERENCES:

Text Books

1. Fundamentals of Fluid Mechanics by Munson, Young, Okiishi, Huebsch, 6th Edition, Wiley publications, 2009.
2. Fluid Mechanics-Fundamentals & Applications by Yunus A Cengel and John A Cimbala, 2nd Edition (Special Indian Edition), Tata McGraw Hill, 2010.

Reference Books

1. Fluid Mechanics by Frank M White, 7th Edition, McGraw Hill Publications, 2011.
2. Fluid Mechanics, Hydraulics and Fluid Machines by Ramamrutham, Dhanpat Rai Publications.
3. Introduction to Fluid Mechanics and Fluid Machines by S K Som, Gautam Biswas and S Chakraborty, 3rd Edition, McGraw Hill Publications, 2011.
4. Introduction to Fluid Mechanics by Fox and MacDonald, 8th Edition, Wiley India, 2013.

E-Books / Web References

1. Fluid Mechanics, Pijush K Kunda and Ira M Cohen, 5th Edition, Elsevier, 2011.
2. Fluid Mechanics Fundamentals and Application, Yunus Cengel and John Cimbala, Kindle Edition.
3. http://nptel.ac.in/courses/112104118/
4. http://nptel.ac.in/courses/112105171/
5. http://www.efluids.com/
6. https://legacy.saylor.org/me201/Intro/

MOOCS

1. http://www.mooc-list.com/course/fluid-mechanics-saylororg
2. https://legacy.saylor.org/me201/Unit01/

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

To set one question each from units 1, 2 and 5 and two questions each from units 3 and 4.

FLUID MECHANICS LAB

Part A

1. Determination of Coefficient of Friction of flow through a pipe.
2. Determination of Minor losses in the pipe.
3. Calibration of flow measuring devices.
4. Discharge measurement using Orifice, Nozzle, Venturi meter and V-notch.

Part B

5. Pressure distribution on symmetrical and cambered airfoil
6. Pressure distribution on cylinder and Sphere
7. Velocity measurement using Pitot static tube.
8. Coefficient of Lift and Drag on streamlined and bluff bodies
9. Flow Visualization on airfoil.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Understand the concept of fluid and measure the static forces of the fluids.
CO 2	Understand and apply the concepts of pressure distribution and buoyancy.
CO 3	Understand and apply Newton's law of motion applied to fluid element & pressure measuring devices.
CO 4	Understand the concepts of laminar and turbulent flow.
CO 5	Understand the concept of dimensional analysis and usage of dimensional numbers.

IV Semester Syllabus

Course		Credits : 03				Marks	
Name	**Engineering Mathematics-4**	**L**	**T**	**P**	**S**	**CIE**	**SEE**
Code	**15MA4GCMAT**	**3**	**0**	**0**	**0**	**100**	**100**

PRE-REQUISITES: Trigonometric formulas, methods of differentiation, methods of integration, partial derivatives. Basic concepts in Probability-addition theorem, conditional probability, Bayes' theorem, discrete random variable, Binomial distribution.

SYLLABUS:

UNIT-1

Numerical Methods

Solution of algebraic and transcendental equations: Newton-Raphson method. Finite Differences and interpolation: Forward differences, backward differences. Newton-Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation. Numerical integration: Simpson's $1/3^{rd}$, $3/8^{th}$ rule, Weddle's rule. Numerical solution of ordinary differential equations: Euler's modified method, Runge-Kutta method of fourth order**.**

Applications: Application of numerical methods to engineering problems.

Suggested Reading: Milne's method to solve ordinary differential equations. Solution of simultaneous differential equations by Runge-Kutta method of fourth order**.** **7 hours**

UNIT-2

Numerical Solution of Partial Differential Equations

Finite-Difference formulas to partial derivatives.

Applications: Solution of one-dimensional heat equation using 2-level formula and Schmidt explicit formula and Crank-Nicolson two-level implicit formula. Solution of one-dimensional wave equation using explicit three level formula and implicit scheme. **8 hours**

UNIT-3

Complex Analysis 1

Function of a complex variable, limits, continuity and differentiability of a complex valued function, Analytic functions, properties of analytic functions, Cauchy-Riemann equations in cartesian and polar form, construction of analytic functions by Milne-Thomson method, Conformal mapping - Transformations - $w=z^2$ and $w=z+\frac{a^2}{z}\ (z\neq 0)$, Bilinear transformations.

Suggested Reading: Standard transformations $w=c+z,\ w=cz,\ w=1/z$, properties of bilinear transformations **7 hours**

UNIT-4

Complex Analysis 2

Complex integration: Line integral, Problems on line integral, Cauchy's theorem, Cauchy's integral formula.
Complex series: Taylor's, Maclaurin's and Laurent's series (without proof).
Zeros, Poles and Residues: Residue theorem (without proof). Evaluation of real definite integrals using residues.

Suggested Reading: Power series- radius of convergence. Problems on Taylor's and Maclaurin's series. Removable and essential singularities.
Applications: Use of harmonic function to a heat transfer problem.

7 hours

UNIT-5

Statistics and Probability

Curve fitting – Principle of least squares, fitting a straight line, fitting of a parabola, fitting of exponential curves of the form $y = a\,b^x$, $y = ae^{bx}$. Correlation and regression. Probability distributions: Discrete distribution - Poisson distribution. Continuous distribution- normal distribution.
Suggested Reading: Fitting the curve $y = a\,x^b$, exponential distribution and uniform distribution

7 hours

Mathematics Lab

- Newton-Raphson method
- Numerical integration
- Solution of ordinary differential equations
- Solution of one dimensional heat and wave equation.
- Curve fitting for a given data
- Correlation and regression for a bivariate distribution.
- Probability distributions.

REFERENCES:

Text Books

1. Advanced Engineering Mathematics, R.K. Jain, S. R. K. Iyengar, 4th edition, 2014, Narosa Publishers.
2. Higher Engineering Mathematics, B.S. Grewal, 40th edition, 2007, Khanna Publishers.

Reference Books

1. Advanced Modern Engineering Mathematics, Glyn James, 3rd edition, 2004, Pearson Education.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 10th edition, vol.1, vol. II, 2014, Wiley-India

3. Higher Engineering Mathematics, B.V. Ramana, 2007, Tata McGraw Hill.
4. Numerical methods for Scientific and Engineering Computation, M. K. Jain, S.R. K Iyengar, R. K. Jain, 5th edition, 2008, New Age International (P) Limited Publishers.

E-Books / Web References

1. Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001
http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
2. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
3. http://ocw.mit.edu/courses/mathematics/ (online course material)

MOOCs

1. http://nptel.ac.in/courses.php?disciplineId=111
2. https://www.khanacademy.org/
3. https://www.class-central.com/subject/math (MOOCS)

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Calculate numerical solutions of algebraic equations, transcendental equations and ordinary differential equations.
CO 2	Compute solution of one dimensional heat and wave equation using finite difference techniques.
CO 3	Construct analytic functions and evaluate real and complex integrals.
CO 4	Apply the principles of least squares to fit a straight line, parabolic and exponential curve for a given data.
CO 5	Estimate the relation between two variables and perform regression analysis.
CO 6	Apply the basic principles of probability and probability distributions.

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

To set one question each from units 2, 3, 5 and two questions each from units 1 & 4.

Course		Credits : 03				Marks	
Name	Applied Thermodynamics	L	T	P	S	CIE	SEE
Code	15ME4DCATD	3	0	0	0	100	100

PRE-REQUISITES:
Basic Thermodynamics

SYLLABUS:

UNIT – 1

Gas Power cycles:
Carnot cycle, Air standard cycles: Otto cycle, Diesel cycle and Dual cycle, Brayton cycle. **06 hours**

UNIT - 2

Pure substances: Mechanism of steam formation: Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapour states of a pure substance with water as example, Enthalpy of change of phase (Latent heat), Dryness factor (quality), representation in P-T, P-V, T-S and H-S diagrams. Steam tables, High pressure Boilers: Benson Boiler, Lamont Boiler, Velox Boilers (process diagram only) **05 hours**

Vapour Power cycles: Rankine Cycle, Actual Vapour Cycle processes, Reheat cycle, Ideal Regenerative cycle, Regenerative cycle. **06 hours**

UNIT – 3

Refrigeration : Reversed Heat engine cycle, Vapour Compression refrigeration cycle, Vapor Absorption refrigeration cycle, Heat pump system, Gas cycle refrigeration (only Reversed Brayton cycle), refrigerant properties, Standard Refrigerants. **06 hours**

Psychrometry: Atmospheric air, psychrometric properties; Dry bulb Temperature, wet bulb Temperature, dew point Temperature, partial pressures, specific and relative humidity and the relation between the two Enthalpy and adiabatic saturation Temperature. Construction and Use of psychrometric chart, Analysis of various processes: heating, cooling, dehumidifying and humidifying and adiabatic mixing of stream of moist air. **06 hours**

UNIT – 4

Nozzles and Diffusers: Types and utility of nozzles, Flow of steam through nozzles, Effect of friction, Nozzle efficiency, Critical pressure conditions for

maximum discharge. First law applied to Nozzles and diffusers, h-s and T-S plots on Nozzles **05 hours**

UNIT – 5

Reciprocating compressors: Operation of a single stage reciprocating compressor, Work input through p-v diagram and steady state steady flow analysis. Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. Multi-stage compressor, saving in work, optimum intermediate pressure, inter-cooling: perfect and imperfect, minimum work for compression. **05 hours**

REFERENCES:

Text Books

1. Basic and Applied Thermodynamics, P .K. Nag, 2nd Edition, Tata McGraw Hill, 2009
2. Thermodynamics: An Engineering Approach, Yunus A. Cengel and Michael A. Boles, 7th Edition, Tata-McGraw hill Pub, 2011.

Reference Books

1. Fundamentals of Thermodynamics, Gordon J.VanWylan & Richard.E.Sonntagg, 7th Edition, Wiley Eastern Ltd, 2009.
2. Engineering Thermodynamics, Rajput, 4th Edition, Laxmi Publications pvt ltd., 2010
3. Engineering Thermodynamics, J.B. Jones and G.A.Hawkins, John Wiley and Sons.
4. Thermo Dynamics, S.C.Gupta, 1st Edition, Pearson Edu.Pvt.Ltd., 2005.
5. Engineering Thermodynamics, Auchutan, 2nd Edition, Phi Learning publications, 2009.
6. Elements of heat Engines (Vol I, II, III), R.C. Patel and C.J. Karamchandani, Acharya Publications, 2010,

E- Books / Web References

1. Engineering Thermodynamics, Achuthan, 2nd Edition, Phi Learning, 2009
2. Fundamentals of Engineering Thermodynamics, Rathakrishnan, 2nd Edition, Phi Learning, 2005
3. http://www.nptel.ac.in/syllabus/112106133/
4. http://www.taftan.com/thermodynamics/
5. http://lorien.ncl.ac.uk/ming/dept/swot/thenotes.htm

MOOCs

1. https://www.coursera.org/course/introthermodynamics
2. https://www.edx.org/course/thermodynamics-iitbombayx-me209-1x
3. https://legacy.saylor.org/me103/Intro

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Understand the thermodynamic cycles to use for a given application and source of heat
CO 2	Develop ability to plot P-T and P-V diagrams of pure substance and explain the influence of Temperature limits on performance of cycles.
CO 3	Analyze problems of practical relevance pertaining to concepts of refrigeration & air conditioning
CO 4	Understand and analyse the working of nozzle & diffuser.
CO 5	Analyze the concepts and functioning of reciprocating compressors and their performance.

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

To set one question each from units 1, 4 and 5 and two questions each from units 2 and 3.

Course		Credits : 04				Marks	
Name	**Kinematics of Machines**	**L**	**T**	**P**	**S**	**CIE**	**SEE**
Code	**15ME4DCKOM**	**3**	**0**	**0**	**1**	**100**	**100**

PRE-REQUISITES:
1. Engineering Physics
2. Engineering Mechanics

SYLLABUS:

UNIT – 1

Introduction: Definitions: link or element, kinematic pairs, degrees of freedom, Grubler's criterion (without derivation), kinematic chain, mechanism, structure, mobility of mechanism, Grashoff's criterion, inversion, machine.
Kinematic Chains and Inversions: Inversions of four bar chain; single slider crank chain and double slider crank chain.
Mechanisms: Quick return motion mechanisms - Whitworth mechanism, crank-&-slotted lever mechanism, straight line mechanisms – Peaucellier's mechanism, Tchebicheff mechanism, intermittent motion mechanisms – Geneva mechanism, ratchet-&-pawl mechanism; toggle mechanism; Davis & Ackerman steering gear mechanism **09 Hours**

UNIT – 2

Velocity & Acceleration Analysis of Mechanisms (Graphical Methods) Velocity and acceleration analysis of four bar mechanism and slider crank mechanism by vector polygons: relative velocity and acceleration of particles in a common link, relative velocity and accelerations of coincident particles on separate links – Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. **10 Hours**

UNIT – 3

Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, determination of linear and angular velocities using instantaneous center method.
Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism. **03 Hours**
Spur Gears: Gear terminology, law of gearing, characteristics of involute action, path of contact, arc of contact, contact ratio, interference in involute gears, methods of avoiding: interference, backlash, comparison of involute and cycloidal teeth. **04 Hours**

UNIT – 4

Gear Trains: Simple gear trains, compound gear trains for large speed reduction, epicyclic gear trains, algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains. **05 Hours**

Unit – 5

Cams: Types of cams, types of followers, displacement, velocity and acceleration time curves for cam profiles. disc cam with reciprocating follower having knife-edge, roller and flat-faced follower, disc cam with oscillating roller follower, follower motions including shm, uniform velocity, uniform acceleration and retardation and cycloidal motion. **08 Hours**

REFERENCES:

Text Books

1. Theory of Machines, Rattan S.S, 3rd Edition, 2009, Tata McGraw-Hill Publishing Company Ltd.,
2. Theory of Machines and Mechanisms, P.L.Ballaney, Khanna Publications, -2001

Reference Books

1. Theory of Machines & Mechanisms , Uickers, J.J., Pennock G.R. & Shigley J.E, SI Edition, 3rd Edition, 2009 OXFORD University Press
2. Theory of Machines, Thomas Bevan, 3rd Edition, 2010, Pearson Education Ltd.
3. Theory of Mechanisms and Machines, Amitabha Ghosh & Ashok Kumar Mallik, 3rd Edition, 2006, East West Press.

E-Books / Web References

1. Robt. F. McKay, The Theory of Machines (https://archive.org/details/theoryofmachines00mckarich)
2. Theory of Machines, Sadhu Singh, 3rd Edition. 2011, Pearson, Kindle Edition
http://www.cs.cmu.edu/~rapidproto/mechanisms/tablecontents.html

MOOCs

1. Dynamics* (https://www.edx.org/course/dynamics-mitx-2-03x#!)
2. NPTEL Course: “Kinematics of Machines” (http://nptel.ac.in/courses/112104121/1)

*Note: This MOOC is on an advanced topic, but contains some basic concepts related to this course.

Self-Study: Students have to learn on their own, concepts related to the course suggested by course-faculty**.** Students’ work will be assessed by a committee for CIE.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Apply knowledge of fundamentals of kinematics and common mechanisms.
CO 2	Analyze graphically, velocity and acceleration in various four bar mechanisms.
CO 3	Compute various parameters of gear teeth for different gear profiles.
CO 4	Design gear trains for power transmission.
CO 5	Synthesize cam profiles for different applications.

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

To set one question each from units 3, 4 and 5 and two questions each from units 1 and 2.

Course		Credits : 04				Marks	
Name	**Design of Machine Elements-I**	**L**	**T**	**P**	**S**	**CIE**	**SEE**
Code	**15ME4DCDM1**	**3**	**1**	**0**	**0**	**100**	**100**

PRE-REQUISITES:

1. Engineering Mechanics
2. Strength of Materials
3. Engineering Materials

SYLLABUS:

UNIT – 1

Introduction: Definitions: normal, shear, biaxial and triaxial stresses, Stress tensor, Principal stresses. Engineering materials and their mechanical properties. Stress-strain diagrams, Stress Analysis, Design considerations: Codes and Standards. **5 Hours**

Design for Static & Impact strength: Static loads and factor of safety. Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials. Stress concentration, Determination of stress concentration factor.
Impact strength: Introduction, Impact stresses due to axial & bending load. Consideration of creep and thermal stresses in design. **7 Hours**

UNIT – 2

Design for Fatigue Strength: Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Endurance limit modifying factors: size effect, surface effect, Stress concentration effects; Fluctuating stresses, Goodman's and Soderberg's relationship; Stresses due to combined loading. **8 Hours**

UNIT – 3

Design of Shafts: Torsion of shafts, design for strength and rigidity with steady loading, ASME & BIS codes for power transmission shafting, shafts under fluctuating loads and combined loads. **7 Hours**

Design of Keys & Cotter Joints: Keys: Types of keys, Design of keys and cotter joints, Design of splines.
Couplings: Design of Flange Couplings, Bush and Pin type flexible coupling. **7 Hours**

UNIT – 4

Riveted and Welded Joints: Types, rivet materials, failures of riveted joints, Joint efficiency, Boiler joints, Tank and Structural joints, Riveted Brackets. Welded Joints: Types, strength of butt and fillet welds. **9 Hours**

UNIT – 5

Threaded Fasteners: Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static, dynamic loads. **3 Hours**
Power Screws: Mechanics of power screw, Stresses in power screws, efficiency and self-locking, Design of power screw. **5 Hours**

REFERENCES:

Data Handbooks (allowed for reference during examinations also):

1. Machine Design Databook, K. Lingaigh, 2nd Edition, McGraw Hill Education, 2010
2. Design Data Hand Book by K. Mahadevan and K. Balaveera Reddy, CBS Publication, 4th Ed. 2013

Textbooks

1. Mechanical Engineering Design: Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2003.
2. Design of Machine elements: V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2010.

Reference Books

1. Machine Design: Robert L. Norton, Pearson Education Asia, 2001.
2. Design of Machine Elements: M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayaram and C. V. Venatesh, Pearson Education, 2006.
3. Machine Design: Hall, Holowenko, Laughlin (Schaum's Outlines Series) Adapted by S. K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. Fundamentals of Machine Component Design: Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.
5. Design of Machine Elements-1: J.B.K. Das & P.L. Srinivasa Murthy, Sapna Book House, VII Edition, June, 2012.
6. Design data: Data Book of Engineers by PSG college-Kalaikathir Achchagam – Coimbatore, 2012.

E-Books / Web References

1. Machine Design, Robert L. Norton, 5/e, e-Textbook, ISBN-10: 0133369048, ISBN-13: 9780133356717, 2014.
2. Shigley's Mechanical Engineering Design (Smartbook), Richard Budynas and Keith Nisbett, 10/e, e-Textbook, ISBN-13: 978-1259241222 ISBN-10: 0073398209, 2014
3. http://nptel.ac.in/courses/112105124/
4. http://www.astm.org/

MOOCs

http://freevideolectures.com/free-college-courses-online/#MechanicalEngg

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Apply concepts of mechanics of materials to estimate the stresses in a machine element and predict failure of components based on theories of failure
CO 2	Understand fatigue failure in machine elements and factors affecting it
CO 3	Design shafts, keys, splines and couplings power transmission
CO 4	Design cotter, riveted & welded joints
CO 5	Design power screws and threaded fasteners

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.
To set one question each from Units 2, 4 & 5 and two questions each from Units 1 & 3.

Course		Credits : 06				Marks	
Name	**Machine Tools and Machining**	**L**	**T**	**P**	**S**	**CIE**	**SEE**
Code	**15ME4DCMTM**	**3**	**0**	**1**	**2**	**100**	**100**

PRE-REQUISITES:
1. Elements of Mechanical Engineering
2. Engineering Physics

SYLLABUS:

UNIT – 1

Theory of Metal Cutting: Single point cutting tool nomenclature, Merchants circle diagram, analysis and simple problems. Shear angle relationship, tool wear and tool failure, tool life, effects of cutting parameters on tool life, tool failure criteria, Taylor's tool life equation. **06 hours**

Cutting tool materials: Desired properties, types of cutting tool materials – HSS, carbides coated carbides, ceramics, cutting fluids: Desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation, heat distribution in tool and work, measurement of tool tip temperature. **06 hours**

UNIT-2

Production Lathe: Classification of Lathes, Specification, Engine lathe, Capstan & Turret lathe - constructional features, tool layout, tool & work holding devices and attachments. Lathe operations. **05 hours**

Shaping, Slotting and Planning Machines Tools: Classification, constructional features of Shaper, Slotter, Planer. Driving mechanisms of Shaper, Slotter and Planer. Operations done on Shaper, Planer & Slotter. Difference between shaping and planning operations. **06 hours**

UNIT-3

Drilling Machines: Classification, constructional features, drilling & related operations, types of drill & drill bit nomenclature, drill materials. Calculation of machining time

Milling Machines: Classification, constructional features, milling cutters nomenclature, milling operations, up milling and down milling concepts. Calculation of machining time.

Indexing: Simple, compound, differential and angular indexing calculations. Simple numerical on indexing. **06 hours**

UNIT-4

Broaching machines: Classification, Construction and principle of operations

Grinding, Lapping and Honing machines: Types of abrasives, bonding process, classification, constructional features (cylindrical and surface

grinding, centre less grinding), selection of grinding wheel. Mounting and balancing of grinding wheel.
Lapping and Honing: Principles of operation, construction, applications
05 hours

UNIT-5

Non-traditional machining processes: Principle, equipment, operation & applications of Ultrasonic Machining, Abrasive Water Jet Machining, Electro Discharge Machining, Electro Chemical Machining, Laser Beam Machining, Plasma Arc Machining. **04 hours**

CNC Machine Tools: Introduction to CNC machines**,** Construction and working of CNC milling centre, CNC Turning centre, Advantages and applications. **02 hours**

Self-Study: Students have to learn on their own, concepts related to the course suggested by course-faculty**.** Students' work will be assessed by a committee for CIE.

REFERENCES:

Text books

1. Workshop technology, Hazara Choudhry,Vol-II , Media Promoters & Publishers Pvt ltd 2004
2. Production Technology, R.K Jain, Khanna Publications, 2003

Reference Books

1. Production Technology, HMT, Tata McGraw Hill, 2001.
2. Fundamentals of Metal machining and machine tools by G. Boothroyd, McGraw Hill, 2000
3. Manufacturing Science by Amitabha Ghosh and Malik, affiliated East west press, 2003.

E-Books / Web references

1. Fundamentals of machining and machine tools,3rd edition, Geoffrey Boothroyed and Winston A. Knight, Taylor & Francis Group, 2006 (Link:https://books.google.co.in/books?id=Y0cRCFalmekC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false)
2. Nontraditional Machining Processes, J. Paulo Davim, Aveiro, Portugal, February 2013 (Link:http://www.springer.com/us/book/9781447151784http://nptel.ac.in/courses/112105127/)
3. http://www.astm.org/DIGITAL_LIBRARY/MNL/SOURCE_PAGES/MNL11.htm

4. http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/COMPTECH/PAGES/CTR10654J.htm

MOOCs

1. http://nptel.ac.in/courses/112105126/

Scheme of Examination (SEE):

Answer FIVE full questions, each of 20 marks.

To set two questions each from Units 1 and 2 and one question each from units 3, 4, and 5.

MACHINE TOOLS AND MACHINING - LAB

List of Experiments

One Model each involving

c) Lathe operations
d) Milling operations
e) Shaping operation

Part A:

a) Preparation of one model on lathe involving plane Turing, taper turning, Step turning, facing, convex shape turning, external thread cutting, V-thread and square thread.

Part B

b) Cutting of V-groove using a shaper, cutting of spur gear teeth, Helical gear using milling machine.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Understand the fundamentals of metal cutting and selection of cutting tools and materials.
CO 2	Understand the constructional features and working of various machine tools.
CO 3	Understand the basic and super finishing operations.
CO 4	Compute machining time for various machining operations.
CO 5	Understand the principles and operations of Non-conventional machining processes.
CO 6	Produce simple components using various machine tools.

Course		Credits : 05				Marks	
Name	Mechanical Measurements & Metrology	L	T	P	S	CIE	SEE
Code	15ME4DCMMM	3	0	1	1	100	100

PRE-REQUISITES:

1. Engineering Physics
2. Engineering Mathematics

SYLLABUS:

UNIT-1

Introduction

Introduction to metrology & measurements, definition and objectives and classification of metrology, standards of length- wave length standard, sub division of standards. **02 Hours**

Systems of Limits, Fits & Tolerancing

Definition of tolerance, tolerance specification in assembly, principle of interchangeability and selective assembly, limits of size, Indian standards, concepts of limits of size and tolerances, cost v/s tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919-1963), Geometrical Dimensioning and Tolerancing (GD&T), hole basis system, shaft basis system, simple problems.

07 Hours

Gauges

Classification of gauges, Taylor's principle, design of GO, NO GO gauges, wear allowance on gauges, types of gauges- plain plug gauges, ring gauges, snap gauge, limit gauge, simple problems. **02 Hours**

UNIT-2

Comparators

Introduction to comparators, classification, characteristics, systems of displacement amplification in mechanical comparators, Reed type, Sigma comparator, Zeiss ultra optimeter, Solex air gauge, ultrasonic gauges, LVDT.

03 Hours

Line & End Standards

Line and end standard, slip gauges, wringing phenomena, numerical problems on slip gauges. **04 Hours**

Angular Measurements

Bevel protractor, sine bar, angular gauges, numerical on building of angles.

03 Hours

UNIT-3

Measurements & Measurement Systems

Definition, generalized measurement system, accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system-response-time delay, errors in measurement. **02 Hours**

Transducers Intermediate & Terminating Devices

Primary & secondary transducers, classification, advantages, introduction to mechanical and electrical amplification, terminating devices, mechanical oscillographs, XY plotters. **02 Hours**

UNIT-4

Force, Torque & Pressure Measurements

Working principle of analytical balance, proving ring, pronybrake, hydraulic dynamometers, Pirani gauge, Mcleod gauge, Bridgeman gauge. **03 Hours**

Temperature & Strain Measurements

Resistance thermometer, thermocouple laws of thermocouple, materials used for construction, optical pyrometer, electrical strain gauge, Wheatstone bridge for strain measurement. **03 Hours**

UNIT-5

Measuring Machines

Universal measuring machine, profile projector, tool maker's microscope, co-ordinate measuring machine and types, machine vision, autocollimator, laser interferometer. **04 Hours**

Metrology for Nano Measurements

Clean room technology, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, confocal microscopy, focused ion beam, photoelectron spectroscopy, x-ray diffraction (working principles with block diagrams for all the concepts in this unit with advantages and limitations). **05 Hours**

Self-Study: Students have to learn on their own, concepts related to the course suggested by course-faculty**.** Students' work will be assessed by a committee for CIE.

REFERENCES:

Text Books

1. Mechanical Measurements, Beckwith Marangoni and Leinhard, Pearson Education, 6th Ed., 2006.
2. Engineering Metrology, R. K Jain, Khanna Publishers, Twentieth Edition 2008.

3. Nano: The Essentials, Understanding Nano Science and Technology, by T Pradeep, Tata McGraw Hill Publishing 2009.
4. Measurement Systems, Applications & Design, by Ernest O. Doebelin, Fourth Edition1990.

Reference Books

1. Engineering Metrology, I C Gupta, Dhanpat Rai Publications, Delhi
2. Mechanical Measurements and Instrumentation, Er. R K Rajput, S K Kataria & Sons Publications, 2012

E-Books / Web References

1. Cleanroom Technology, FESTO world wide (http://www.festo.com/net/SupportPortal/Files/8842/HB_CleanRoom_en.pdf)
2. Nanometrology, European Nanotechnology Gateway, Eighth Nanoforum Report (http://nanoparticles.org/pdf/nanometrology.pdf)
3. NPTEL course on Metrology & Measurements Link: http://nptel.ac.in/courses/112106138/
4. MIT Open courseware Lecture: Metrology, shot noise and Heisenberg limit Link: http://ocw.mit.edu/courses/physics/8-422-atomic-and-optical-physics-ii-spring-2013/video-lectures/lecture-7-metrology-shot-noise-and-heisenberg-limit-part-1/

Scheme of Examination (SEE):

Answer FIVE full questions, each of 20 marks
Two questions each to be set from units 1 and 2 and one question each from units 3, 4, and 5.

MECHANICAL MEASUREMENTS & METROLOGY LAB

Part A: Metrology

1. Calibration of line and end standards equipment using slip gauges.
2. Calibration of pressure gauge
3. Calibration of load cell
4. Calibration of LVDT
5. Calibration of thermocouple

Part B

1. Measurement of angles using sine-bar, sine-center and bevel protractor
2. Measurement of screw thread using two wire and three wire method
3. Measurement of surface roughness using Talysurf and mechanical comparator
4. Measurement of gear tooth profile using gear tooth vernier
5. Measurement using optical profile projector and toolmaker's microscope
6. Measurements of alignment using autocollimator (Demo)
7. Use of strain gauge for determining elasticity in specimen.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Understand the various standards of measurements and usage of different measuring devices.
CO 2	Understand the system of limits, fits, tolerances and gauging.
CO 3	Understand the measurement systems and transducing elements and intermediate devices.
CO 4	Understand the principles and measurement of various phenomena like force, torque, pressure, temperature and strain.
CO 5	Understand the application of measurement systems and nano measurements principles.
CO 6	Demonstrate calibration of various physical parameters and phenomena.