Academic Program: UG

Academic Year 2019-20

Syllabus

III & IV Semester B.E.

Mechanical Engineering

SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF ENGINEERING & TECHNOLOGY,
DHARWAD – 580 002
(An Autonomous Institution recognized by AICTE & Affiliated to VTU, Belagavi)

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SDM College of Engineering & Technology, Dharwad

It is certified that the scheme and syllabus for V& VI semester of UG program in Mechanical Engineering is recommended by Board of Studies of Mechanical Engineering Department and approved by the Academic Council, SDM College of Engineering &Technology, Dharwad. This scheme and syllabus will be in force from the academic year 2019-20 till further revision.

Principal Chairman BoS & HoD

SDM College of Engineering & Technology, Dharwad
Department of Mechanical Engineering

College

Vision:
To develop competent professionals with human values.

Mission:
1. To have contextually relevant Curricula.
2. To promote effective Teaching Learning Practices supported by Modern Educational Tools and Techniques.
3. To enhance Research Culture.
4. To involve Industrial Expertise for connecting classroom content to real life situations.
5. To inculcate Ethics and impart soft-skills leading to overall Personality Development.

SDMCET- Quality Policy
- In its quest to be a role model institution, committed to meet or exceed the utmost interest of all the stake holders.

SDMCET- Core Values
- Competency
- Commitment
- Equity
- Team work and
- Trust

Department

Vision:

To establish a synergetic Mechanical Engineering program anchored in fundamentals and relevant state of the art technologies, thereby enabling the students to achieve all round development for careers in industry and for higher learning, being responsible to society and environment.

Mission:

1. To establish a curricula & syllabi consisting of robust core courses with emphasis on imparting fundamental principles of mechanical engineering coupled with adaptive and relevant electives catering to the cutting edge technologies.
2. To promote interactive teaching practices using modern educational tools & techniques to attain synergy in teaching, research and industrial practices.
3. To imbibe industrial expertise for connecting class room learning to real life situation.
4. To impart soft skills and professional ethics enabling students to achieve an all-round personality development, making them responsive to societal needs and environmental concerns.

Programme Educational Objectives (PEOs):

1. Graduates will be successful in industry, research and higher learning.
2. Graduates will formulate, analyze and solve engineering problems.
3. Graduates will work in teams to address industrial and socially relevant problems / projects.
4. Graduates exhibit awareness and commitment to lifelong learning & practice professional ethics.

Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

1. **Industrial interactions:** Enhance knowledge of mechanical engineering with industrial practices and standards by exposure to industries.
2. **Role of economics and costing:** Learn the concepts of economics and costing to provide effective solutions to mechanical engineering problems.

III Semester

Course Code	Course Category	Course Title	Teaching		Examination				
			L-T-P (Hrs/Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
					Max. Marks	*Max. Marks	Duration in Hrs.	Max. Marks	Duration In Hrs.
18UMAC300	BS	Engineering Mathematics-III	3 - 0 - 0	3	50	100	3	-	-
18UMEC300	PC	Basic Thermodynamics	3 - 2 - 0	4	50	100	3	-	-
18UMEC301	PC	Materials Science	4 - 0 - 0	4	50	100	3	-	-
18UMEC302	PC	Strength of Materials	3 - 2 - 0	4	50	100	3	-	-
18UMEC303	PC	Manufacturing Processes- I	3 - 0 - 0	3	50	100	3	--	--
18UMEC304	PC	Machine Drawing	2 - 0 - 2	3	50	100	3	--	--
18UMEL305	PC	Materials Science & Materials Testing Lab	0 - 0 - 3	1.5	50	--	--	50	3
18UMEL306	PC	Foundry & Forging Lab	0 - 0 - 3	1.5	50	--	--	50	3
		Total	**18- 4- 8**	**24**	**400**	**600**		**100**	

BS- Basic Science, PC- Program Core
CIE: Continuous Internal Evaluation **SEE**: Semester End Examination
L: Lecture **T**: Tutorials **P**: Practical
*SEE for theory courses is conducted for 100 marks and reduced to 50 marks

IV Semester

Course Code	Course Category	Course Title	Teaching		Examination				
			L-T-P (Hrs/Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
					Max. Marks	*Max. Marks	Duration in Hrs.	Max. Marks	Duration In Hrs.
18UMAC400	BS	Engineering Mathematics-IV	3 - 0 - 0	3	50	100	3	-	-
18UMEC400	PC	Fluid Mechanics	3 - 2 - 0	4	50	100	3	-	-
18UMEC401	PC	Manufacturing Processes - II	4 - 0 - 0	4	50	100	3	-	-
18UMEC402	PC	Applied Thermodynamics	3 - 2 - 0	4	50	100	3	-	-
18UMEC403	PC	Metrology and Measurements	3 - 0 - 0	3	50	100	3	--	--
18UMEC404	PC	Design of Machine Elements-I	2 - 2 - 0	3	50	100	3	--	--
18UMEL405	PC	Measurements Lab	0 - 0 - 3	1.5	50	--	--	50	3
18UMEL406	PC	Thermal Engineering Lab - I	0 - 0 -3	1.5	50	--	--	50	3
18UMEL407	PC	Introductory Project	0 - 0 -2	1	50	--	--	--	--
		Total	**18 - 6 - 8**	**25**	**450**	**600**		**100**	

BS- Basic Science, PC- Program Core
CIE: Continuous Internal Evaluation **SEE**: Semester End Examination
L: Lecture **T**: Tutorials **P**: Practical
*SEE for theory courses is conducted for 100 marks and reduced to 50 marks

III Semester

18UMAC300	Engineering Mathematics-III	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives:

To have an insight into Laplace transforms, Fourier series, Fourier transforms, Difference equations and Z-transforms. To develop the proficiency in variational calculus and solving ODE's arising in engineering applications, using numerical methods.

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

COs	Description of the course outcomes: At the end of course the students will be able to	Mapping to POs (1-12)		
		Mastering 3	**Moderate 2**	**Introductory 1**
CO-1	Transform the given function using Laplace /Fourier transforms depending on the nature of engineering applications.	-	1,2	-
CO-2	Express periodic function as a Fourier series and obtain the various harmonics of the Fourier series expansion for the given numerical data.	-	1,2	-
CO-3	Solve difference equations using Z-transform.	-	-	1
CO-4	Solve first and second order ordinary differential equations arising in engineering problems using single step and multistep numerical methods.	-	1,2	-
CO-5	Determine the extremals of functional using calculus of variations and solve problems arising in engineering.	-	-	1,2

POs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mapping Level	1.6	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-

1. Introductory (Slight) 2. Reinforce (Moderate) 3.Mastering (Substantial)

Content

Chapter I

Laplace Transforms: Definition and Properties. Laplace transform of elementary functions. Laplace transforms of Periodic functions and unit-step function – problems.

Inverse Laplace Transforms: Inverse Laplace transform - problems, Convolution theorem (without proof) to find the inverse Laplace transform and problems, solution of linear differential equations using Laplace transform. **8 hrs**

Chapter II

Fourier Series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions of period 2π and arbitrary period. Half- range Fourier series. Practical harmonic analysis, examples from engineering field. **8 hrs**

Chapter III

Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Simple problems.

Z-Transforms and Difference Equations : Z-transform- definition, Standard Z-transforms, Damping and shifting rules, Initial value and Final value theorems (without proof) with problems. Inverse Z-transform. Simple problems. Difference equations-basic definition. Application of Z-transform to solve Difference equation. **8 hrs**

Chapter IV

Numerical Solutions of Ordinary Differential Equations (ODE's): Numerical solution of ODE's of first order and first degree- Taylor's series method, Modified Euler's method. Runge –Kutta method of fourth order, Milne's predictor and corrector method (No derivations of formulae). Problems. **7 hrs**

Chapter V

Numerical Solution of Second Order ODE's: Runge-Kutta method and Milne's predictor and Corrector method. (No derivations of formulae). Calculus of Variations: Variation of function and functional, variational problems, Euler's equation (without proof), Geodesics(plane), hanging chain problems.**8 hrs**

Text Books:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2017.
2. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed.(Reprint).2016.
3. Srimanta Pal et al: Engineering Mathematics, Oxford University Press, 3rd Edition, 2016.

Reference books:

1. C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics", 6th Edition, McGraw-Hill Book Co., New York, 1995.
2. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India, 4th Edition 2010.
3. B. V. Ramana: "Higher Engineering Mathematics" 11th Edition, Tata McGraw-Hill, 2010.
4. N. P. Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers,7th Ed., 2014.
5. Veerarajan T., "Engineering Mathematics for First year", Tata McGraw-Hill, 2008.
6. Thomas G.B. and Finney R.L."Calculus and Analytical Geometry" 9th Edition, Pearson,2012.

Web links and Video Lectures:
http://nptel.ac.in/courses.php?disciplineID=111.
http://www.class-central.com/subject/math(MOOCs).
http://academicearth.org/.
VTU EDUSAT PROGRAMME – 20.

18UMEC300 Basic Thermodynamics (3-2-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Equilibrium, different processes, State Equations, Ideal gasses, Real gasses and laws and equations governing them.
2. “Energy and its forms”, “Laws of Thermodynamics” and their use to analyze energy conversion systems.
3. Knowledge of pure substance, Entropy and Availability and Irreversibility.
4. Usage of Compressibility charts, steam tables, Mollier Charts.
5. Thermodynamic processes using P-V, T-S and H-S diagrams.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Explain the basic thermodynamics terms and concepts.	1	2	-
CO-2	Apply the first law of thermodynamics to solve problems on closed and open systems.	1	2	-
CO-3	Apply Second Law of Thermodynamics in analyzing the thermal efficiencies of heat engines.	1	2	-
CO-4	Calculate change in entropy for different thermodynamic process	1	2	-
CO-5	Calculate the properties of the pure substances using thermodynamic relations, tables & charts and explain the concepts of availability and irreversibility.	1	2	-
CO-6	Solve numerical problems on real and ideal gases using basic gas equations	1	2	-

PO s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	3	2	-	-	-	-	-	-	-	-	-	-	-	-

Pre-requisites: Sound knowledge of Mathematics, Basic Science, Physics.

Course Contents:

1. **Fundamental concepts and definitions:** Thermodynamics; definition and scope, microscopic and macroscopic approaches, open and closed systems, thermodynamic properties, thermodynamic state, path and process, path and point function, quasistatic process, cyclic and non cyclic processes,

thermodynamic equilibrium, Zeroth law of thermodynamics, Temperature concepts and scales. **5L+2T Hrs**

2. **Work, Heat and First Law of Thermodynamics:** Work and heat, Thermodynamic definition of work, expression for displacement work in various processes through P-V diagrams, electrical work, shaft work, paddle wheel work, flow work, heat definition, unit and sign convention, equivalence of heat and work, Joules experiment. Statement of first law of thermodynamics, extension of first law to non cyclic processes, energy, energy as the property of the system, enthalpy, specific heat at constant volume and constant pressure, Steady state, Steady flow energy equation, some important applications, Limitations of first law of thermodynamics. **8L+2T Hrs**
3. **Second Law of Thermodynamics:** Thermal reservoir, Heat engine, schematic representation and efficiency, reversed heat engine, schematic representation and coefficient of performance and Heat Pump. Kelvin-Plank statement and Clausius statement of second law of thermodynamics, PMM-I and PMM-II, equivalence of the two statements, reversible and irreversible processes, factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot Theorem and its corollaries. **5L+2T Hrs**
4. **Entropy:**Clausius inequality; statement, proof, application to a reversible cycle, entropy a property, entropy a definition, principle of increase of entropy, calculation of entropy using T-ds relations, entropy as a coordinate. **Availability and Irreversibility:** Maximum work, maximum useful work for a system and a control volume, availability of a system and a steadily flowing stream, irreversibility, second law efficiency. **6L+2T Hrs**
5. **Pure substance:** P-T and P-V diagrams, triple point and critical points, sub cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of a pure substance with water as example. Enthalpy of change of phase (Latent heat) dryness fraction, T-S and h-s diagrams, representation of various processes on these diagrams, throttling calorimeter, separating and throttling calorimeter. Problems using h-s diagram, Mollier chart and steam tables for various processes. **5L+2T Hrs**
6. **Thermodynamic relations:** Introduction, Maxwell's equations, problems, coefficient of expansion and compressibility, energy relations for simple systems, T-ds equations, specific heat relations, relation for internal energy and enthalpy, numerical, characteristic functions, Joule-Thomson coefficient. **5L Hrs**
7. **Real and Ideal gases:** Introduction, Vander wall's equation, Vander wall's constants in terms of critical properties, law of corresponding states, compressibility factor, compressibility chart, ideal gas, equation of state, internal energy and enthalpy as function of temperature only, universal and particular gas constants, evaluation of heat, work, change in internal energy, enthalpy and entropy in various quasi static processes, ideal gas mixture; Dalton's law of

additive pressure, Amagat's law of additive volumes, evaluation of properties, analysis of various processes. **6L+2T Hrs**

REFERENCE BOOKS:

1. P. K. Nag, Basic and Applied Thermodynamics, 2nd edition, TMH Publishing Co. Ltd, New Delhi, Revised and enlarged 2011.
2. Garden Van Wylen, Richard Sonntag and Claus Borgenakke, Fundamentals of Classical Thermodynamics, 4th edition, John Wiley & sons, New York, 1997.
3. Yunus A Cengel and M.A. Boles, Thermodynamics and Engineering Approach, TATA Mc Hill Publications edition, 2008.
4. D. B. Spalding and E. H. Cole, Engineering Thermodynamics, ELBS / Edward Arnold (Publishers) Ltd., London, 3rd edition,1973.
5. David Burghardt, Engineering Thermodynamics with Applications, 3rd edition, Harper & Row Publishers, New York, 1986.
6. R K. Rajput, Engineering Thermodynamics, 4th edition, Laxmi Publications (P) Ltd., Daryaganj, New Delhi – 2, 2010

DATA HAND BOOK:

1. Prof. B.T. Nijaguna and Prof. B.S. Samaga, KREC, Surathkal, Thermodynamics Data Hand Book and now published by Sudha Publishers, Avenue Road, Bangalore, 1995

18UMEC301	Materials Science	(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Diverse activities involved with material science.
2. Basic concepts regarding structure-property-processing relations across all material classes.
3. Formation, properties and significance of the alloys.
4. Modern materials like – Special steels, Super alloys and Composites.
5. Many factors that ultimately determine a material selection for a given application.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs(1-12) & PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	List various metals, their structures, defects and define their mechanical properties.	-	1,2	-
CO-2	Describe and compare the crystal structures of the solids, use of diffusion phenomenon and their applications.	1,2	-	-
CO-3	Construct the phase diagrams for various solid solutions.	-	2	-
CO-4	Interpret the phase diagrams, effect of heat treatment on eutectoid steels and microstructures	2	-	-
CO-5	Describe the types of ceramics and composite materials.	-	1	-
CO-6	Recognize ferrous and nonferrous metals and alloys using appropriate codes and composition.	-	1	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	2.25	2.5	-	-	-	-	-	-	-	-	-	-	-	-

Prerequisites: Basic sciences

Course Contents:

1. **Crystal Structures:** Classification of materials, BCC, FCC & HCP crystal structures, imperfections in crystals-point, line & surface defects, Microscopic examination. **6 Hrs**
2. **Atomic Diffusion:** Basic concepts, significance of diffusion, Fick's laws of diffusion, Factors influencing diffusion, Industrial applications of diffusion.**5 Hrs**

3. **Mechanical Properties of Metals:** Elastic deformation, Plastic deformation, dislocations & strengthening mechanisms – characteristics, Slip and twin. Failure: Fundamentals of fracture – Brittle & ductile fractures, Impact fracture testing, Tensile test, Hardness tests, Fatigue: Cyclic stresses, S-N curve, crack initiation & propagation, fatigue test. Creep: Generalized creep behavior, stresses & temperature effects, creep test. **8 Hrs**
4. **Solid Solutions & Phase Diagrams:** Fundamentals of alloying, Types of solid solutions, Hume – Rothery rules, Lever rule. Classification and construction & interpretations of phase diagrams, Isomorphous, Eutectic, eutectoid & Peritectic systems. Iron-Iron carbon diagram – Construction and Interpretation. **9 Hrs**
5. **Phase transformations:** Kinetics of phase transformations, homogeneous and heterogeneous nucleation. Micro structural and property changes in Iron-carbon alloys, TTT and CCT curves, and Mechanical behavior of Iron-carbon alloys. Heat treatments – Basic concepts, objectives, Annealing – types and applications, Hardening – Harden ability, Jominy end quench test, hardenability curves. **9 Hrs**
6. **Ferrous & Nonferrous metals and alloys:**
   Ferrous alloys: Classification, AISI / UNS designations mechanical characteristics of steels, - Low carbon steels, medium carbon steels and high carbon steels. SAE designations & mechanical characteristics of cast Irons – gray cast iron, ductile iron, white / malleable iron. Processing of Ferrous alloys. **6 Hrs**
7. **Non Ferrous Alloys:** Copper and its alloys – UNS designations, compositions & properties. Aluminum and its alloys - UNS designations, compositions & properties. **4 Hrs**
8. **Advanced materials:**
   Ceramics: A basic concept, Classification, features of glasses, clay products, refractories, abrasives and advanced ceramics & applications.

Composites: Classification of composites, types of composites- MMCs, CMCs, FRPs & Sandwich structures - advantages, limitations & industrial applications **5 Hrs**

Reference Books:

1. William D. Callister, Materials science &Engg., An Introduction, John Wiley & Sons Inc, 2010.
2. William F. Smith, Principles of Materials Science Engg., 3rd International Edition, McGraw Hill Publishing Co.1996
3. Donald R. Askelandad Pradeep P. Phule, The Science and Engineering of Materials, THOMSON BOOKS/COLE, 2010.
4. V Raghavan, Materials Science &Engg. 4th Edition, Prentice Hall of India, 2002.

18UMEC302	Strength of Materials	(3-2-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Theory behind design and analysis and procedures of rod like members subject to axial force, twisting and bending
2. Compound stresses and equations to calculate the same (analytical and graphical)
3. Buckling of columns & calculation of buckling load.
4. Nature of stresses in thick and thin cylinders and calculations.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs(1-12) & PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Analyze for stress, and deformation of members subjected to axial load, bending, torsion or any combination of these.	1	-	-
CO-2	Analyze for stresses and deformation in thin and thick cylinders subjected to internal and / or external pressures.	1	-	-
CO-3	Calculate principal stresses and maximum shear stress under two dimensional combined loading using analytical method or Mohr's circle method	1	-	10
CO-4	Design axially loaded member, shaft and beam using strength or deformation criteria.	1	3	-
CO-5	Use concept of factor of safety and allowable stress for design of components	1	3	-
CO-6	Calculate critical load in columns using Euler's or Rankine's equations	1	-	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	3	-	2	-	-	-	-	-	-	1	-	-	-	-

Pre-requisites: Engineering Mechanics

Course Contents:

1. **Stress and Strain:** Introduction, mechanical properties of materials, Linear elasticity, Hooke's law, Poisson's ratio, stress-strain relationship, Extension and shortening of a bar, bars with varying cross section in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, factor of safety, thermal stresses. Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shears strain.
   8L+4T Hrs
2. **Bending moment and shear forces in beams:** Introduction, types of beams, loads and reactions, shear force and bending moments, sign convention, relationship between shear force and bending moment, shear force and bending moment diagrams for different beams subjected to uniformly distributed load, concentrated load, and couples. **4L+2T Hrs**
3. **Stresses in beams:** Introduction, theory of simple bending, Euler's equation of bending, shear stresses in beams, shear stresses across rectangular, circular, symmetrical *and unsymmetrical* I and T sections. **8 Hrs**
4. **Torsion of circular shaft:** Introduction, pure torsion, assumptions, torsion equation, pure torsion equation, power transmitted in circular shaft, Compound Cylinder. **4 Hrs**
5. **Compound stresses:** Introduction, Plane stress, stresses on inclined sections, analytical and graphical (Mohr's Circle) methods, Principal Stresses, Maximum shear Stress. **6 Hrs**
6. **Deflection in beams:** Introduction, equation for deflection, slope and moments, double integration method, Macaualy's Method. **4L+2T Hrs**
7. **Columns:** Introduction to columns, Euler formula for different end conditions, its limitations, Rankine formula. **5 Hrs**
8. **Thick and thin cylinders:** Stresses in thin cylinders, changes in dimensions of thin cylinders, thick cylinders subjected to internal and external pressure.
   5 Hrs

Reference Books:

1. Singer & Pytel, Strength of Materials, Harper and Row publications.
2. Dr. S. S. Bhavikatti, Strength of Materials, 2nd edition, Vikas Publishing House Pvt. Ltd., 2003.
3. Ferdinand Beer &Russel Johnston, Mechanics of materials 5th edition, Tata McGraw Hill, 2010.
4. Egor P Popov, Mechanics of Materials Pearson Education, India, 2nd edition, 1998.

18UMEC303	Manufacturing Processes- I	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Getting an object by heating metal to molten state and cooling it in a cavity of desired shape and size.
2. Joining two metals pieces with an application of heat with or without pressure and extra metal (filly metal)
3. Getting an object with an application of basic forces tensile, Compressive and shear forces.
4. Getting an object of high quality and precision by just sintering the different metal powders.
5. Getting an object of desired shape and size by non-traditional methods.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Classify basic manufacturing processes and explain the principles of casting, welding, forming and powder metallurgy.	1	-	-
CO-2	Describe constructional and operational features of moulding machines.	1	-	-
CO-3	Select appropriate material and process of manufacture for a given part.	1	4	-
CO-4	Explain the use and methods of production of metal powders used in powder metallurgy.	1	-	-
CO-5	Explain high energy rate forming process.	1	-	-
CO-6	Identify defects in manufacturing processes and suggest the remedies to eliminate these defects.	-	3	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	3	-	2	2	-	-	-	-	-	-	-	-	-	-

Prerequisites:

- Basics of foundry, different casting processes furnaces and casting defects etc.
- Welding theory and various welding processes like arc, resistance, thermistor, friction, EBM, laser beam welding etc.

- Study of various other manufacturing processes like metal forming, forging, rolling, drawing along with basics of powder metallurgy and high energy rate forming.

Course contents:

1. **Casting process:** Introduction to casting process, steps involved. Advantages, dis-advantages and application of casting process.
   Pattern: Definition, materials used for patterns (any four), pattern allowances and their importance, types of patterns (any six). **4 Hrs**
2. **Sand muddling** Principle ingredients in moulding sand. Classification of moulding sand–Types of moulding sand–properties of moulding sand. Sand Testing – Grain finess, Clay content, Permeability, Compression strength, hardness. Core – Core Sand, binders, coremaking, corebaking, Types of cores. **4 Hrs**
3. **Moulding:** Hand, machine, jot-squeeze machine moulding, sand slinger, CO_2 moulding, Investment casting, permanent moulding, semi-centrifugal moulding, centrifugal casting, continuous casting. **Casting defects**: Causes, features, remedies. **6 Hrs**
4. **Melting furnaces:** Cupola, direct & indirect electric arc, Induction furnace.**3 Hrs**
5. **Welding:** Working principle of arc welding, TIG, MIG, SAW, Resistance (any one), Friction (any one), Explosive, EBW, and Laser Beam Welding. **4 Hrs**
6. **Metal forming**: Elastic & plastic state of metal, flow curve, cast and wrought product, merits & demerits of metal working processes, classification based on applied force & temperature. **3 Hrs**
7. **Forging:** Introduction, Classification, defects, causes, remedies in forged components. **3 Hrs**
8. **Rolling:** Introduction, classification of rolling mill, force & geometry relationship and rolling load and power (no derivation), rolling defects- causes and remedies. **3 Hrs**
9. **Drawing & Extrusion:** Draw bench, c/s of drawing die, wire, tube, plug & moving mandrel drawing. **Extrusion**: Introduction, direct & indirect extrusion, applications. **3 Hrs**
10. **Powder metallurgy:** Steps involved in PM Process, secondary operations, merits, demerits and applications of PM process. **3 Hrs**
11. **High Energy Rate Forming:** Working of Explosive, Electro Hydraulic & Electro Magnetic Forming. **3 Hrs**

Reference Books:

1. Serope Kalpakjian, Steven R. Schmid, Manufacturing Technology, 4th edition, Pearson Education Asia, 2000.
2. George E Dieter, Mechanical Metallurgy, S I Metric Edition, McGraw Hill, 2000.
3. Amitabh Ghosh & A. K. Mallik, Manufacturing Science, 2nd edition, East West Press, 2010.

18UMEC304	Machine Drawing	(2-0-2) 3

Contact Hours: 39

Course Learning objectives (CLOs): The objective of this course is to make the student aware of:

1. Importance of making drawings of machine parts as per standards.
2. Detailed drawings of machines parts from assembly drawing and vice versa.
3. Geometrical dimensioning & tolerancing
4. Solid modeling of Screw Jack, Plummer Block, Machine Vise.

Course outcomes (COs):

ID	Description of the course outcome	Mapping to POs (1-12)/PSOs (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Convert the given pictorial views in to orthographic projections of machine parts/objects using drawing conventions	-	1	-
CO-2	Draw or sketch the thread forms & fasteners / draw or sketch the orthographic views of fastener used in fastening two plates.	-	1	-
CO-3	Represent the dimensions on given part with tolerances for fits / and dimensions depicting tolerances for control of geometrical features.	-	1	-
CO-4	Create the parts drawings/assembly drawings in (sectioned) 2D of simple mechanical devices.	-	1	-
CO-5	Create the 3D models of mechanical parts and relevant assembly using the software.	-	5	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	2	-	-	-	2	-	-	-	-	-	-	-	-	-

Pre requisites: Engineering Drawing, Modeling software awareness, Engineering Materials, Elements of Mechanical Engineering.

Course Contents:

1. **Orthographic views (2D):** BIS conventions. Conversion of pictorial views into orthographic projections of **simple machine parts** with and without section.

6 Hrs

2. **Thread forms and threaded fasteners: S**ectional views of threads, ISO Metric (Internal & External), and square threads. Assembly of two plates using Hexagonal headed bolt and nut with washer, simple assembly using stud with nut and washer. **6 Hrs**
3. **GD & T:** Part drawings of a press tool representing various geometrical features and their tolerances. **3 Hrs**
4. **Couplings (2D) :** Protected type flange coupling assembly. **3 Hrs**
5. **Assembly Drawings (2D): A**ssembly drawing of– Screw jack (Bottle type) and simple jig. **12 Hrs**
6. **Computer aided 3D modelling: (Solid edge)**
   3D modeling of Screw jack, Plummer block. **9 Hrs**

Reference Books:

1. N.D.Bhatt, 'Machine Drawing', 45th edition, Charotar Publishers, 2008
2. K.R.Gopalkrishna, 'Machine Drawing', 22nd Edition, Subhas Publication 2013
3. 'A Primer on Computer Aided Machine Drawing-2007', VTU, Belgaum
4. Sham Tickoo,N. Siddeshwar, P. Kanniah, V.V.S. Sastri, 'Auto CAD 2006, for engineers and designers', Dream tech 2005, Tata McGraw Hill, 2006.
5. K C John 'Text Book Of Machine Drawing' PHI Learning Pvt Ltd,2009.

18UMEL305 Materials Science & Materials Testing Lab (0-0-3) 1.5

Contact Hours: 36

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Diverse activities involved with material science.
2. Basic concepts regarding structure-property-processing relations across all material classes.
3. Formation, properties and significance of the alloys.
4. Modern materials like – Special steels, Super alloys and Composites.
5. Many factors that ultimately determine a material selection for a given application.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Characterize the properties of materials subjected to tension, compression and shear.	1, 4, 9	2	3, 6
CO-2	Determine the impact strength of given specimen.	1, 4, 9	2	3, 6
CO-3	Find the hardness of metals using different methods.	1, 4, 9	2	3, 6
CO-4	Identify the different materials by observing microstructure.	1, 4, 9	3	-
CO-5	Detect cracks and flaws on metals using non-destructive tests.	1, 4, 9	3	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	3	2	1.4	3	-	1	-	-	3	-	-	-	-	-

Prerequisites: Engineering physics, chemistry, Strength of materials

Course Contents:

1. Preparation of specimen for metallographic examination of engineering materials and study the microstructure of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze.
2. Heat treatment: Annealing, normalizing (demonstration only), hardening and tempering of steel & to study their Rockwell hardness.
3. Testing of metals
    - Tensile test
    - Shear test

- Compression test
- Torsion and bending test
- Izod test
- Charpy test

4. Testing of non-metals like wood composites etc.
5. Experiment on Wear Study.
6. Brinell, Rockwell and Vicker's Hardness tests.
7. Fatigue Test
8. Non-destructive test experiments
   (a) Ultrasonic flaw detector,
   (b) Magnetic crack detector,
   (c) Dye penetrant testing.

18UMEL306	Foundry & Forging Lab	(0-0-3) 1.5

Contact Hours: 36

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Diverse tests involved with materials.
2. Basic concepts regarding structure-property-processing relations across all material classes.
3. Formation, properties and significance of the alloys.
4. Modern materials like – Special steels, Super alloys and Composites.
5. Many factors that ultimately determine a material selection for a given application.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Classify the various foundry sands and prepare the sand suitable for mold making.	1	--	--
CO-2	Conduct tests on foundry sands to determine properties for different ingredient compositions.	1,2	--	--
CO-3	Identify the various foundry tools and operations.	1,2	4	5
CO-4	Illustrate the applications of foundry tools and operations in preparing various patterns and molds.	2,3	--	1
CO-5	Identify the various tools and operations used in forging process.	1,2	--	5
CO-6	Prepare forging models using appropriate tools and operations.	3	9	1,2

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	2.6	2.6	3	2	1	--	--	--	2	--	--	--	--	--

Prerequisites: Material Science

Course Contents:

1. **Testing of moulding sand and Core sand:**
   - Compression test, shear test and tensile test
   - Permeability test
   - Core hardness &Mould hardness tests
   - Grain fineness test
   - Clay content test

2. **Foundry Practice:** Use of foundry tools and other equipment's. Preparation of moulds (ready to pour) using two boxes, use of split pattern, match plate pattern and Cores.
3. **Forging Models:** Preparing minimum three models involving upsetting, drawing and bending operations.

IV Semester

18UMAC400	Engineering Mathematics-IV	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives: To provide an insight into applications of conformal mapping, integration of complex functions and application of probability distributions in Engineering.

Course outcomes (COs):

COs	**Description of the course outcomes:** At the end of course the students will be able to	**Mapping to POs (1-12)**		
		Mastering 3	**Moderate 2**	**Introductory 1**
CO-1	Construct and use the concepts of analytic function to solve the problems arising in Engineering field.	-	-	1
CO-2	Utilize conformal transformation and complex integral to transform irregular domain onto a relatively simple domain.	-	-	1
CO-3	Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.	-	1,2	-
CO-4	Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.	-	1,2	-
CO-5	Estimate the correlation, covariance using joint probability distributions. Also use student's t-distribution, Chi-square distribution as a test of goodness of fit .	-	1,2	-

POs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Mapping Level	1.6	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1 -> Introductory (Slight); 2 -> Reinforce (Moderate); 3 -> Mastering (Substantial)

Contents:

Chapter I

Calculus of complex functions: Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms. Construction of analytic functions: Milne-Thomson method-Problems. **7 hrs**

Chapter II

Conformal transformations: Introduction. Discussion of transformations: $w = e^z; w = z^2$, $w = z + \frac{1}{z}, z \neq 0$). Bilinear transformations- Problems.
Complex integration: Line integral of a complex function, Cauchy's theorem and Cauchy's Integral theorem. **8 hrs**

Chapter III
Probability Distributions: Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normaldistributions- problems (No derivation for mean and standard deviation)-Illustrative examples. **8 hrs**

Chapter IV
Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation and rank correlation-problems. Regression analysis- lines of regression–problems.
Curve Fitting: Curve fitting by the method of least squares- fitting the curves of the form $= ax + b; y = ax^2 + bx + c; y = ax^b$. **8 hrs**

Chapter V
Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation and covariance.
Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit. **8 hrs**

Text Books:

1. E. Kreyszig:Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed.(Reprint) 2016.
2. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2017.
3. Srimanta Pal et al: Engineering Mathematics, Oxford University Press, 3rd Edition, 2016.

Reference books:

1. C. Ray Wylie, Louis C. Barrett : "Advanced Engineering Mathematics", 6th Edition,McGraw-Hill Book Co., New York, 1995.
2. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India, 4th Edition 2010.
3. B. V. Ramana: "Higher Engineering Mathematics" 11th Edition, Tata McGraw-Hill, 2010.
4. N. P. Bali and Manish Goyal : A Text Book of Engineering Mathematics, Laxmi Publishers,7th Ed., 2014.

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111.
2. http://www.class-central.com/subject/math(MOOCs).
3. http://academicearth.org/.

18UMEC400	Fluid Mechanics	(3-2-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Fluid and its properties, Laws governing objects submerged in fluids. Pascal law, hydrostatic forces on submerged body.
2. Fluid flow concepts, Fluid kinematics, velocity potential and stream functions. ideal fluid flow concepts, dimensional analysis , similitude
3. Fluid dynamics continuity equation, Bernoulli's theorem, application of Bernoulli's theorem
4. Flow through pipes, major and minor losses in flow through pipe.
5. Boundary layer theory, critical Reynolds number. Flow over flat plate, inside pipe, flow past immersed Bodies, Lift and drag force
6. Compressible flow, sonic velocity Mach number isentropic flow.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Demonstrate the basic knowledge on fluid properties, and laws governing statics kinematics and dynamics of fluid and dimensions of physical quantity.	1	-	-
CO-2	Describe classification of fluids, fluid flow, stability criteria of submerged bodies, and flow past cylinder, dimensionless numbers, critical Reynold no. and similitude.	-	1,2	-
CO-3	Apply laws governing statics of fluid for manometer, submerged surfaces to derive equations for hydrostatic force and centre of pressure for submerged bodies.	-	1,2	-
CO-4	Derive the dimensionless numbers using dimensional analysis of a fluid system through Rayleigh method and Buckingham's π theorem	1,2	-	-
CO-5	Determine Velocity potential function and stream function and calibrate flow measuring devices.	-	-	1,2
CO 6	Calculate pressure head, flow rates, evaluate major and minor loses in flow through pipe.	1,2	-	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	2.3	2.2	-	-	-	-	-	-	-	-	-	-	-	-

Pre-requisites: Engineering mathematics. Basic science, engineering mechanics

Course Contents:

1. Properties of Fluids: Introductory concepts and definitions, properties of fluids, classification of fluids and regimes of flow. **6 Hrs**
2. Fluid Statics: Pascal's law, pressure variation in static fluid, manometers (simple and differential U tube) and mechanical gauges. **6L+2T Hrs**
3. Submerged surfaces & Floatation: Hydrostatic force on submerged plane surfaces (horizontal, vertical and inclined). Buoyancy and stability criteria (no derivations for Meta centre). **6L + 3T Hrs**
4. Fluid Kinematics: Fluid flow concepts,types of flow, lines of flow, stream function and velocity potential function for 2D flow, Relationship between them and flow nets, Ideal flow concepts (Uniform flow, Source and sink flow, Doublet, Flow past the cylinder), continuity equation. **6 Hrs**
5. Dimensional Analysis: Dimensions of physical quantities, dimensional homogeneity-Buckingham's pi theorem, the Rayleigh's method, important dimensionless numbers, Critical Reynolds number, similitude. **4L + 1T Hrs**
6. Fluid Dynamics & its applications: Euler's Equation of motion, Bernoulli's equation, Venturimeter, orifice meter, pitot tube, V- notch, Rota meter, Hot wire Anemometer and Methods of fluid flow visualization. **6L + 2T Hrs**
7. Flow through Pipes: Hagen Poisuille's equation, minor and major losses in pipe flow - Energy line and hydraulic gradient line, Darcy and Chezy equations.**6 Hrs**
8. Boundary layer theory: Hydrodynamic boundary layer, boundary layer thickness, displacement, momentum & energy thickness, (Qualitative discussions and No derivations) Flow over a flat plate, Flow inside a pipe. Flow past immersed Bodies: Lift and Drag force, skin friction, Introduction to compressible Flow. **4 Hrs**

Note: Activities/Topics for self-study to be decided by course instructor.

Reference Books:

1. Dr. R K. Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines" 9th edition, Laxmi Publication (P) Ltd., New Delhi. 2013
2. Yunus Cengel "Fluid Mechanics(SI units)" McGraw Hill, 2014
3. Dr. Jagadishlal, "Fluid Mechanics and Hydraulics" Metropolitan Book Co. Pvt. Ltd., New Delhi, 1995.
4. White, "Fluid Mechanics" 6th edition, Tata McGraw Hill 2010.
5. Open course ware and MOOCS

18UMEC401	Manufacturing Processes - II	(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Basics of metal cutting, various machine tools, various modern machining processes, cutting tool materials and design of jigs and fixtures.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Classify basic machine tools and explain principles, constructional features & operations.	1	-	-
CO-2	Compute machining time for jobs on various machine tools.	1	-	-
CO-3	Distinguish the various systems of tools signatures.	1	-	-
CO-4	Analyze various forces & velocity relationships that arise during machining and select tool materials & assess tool life.	1	4	-
CO-5	Explain Modern machining processes and traditional machining.	1	-	-
CO-6	Design jig and fixture for a given job.	-	3	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	3	-	2	2	-	-	-	-	-	-	-	-	-	-

Pre requisites: Basic manufacturing processes

Course Contents:

1. **Machine Tools:** Introduction, Definition, requirements of machine tools, primary and secondary motions – tool and work movements for producing flat, cylindrical surfaces and holes, (2 Hrs). **Lathe:** Description and functions of lathe parts in brief, tool and work holding devices. Operations on lathe in brief, taper turning methods and thread cutting (with Numericals) (6 Hrs). **Drilling:** drilling, types of drilling machines and related operations. (2 Hrs). **Milling:** Principle of milling, types of milling machines, Description and working of horizontal and vertical milling machines and milling operations**.** (4 Hrs). **Grinding:** Classification, surface, centre less and internal grinders. Abrasives - bonds, grit, grade and structure of wheels. Designation of wheels. (3 Hrs). Machining time Calculation (turning, milling and drilling) (2 Hrs). **Gear manufacturing.** Indexing (direct and plain indexing with simple Numericals) and hobbing. (3 Hrs). **22 Hrs**

2. **Theory of metal cutting:** Aims and objectives in machining. Single point cutting tool geometry and nomenclature – machine reference (ASA), orthogonal rake system (ORS) and normal rake system (NRS). Mechanics of chip formation, types of chips, orthogonal and oblique cutting, relationship between chip thickness ratio, shear angle and rake angle in orthogonal machining. Velocity relationships. Merchant's analysis, Merchant's theory. **9 Hrs**
3. **Cutting tool materials:** Desired properties, types; HSS, carbides, coated carbides, ceramics, coronite, cermets, CBN, and diamond. CVD and PVD (principle in brief). Broad classification of carbide tools (PMK classification). **6 Hrs**
4. **Tool wear, cutting fluids and Machinability:** Types, mechanism, tool life criterion. Taylor's tool life equation. Cutting fluids - desired properties, types, selection. Factors affecting Machinability. Constraints in fulfilling machining objectives and control over the machining constraints, (With empirical formulae). **6 Hrs**
5. **Design and application of Jigs and Fixtures for aiding machining**: Purpose, considerations, principles, functions & design, design for few specific machining requirements. **6 Hrs**
6. **Modern machining processes:** Principles, equipment, operations and applications of Electric Discharge Machining, LBM, ECM. **3 Hrs**

Reference Books:

1. A.B. Chattopadhyay, Machining and Machine tools, Willey India.
2. SeropeKalpakjianSteuen R Schmid Manufacturing Technology, Pearson Education Asia, 4th edition, 2001.
3. Amitabh Ghosh & A. K. Mallik, Manufacturing Science, 2nd edition, East West Press, 2010.
4. HMT, Production Technology, Tata McGraw Hill, 2000.
5. Elements of Workshop Technology, Vol II. 14th edition, A.K.HajraChoudhury and Nirjhar Roy, 2010
6. Geoffrey Boothroyd and Winston A. Knight, Fundamentals of Machining and Machine Tools, 3rd edition, CRC Press. Taylore and Francis Group.

18UMEC402	Applied Thermodynamics	(3-2-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Applications of Thermodynamics principles to Gas and vapour power cycles
2. Performance analysis of R.A.C and optimization of compression
3. Basic combustion reaction analysis applied to specified conditions
4. Analysis of reversed Camot cycle based, Refrigerator and A/c systems
5. Thermal and analysis of different Refrigerator and A/c equipments
6. Use of standard D-H and Refrigeration tables for analysis
7. Measurement methods and actual performance analysis of IC Engines

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Derive and apply the thermodynamic equations for the performance evaluation of different power cycles.	1	2	-
CO-2	Derive and apply the thermodynamic equations to assess the performance of single and multistage air compressor.	1	2	-
CO-3	Apply the thermodynamic principles to assess the performance of refrigeration and Air conditioning systems.	1	2	-
CO-4	Describe the energy balance equation for a chemical reaction in combustion and exhaust gas analysis of common fuels for IC Engines.	1	2	-
CO-5	Calculate the performance parameters of IC Engines.	1	2	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	3	2	-	-	-	-	-	-	-	-	-	-	-	-

Pre requisites: Basic Thermodynamics concepts

Course Contents

1. **Gas power cycles:** Air standard cycles, Otto, Diesel, Dual, P-V and T-S diagrams, description, efficiencies and mean effective pressure, comparison of Otto, diesel and dual combustion cycles. Gas Turbines: Classification of Gas turbines, Brayton cycle, analysis of open and closed cycle gas turbine, methods

to improve thermal efficiency of the cycle, Effect of Regeneration, Inter cooling and Reheating. **6L+2T Hrs**

2. **Vapour power cycles:** Carnot vapour power cycle, drawbacks as a reference cycle, simple Rankine cycle; description, T-S diagram, analysis for performance, comparison of Carnot and Rankine cycle. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles, regenerative Rankine cycle, open and closed feed water heaters, reheat Rankine cycle. **6L+2T Hrs**
3. **Reciprocating Compressors:** Operation of a single stage reciprocating compressors, work input through p-v diagram, effect of clearance and volumetric efficiency, adiabatic, isothermal and mechanical efficiencies. Multi-stage compressor, saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression. **5L+2T Hrs**
4. **Combustion Thermodynamics:** Theoretical (Stoichiometric) air for combustion of fuels, excess air, mass balance, actual combustion. Exhaust gas analysis. A/F ratio, energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion, combustion efficiency. **5L+1T Hrs**
5. **I.C. Engines:** Performance Testing of Two-stroke and Four-stroke I. C. engines - Measurement of speed, air flow, fuel consumption, Measurement of Brake Power and Indicated Power, Performance curves, Heat Balance sheet and Multi cylinder Engines testing, Morse test. **8L+2T Hrs**
6. **Refrigeration:** Vapour compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, air cycle refrigeration, reversed Carnot cycle, Vapour absorption refrigeration system and Air refrigeration system. Use of refrigeration tables and p-h chart. Classification of Refrigerants. Desirable properties of refrigerants. **5L+2T Hrs**
7. **Psychrometrics:** Atmospheric air and Psychrometric properties: DBT, WBT, DPT, partial pressure, specific and relative humidity and relation between the enthalpy and adiabatic saturation temperatures. Construction and use of psychrometric chart. Analysis of various processes: Heating, cooling, dehumidifying and humidifying. Adiabatic mixing of stream of moist air. Analysis of summer and winter air-conditioning systems. **5L+1T Hrs**

Reference Books:

1. P. K. Nag, Basic and Applied Thermodynamics TMH Publishing Co. Ltd, New Delhi, 2nd edition, 2011.
2. Yunus A Cengel, Michael A Boles, Thermodynamics An engineering approach McGraw Hill Companies, New-Delhi, 6th edition, 2008

3. Refrigeration and Air Conditioning by C. P. Arora, Tata-McGraw-Hill publishing Co. Ltd. New Delhi, 2nd edition, 2004.
4. Thermal Engineering by R. K. Rajput, Laxmi Publishers (P) Ltd., New Delhi, 6th edition, 2006.
5. Internal combustion engines – M L Mathur and R P Sharma, DhanapathRai Publications., 3rd edition 2007.

Data Handbook:

1. Tables and Charts on Refrigerants and Psychometric Properties (S. I. Units) by P. N. Maskara and Satish Chand, Technical Publishers of India, Subhas Nagar, Allahabad, 1994.
2. Thermodynamics Data Hand Book (S. I. Units) by Prof. B. T. Nijaguna and Prof.B.S. Samaga, Sudha Publishers, Avenue Road, Bangalore

18UMEC403	Metrology and Measurements	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Need, standards and principles of measurement.
2. Basics of limits, fits and tolerances and their importance to the real manufacturing.
3. Principles of various mechanical elements – such as screws, threads and gears.
4. Basics of measurements systems.
5. Principles of transducers.
6. Working of force, torque, pressure, temperature, strain measurement systems.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Define the various standards of measurements, limits, fits, tolerances, comparators, screw thread and gear parameters.	1,13	-	-
CO-2	Compare different types of limit gauges, comparators, screw thread and gear measurement methods and coordinate measuring machines.	1,2	-	-
CO-3	Explain the typical modes of measuring linear, angular dimensions and the use of interferometry in metrology.	1,2	4	-
CO-4	Classify automatic gauges, comparators and establish the new methods of measurement in engineering metrology.	2,3	-	1
CO-5	Describe the various principles of measurement of force, strain, torque, pressure and temperature.	1,2	-	-
CO-6	Evaluate the best method for the measurement of force, torque, pressure, temperature and strain.	3	-	1,2

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	2.6	2.6	3	2	-	-	-	-	-	-	-	-	3	-

Pre requisites: Engineering mathematics, Basic science, Engineering Mechanics, Elements of Mechanical Engineering, Engineering drawing.

Course Contents:

1. **Standards of measurement:** Definition and Objectives of metrology, Standards of length - International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, comparison, transfer from line standard to end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-81, M-112), Numerical problems on building of slip gauges. **7 Hrs**
2. **System of limits, Fits, Tolerances and gauging:** Definition of tolerance, Specification in assembly, Principle of inter changeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919 -1963), geometrical tolerance, positional - tolerances, hole basis system, shaft basis of system, classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges -plain plug gauge, ring Gauge, snap gauge, limit gauge and gauge materials. **8 Hrs**
3. **Comparators and Angular measurement:** Introduction to Comparator, Characteristics, classification of comparators, mechanical comparators - Johnson Mikrokator, Sigma Comparators, dial indicator, Optical Comparators - principles, Zeiss ultra optimeter, Electric and Electronic Comparators - principles, LVDT, Pneumatic Comparators, back pressure gauges, Solex Comparators. Angular measurements, Bevel Protractor, Sine Principle and. use of Sine bars, Sine center, use of angle gauges, (numericals on building of angles) Clinometers. **6 Hrs**
4. **Interferometry, Screw thread and gear measurement:** Interferometer Principle of interferometry, autocollimator. Optical flats. Terminology of screw threads, measurement of major diameter, minor diameter pitch, angle and effective diameter of screw threads by 2-wire and 3-wire methods, Best size wire. Toolmakers microscope, gear terminology, use of gear tooth Vernier caliper and gear tooth micrometer. **7 Hrs**
5. **Advanced metrology:** Co-ordinate measuring machine (CMM) need, construction, types- applications in measurements and machine tool metrology, Introduction to computer aided inspection. **3 Hrs**
6. **Measurement of Force, Torque and pressure:** Principle, platform balance, proving ring, Torque measurement, Prony brake, hydraulic dynamometer. Pressure Measurements, Principle, Bridgeman gauge, Mcloed gauge. **4 Hrs**
7. **Temperature and strain measurement:** Thermocouple, laws of thermocouple, materials used for construction, pyrometer, Optical Pyrometer. Strain Measurements, Strain gauge, gauge factor. **4 Hrs**

Reference Books:

1. Beckwith Marangoni and Lienhard, “Mechanical measurements” Pearson Education, 6th Ed., 2007
2. R. K. Jain, “Engineering Metrology” 25th edition, Khanna Publishers, 2011
3. I. C. Gupta, “Engineering Metrology”, 7th edition, Dhanpat Rai Publications, Delhi, 2012
4. Alsutko, Jerry. D.Faulk, “Industrial Instrumentation” Thompson Asia Pvt. Ltd. 2002
5. Ernest O. Doebelin & Dhanish N. Manik, “Measurement Systems”, 6th editions, McGRAW Hill Book Co. 2011

18UMEC404	Design of Machine Elements – 1	(2-2-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Materials and properties used in machine elements.
2. Theories of failures and application.
3. Designing commonly used machine elements used for joining and power transmission.
4. Use of design data book and BIS standards.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Solve problems on eccentric loading & stress concentration in simple machine members	1	-	6
CO-2	Select suitable material for given application as per standards	1	-	6
CO-3	Apply theories of failure in design of machine components using factor of safety	3	1	6
CO-4	Design power transmission elements like shafts, keys, couplings and power screws	3	1	6
CO-5	Design the joints using threaded fastener, weld joints and rivets	3	1	6
CO-6	Apply fundamentals of fatigue in design of machine elements	3,1	-	6

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	2.5	-	3	-	-	1	-	-	-	-	-	-	-	-

Prerequisites: Engineering Mechanics, Strength of materials

Course Contents:

1. Introduction: Design methodologies, stress analysis, problems on axial, bending, torsional, eccentric loading for simple members of circular & rectangular cross section, stress due to impact loading (no derivation) **5 Hrs**
2. Role of materials, material selection, factor of safety, calculation of allowable stresses, theories of failure (max. of principal stress theory, shear stress theory, distortion energy theory), effect of stress concentration how to minimize stress concentration, problems on stress concentration (discontinuity of max. two discontinuities). **7 Hrs**

3. Design of knuckle joint: Modes of failures in various parts of knuckle joint. **1L+1T Hrs**
4. Design for fatigue strength: Introduction, S-N diagram, low cycle fatigue, high cycle fatigue, and Endurance limit. Modifying factors– size effect, surface effect, stress concentration effects; Fluctuating stresses, Fatigue strength under fluctuating stresses, Goodman's and Soderberg's relationship; stresses due to combined loading. **2L+4T Hrs**
5. Design of shafts: Strength & deflection–ASME code for transmission shafting, including axial loads – (problems not involving more than 2 transmitting elements). **2L+3T Hrs**
6. Keys & coupling: Selection of keys, check for stresses, design of flange coupling. **1L+1T Hrs**
7.
8. Design of Fasteners: Fastener, initial tension concept eccentrically loaded bolted joints – for Brackets & hangers & base of crane etc. **2L+2T Hrs**
9.
10. Design of Power Screws Mechanics of power screw, stresses in power screws, Efficiency and self-locking. **1L+2T Hrs**
11.
12. Riveted joints: Types, failures, design of structural joints – lap & butt joints, eccentric loading problems to be given as assignment (No boiler joints) Lozenge Joint. **1L+2T Hrs**
13. Design of welded joints: Lap joint, butt joint, eccentric welded joint subjected to torsional and bending moments (standard configuration only) **1L+1T Hrs**

Reference Books:

1. Joseph. E Shigley & Charles R MirchKe, Mechanical Engg. 6th edition,Design Tata, 2003. McGraw Hill Edition 2001
2. C. S. Sharma and Kamlesh Purohit, Design of Machine Elements, PHI 2003.
3. Maleev & Hartman, Machine Design CBS Publishers & Distribution, New Delhi
4. V. B. Bhandari, Design of Machine Elements, 3rd edition, Tata McGraw Hill Pub. New Delhi, 2010

Design Data Hand Books:

1. K. Mahadevan & Balaveera Reddy, Design Data Hand Book, CBS Publication, 2014
2. K. Lingaiah, Design Data Hand Book McGraw Hill, 2006

3. H. G. Patil, Machine Design Data Hand Book Shri Shashi Prakashan, Belgaum

18UMEL405	Measurements Lab	(0-0-3) 1.5

Contact Hours: 36

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Importance/need of mechanical measurements and metrology in day to day practical life.
2. Different measurements systems and the errors associated with them.
3. Importance of calibration of measurement instruments.
4. Various Sensors, traducers and strain gauges employed in measuring system.
5. Linear and angular measurements and calibration.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Calibrate various measurement devices like pressure gauge, thermocouple, LVDT, load cell etc.	1	-	3
CO-2	Measure linear dimensions using vernier, micrometer, LVDT etc.	-	1,4,	-
CO-3	Measure angular dimensions using bevel protractor, sine bar etc.	-	1,4	-
CO-4	Measure screw thread parameters by 3-wire method and gear tooth parameters by gear tooth micrometer.	-	1,4	-
CO-5	Use tool maker microscope and profile projector to measure angle, dimensions, profiles, radii of machine components.	-	1,4	-
CO-6	Determine modulus of elasticity using strain gauges.	-	1,4	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	2.2	-	1	2	-	-	-	-	-	-	-	-	-	-

Prerequisites: Mechanical measurements and Metrology

Course Contents:

1. Calibration of Pressure Gauge.
2. Calibration of Thermocouple.
3. Calibration of LVDT.
4. Calibration of Load cell.

5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.
6. Measurements using Optical Projector/Tool maker's Microscope.
7. Determination of angle using Sine Center / Sine bar / bevel protractor.
8. Determination of alignment using Autocollimator / roller set.
9. Determination of Screw thread parameters using two wire / three wire method.
10. Measurements of Surface roughness using Talysurf / mechanical Comparator.
11. Determination of gear tooth profile using gear tooth Vernier / gear tooth micrometer.
12. Calibration of a micrometer using slip gauges.
13. Measurement using Optical Flats.
14. Checking of circular components for roundness.
15. Setting the snap gauges for the given tolerance grade and checking the components.
16. Use of ring gauges and plug gauges for inspection of components.

18UMEL406	Thermal Engineering lab - I	(0-0-3) 1.5

Contact Hours: 36

Course Learning Objectives (CLOs): The objectives of this Laboratory are to make the student to learn:

1. Different types of oils used in energy conversion devices and their application.
2. Fuel properties such as calorific value, viscosity and flash and fire point.
3. Parameters affecting the Internal Combustion Engine performance and their measurement.
4. Parameters to know performance of Internal Combustion Engine.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO1	Determine flash and fire point using different apparatus	-	1,2	4
CO2	Determine the viscosity of given oil and calorific value of fuel using concerned apparatus	-	1,2	3,4
CO 3	Carryout performance test on Multi cylinder engine	-	1,2	4,9
CO 4	Carry out performance test on VCR engine and 2 stroke petrol engine	1	2	4,9

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	2.3	2	1	1	-	-	-	-	1	-	-	-	-	-

Pre-requisites: Basic thermodynamics, applied thermodynamics, Basic Science, Flow analysis,

Course Contents:

1. Determine the flash point and fire point of a given oil using Cleveland open cup apparatus.
2. Determine the flash point of given oil using Pensky-Martin closed cup apparatus.
3. Determine the flash point of given oil using Abels closed cup apparatus.
4. Determine the viscosity of oil using Red wood viscometer.
5. Determine the viscosity of oil using Say-bolt viscometer.
6. Determine the area of irregular shape using Planimeter.
7. Performance test on four stroke IC engine and Heat balance sheet.
8. Performance test on VCR engine and Heat balance sheet.
9. Performance test on 2 stroke Bajaj engine.

18UMEL407	Introductory Project	(0-0-2) 1

Contact Hours: 25

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Practical significance of projects.
2. Engineering concepts and its application to real world problems.
3. Literature review for engineering problems
4. Existing solutions to engineering problems.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Perform literature review for given topic	1,2	-	-
CO-2	Identify problem from literature review	1,2	-	-
CO-3	Establish objectives and methodology for the problem defined.	1,2	3,4	-
CO-4	Analyze the existing solution for the identified problem.	1,2	3,4	5,6,7,12, 14
CO-5	Prepare a report and present their findings using PPT.	10	9	8,12

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping level	3	3	2	2	1	1	1	1	2	3	-	1	-	1

Course Contents:

Introductory project is introduced with an objective of understanding and identifying the community expectation in terms of possible Engineering solutions by applying the fundamental knowledge of basic sciences and basic engineering courses. The project shall be engineering oriented in terms of problem definition, related literature survey and existing solutions. The team consisting of 10-12 students shall be asked to identify the problems related to community and try to propose a solution. The faculty members handling the courses for that semester shall guide the students. A committee consisting of minimum 3 faculty members shall evaluate at the end for CIE. There is no SEE for introductory project