Semester III

Materials Science

1.1 Course Number: ME201
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: Diploma level Physics & Chemistry
1.5 Syllabus Committee Members: Dr. Naveen Mani Tripathi, Dr. Abhimanyu Kar, Dr. Sanat Kumar Singha & Dr. Karthik Babu NB

2. **Objective:**

i) Understand the classification of materials, bonding and the crystal structure.
ii) Identify and understand defects in crystals.
iii) Interpret and understand the phase diagrams of materials, transformation across various regions, pearlite transformation, TTT Diagram.
iv) Select suitable heat-treatment process to achieve desired properties of metals and alloys.
v) Understand the basic mechanisms of diffusion and the factors governing them. Develop an understanding on the properties and applications of different steels in engineering applications.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Atomic Bonding**	Structure of atoms and molecules, Bonding in solids: types of bonds and comparison of bonds, Classification of engineering materials based on bonds, Numerical problems on bond energy calculation	3
2	**Crystal Structure and Defects**	Crystal geometry, structure of solids (indexing of plane and direction & problems on planar and volume density), X-ray diffraction (principle and indexing examples (with extinction rules), real time problems on XRD indexing) (4) Imperfection in crystals - types of imperfection. Point imperfection, line, surface and volume defects [in context of definitions and real time applications], Numerical problems on point defects (2)	6
3	**Properties of Materials**	**Mechanical properties of materials:** Stress-Strain Curves for Brittle and Ductile Materials, Theoretical and Observed Shear Stress, Critical Resolved Shear Stress, (3) Deformation: Elastic, Anelastic, Plastic, Yield Criteria. (2) Fatigue: definition, types and method for improving fatigue resistance, application of SN curve for fatigue life measurement (numerical problems to solve) (2) Creep: Definition, types and methods for improving creep resistance, application of LM parameter for creep life measurement (numerical problems to solve) (2) Fracture: Definition, types, microstructural comparison	12

		and fracture toughness / stress intensity calculation (with preexisting crack in infinite and semi-infinite plate) (2) Impact toughness: Izod and Charpy test (2) Deformation of materials: Rolling, forging, extrusion, wire drawing [definition, types, products' properties, industrial application in context of chemical and steel industries] (4)	
4	**Engineering Materials**	**Ferrous metals & alloys:** Iron and their alloys, steel (types and brief application), Gibbs phase rule, lever rule, Iron carbon equilibrium diagram and microstructure evaluation by metallography. (5) ***Non-ferrous metals and alloys:*** Aluminium, copper, Zinc and Nickel alloys (with reference to the application in chemical and steel industries) (4)	9
5	**Heat Treatment and NDT**	Description of processes: Annealing, hardening, normalizing and tempering Hardening processes: surface hardening, Flame hardening case hardening, methods, their scope, limitation and advantages TTT curves: interpretation and use Non-Destructive Testing: Introduction and classification of NDT techniques; (a) Magnetic particle testing: Operating principle and magnetising technique. (b) Liquid Penetrating technique: Principle, process description. (c) Ultrasonic Testing: Definition, advantages and applications, inspection methods. (d) Radiography: Electromagnetic radiation sources, process description. (e) Eddy current testing; Leak testing: Bubble emission testing, Air leak testing.	10
Total			**40**

4. Readings

4.1 Textbooks:

1. Materials Science, V. Raghavan, PHI Learning Private Ltd., 2010.
2. Materials Science, G.K. Narula, K.S. Narula, V.K. Gupta, Tata McGraw Hill, 2010.

4.2 Reference Books:

1. Engineering Materials: Polymers, Ceramics and Composites, A.K. Bhargava, PHI Learning (P) Ltd.
2. Callister's Materials Science and Engineering, W.D.Callister, Jr, R. Balasubramaniam Wiley India, 2010

5. Outcome of the Course:

1) Describe the fundamentals of material science and concepts of unit cell & crystallography.
2) Illustrate different properties of materials and co-relate to the practical applications of different material.
3) Apply different heat treatment processes according to their corresponding needs.
4) Describe the basic properties of ceramics, composites and alloys with their applications.

Fluid Mechanics

1.1 Course Number- ME204
1.2 Contact Hours- 3-1-0 Credits: 11
1.3 Semester Offered- 2nd Year Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee members- Dr. Abhimanyu Kar, Dr. Sanat Kumar Singha, Dr Naveen Mani Tripathi, Dr. Karthik Babu NB

2. Objective:

i) To study statics, kinematics and dynamics of fluids.
ii) To understand the characteristics associated with the fluid flow though pipeline systems.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Fluid Statics**	Brief description of various fluid properties, Pressure at a point, Compressible and Incompressible fluid, Measurement of pressure, Manometry, Buoyancy, Archimedes' principle and stability	6
2	**Fluid Kinematics**	Classification of fluid flows – viscous vs inviscid flow, internal vs external flow, compressible vs incompressible flow, laminar vs turbulent flow, natural vs forced flow, steady vs unsteady flow, uniform vs non-uniform flow; Flow patterns – timeline, streamline, path line, streamline	9
3	**Fluid Dynamics**	Fluid flow rate, Conservation of mass, Continuity equation, The Bernoulli's equation and its application	9
4	**Pipe Flow**	Flow regimes in a pipe, Energy loss in pipes through Darcy-Weisbach equation and Hagen-Poiseuille equation, Friction factor, Turbulent flow in pipes, Moody's Diagram	9
5	**Turbulence**	Turbulence: Transition from laminar to turbulent flows, Nature of turbulence, Isotropic turbulence, Reynolds stress, Eddy viscosity	6
Total			**39**

4. Readings

4.1 Textbooks/ Reference Books:

1) Elger, Donald F., Barbara A. LeBret, Clayton T. Crowe, and John A. Roberson. Engineering fluid mechanics. John Wiley & Sons, 2020.
2) Yunus, A. Cengel. Fluid Mechanics: Fundamentals and Applications (SI Units). Tata McGraw Hill Education Private Limited, 2010.
3) Fox, Robert W., Alan T. McDonald, and John W. Mitchell. Fox and McDonald's introduction to fluid mechanics. John Wiley & Sons, 2020.
4) R.K. Bansal, A textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications.

5. Outcome of the Course:

1) Knowledge of fluid properties, stress, buoyancy and floatation.
2) Classify fluid flow and flow pattern.
3) Understand continuity and Bernoulli equations.
4) Derive Darcy-Weisbach equation and Hagen-Poiseuille equation associated with pipe flow.
5) Calculate friction factor from Moody diagram.
6) Knowledge of minor & major losses and energy & hydraulic grade lines corresponding to pipe flow.
7) Classify flow control valves and safety valves.

Manufacturing Technology –I

1.1 Course Number- ME205
1.2 Contact Hours- 3-1-0 Credits: 11
1.3 Semester Offered- 2nd Year Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee members- Dr. Abhimanyu Kar, Dr. Sanat Kumar Singha, Dr Naveen Mani Tripathi, Dr Karthik Babu NB

2. Objective:

i) To understand some important primary and secondary manufacturing processes
ii) To be able to select methods, equipment and their specifications for manufacturing any object using these manufacturing processes.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Metal Casting Processes**	Sand Casting: Sand Mould – Type of patterns – Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces: Blast and Cupola Furnaces; Principle of special casting processes: Shell – investment – Ceramic mould – Pressure die casting – Centrifugal Casting – CO_2 process – Stir casting; Defects in Sand casting	8
2	**Joining Processes**	Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding – Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding – Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding – Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.	7
3	**Metal Forming Processes**	Hot working and cold working of metals – Forging processes – Open, impression and closed di forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion.	8
4	**Sheet Metal Processes**	Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations –Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Rubber pad	8

		forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming.	
5	**Manufacture Of Plastic Components**	Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding – Typical industrial applications – introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.	8
Total			**39**

4. Readings:

4.1 Textbooks/ Reference Books:

1. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2008
2. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2013
3. Gowri P. Hariharan, A.Suresh Babu, "Manufacturing Technology I", Pearson Education, 2008
4. Paul Degarma E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing" Eight Edition, Prentice – Hall of India, 1997.
5. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-2013
6. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006
7. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014.

5. Outcome of the Course:

1) Being able to calculate the energy and force required for metal forming operations
2) Being able to understand the various defects that can occur in casting, forging and welding with ways to avoid it.
3) Being able to design the manufacturing process of a given object with the processes covered.
4) Being able to operate with the help of an operator the machinery used in industrial production processes.

Engineering Thermodynamics

1.1 Course Number- ME206
1.2 Contact Hours- 3-0-0 Credits: 9
1.3 Semester Offered- 2nd Year Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee members- Dr. Abhimanyu Kar, Dr. Sanat Kumar Singha, Dr Naveen Mani Tripathi, Dr. Karthik Babu NB

2. Objective:

i) To understand basic concept of thermodynamics and its properties.
ii) To generate the ability to differentiate different forms of energy i.e., heat and work.
iii) To apply first law of thermodynamics to closed and flow systems.
iv) To realize the need of second law of thermodynamics, spontaneity and irreversibility in nature.
v) To learn basic concepts of real gases and working of external and internal combustion engines.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Basic concepts and definition**	Scope and limitations of Thermodynamics, Macroscopic and Microscopic approaches; Definition of System, Surrounding, closed systems, and open system; Properties: (extensive and Intensive), Characteristics of properties (point and path function), and its representation on a property diagram; Units of measurements: Force, Pressure, and Energy.	6
2	**Equilibrium and Zeroth Law**	Equilibrium: Thermal, Mechanical, Chemical, Thermodynamic; Zeroth Law of Thermodynamics and temperature, Measurement of temperature and calibration of Thermometers, the ideal gas temperature scale.	5
3	**Processes and its representation**	Reversible and Irreversible processes; Different types of process and their representations.	2
4	**Work and Heat Transfer**	Definitions and calculations: Work Transfer, Different modes of work, Displacement Work for various processes, Heat Transfer, Specific heat, Latent heat.	4
5	**First Law of Thermodynamics**	Joule's experiment, Introduction of internal energy as a thermodynamics property, Introduction of enthalpy as a thermodynamic property; Definition of specific heats and their	5

		use in calculation of internal energy and enthalpy with emphasis on ideal gases.	
6	**Applications of First Law of Thermodynamics**	Application of First Law to control mass: Work done and heat transfer in various types of elementary processes; Application of First Law to control volumes; Nozzle, Diffuser, Compressor, Turbine, Throttling device, Heat Exchanger. (Only steady flow need be considered).	8
7	**Second Law of Thermodynamics**	Limitations of first law of thermodynamics; Cyclic heat engine; Energy reservoirs; Refrigerator and Heat Pump; Kelvin-Plank statement and Clausius statement of second law; Reversibility and Irreversibility; Carnot Cycle and Carnot Theorems;	5
8	**Entropy**	Clausius' Theorem and Clausius' inequality; Concept of entropy; Entropy and Disorder; Entropy changes in various processes, Entropy Principle and its application,	5
	Total		**40**

4. Readings

4.1 Textbooks:

1. Engineering Thermodynamics by P.K. Nag, Publisher: TMH
2. Basic Engineering Thermodynamics by Rayner Joel, Pearson Education

4.2 Reference Books:

1. Engineering Thermodynamics by Van Wylen and Sontang, John Wiley
2. Engineering Thermodynamics by M. Achuthan, Publisher: PHI
3. Applied Thermodynamics by Eastop and McConkey, Publisher: Pearson
4. Fundamental of Engineering Thermodynamics by E. Rathakrishnan, publisher. PHI
5. Engineering Thermodynamics by Russel and Adebiyi, publisher, Oxford
6. Steam Tables in SI Units by Ramalingam, Scitech.

5. Outcome of the Course:

1) Basic understanding thermodynamics and its applications
2) Understand the basics of Engineering Materials (its applications) and Stress-Strain
3) Basic understanding of boilers, engines and latest automobile technologies.
4) Understand the basics Applied Mechanics, Simple lifting Machines & Power Transmission
5) Understand the basics of Engineering surveying and Smart Infrastructure Development.

Strength of Materials

1.1 Course Number- ME208
1.2 Contact Hours- 3-1-0 Credits: 11
1.3 Semester Offered- 2nd Year Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee members- Dr. Abhimanyu Kar, Dr. Sanat Kumar Singha, Dr Naveen Mani Tripathi, Dr. Karthik Babu NB

2. Objective:

To give students a foundational understanding of material mechanics so they may create engineering systems and solve real engineering challenges.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**The deformation of a real body under static loads**	Basic of stress & strain, Generalized Hooke's law, Elastic constants and Relationship. Stresses and strains on oblique planes under uniaxial and biaxial loading., Analysis of plane stress and plane strain, Mohr's circle of stress and strain.	7
2	**Beams**	Shear force and Bending moments for different types of beams, Simple bending theory, bending stress analysis for symmetrical and unsymmetrical sections, Strain energy due to bending, Shear stress distribution in massive and thin-walled cross section, Shear centre, Strain energy due to shear.	8
3	**Slope and deflection of beams**	Relationship between curvature, deflection and slope, Method of Superposition, Macaulay's method, Moment-Area method, Conjugate Beam method.	9
4	**Torsion**	Torsional rigidity, Torsion of circular bars, Torsion in thin tubular section, Strain energy due to Torsion.	6
5	**Column and struts**	Elastic buckling concept, Euler's theory for crippling load, Empirical formulae for crippling load. Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure.	8
Total			**38**

4. Readings

4.1 Textbooks:

1. Ramamrutham, S. Strength of Materials, Dhanpat Rai Publishing Company
2. Bansal, R.K. Strength of Materials, Laxmi Publications Pvt. Ltd.
3. Nag, D., Chanda, A. Strength of Materials, Wiley-India.
4. Subramaniam, R. Strength of Materials, Oxford University Press.

5. Singh, S. Strength of Materials, Katson Book.
4.2 Reference Books:

1. Shames, I.H. Introduction to Solid Mechanics, Prentice Hall of India.
2. Rajput, R.K. Strength of Materials, Dhanpat Rai & Sons.
3. Singh, S. Strength of Materials, Khanna publications.

5. Outcome of the Course:

1. Recognize the concepts of stress and strain at a point along with the stress and strain relations for homogenous, isotropic materials.
2. Compute the stresses and strains that axially loaded, circularly torsionated, and flexure-laden members will experience.
3. Determine the stresses and strains related to pressure vessels with thin walls that are spherical and cylindrical.

Renewable and Alternative Energy Sources

1.1 Course Number- ME209
1.2 Contact Hours- 3-1-0 Credits: 11
1.3 Semester Offered- 2nd Year Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee members- Dr. Abhimanyu Kar, Dr. Sanat Kumar Singha, Dr Naveen Mani Tripathi, Dr. Karthik Babu NB

2. Objective:

i) To study the various methods of electricity production from solar, wind, biomass and geothermal energy
ii) To be able to calculate the potential of solar or wind energy at a given location from weather data
iii) To understand the mechanisms of energy storage in large scale including in the form of hydrogen

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Solar Energy– Basics**	Sun as a source of energy. Sun earth radiation spectrums. Spectral energy distribution of solar radiation. Measurement of solar radiation. Empirical equations for estimating solar radiation availability. Solar collectors, comparison of concentrating and non-concentrating types of solar collectors. Effect of various parameters and performances. Solar water heaters, solar refrigeration and air conditioning systems, solar cooker, solar furnaces, solar greenhouse, solar dryer, solar distillation, solar thermo-mechanical systems. Solar cell fundamentals, classification of solar PV systems.	8
2	**Wind Energy**	Wind energy, energy estimation of wind, power extraction from wind, classification and description of wind machines. Elementary design principles; coefficient of performance of a wind mill rotor, aerodynamic considerations of wind mill design	7
3	**Biomass, Ocean Energy and Geothermal Energy**	Usable forms of bio mass, their composition and fuel properties. Bio gas production from waste biomass. Tidal energy technology, ocean thermal energy, origin and characteristics of resources. Application, types and analysis of geothermal resources.	8
4	**Batteries and Fuel Cells**	Basic Battery theory, definition of fundamental quantities, Battery fundamental characteristics, different types of battery	8

		arrangement, classification of batteries. Design and principle of operation of fuel cells, classification and types of fuel cells, advantages and disadvantages of fuel cells, conversion efficiency, types of electrodes, work output and EMF, application of fuel cells.	
5	**Hydrogen for Energy Storage**	Hydrogen production methods – electrolysis, thermos chemical, fossil fuel and solar energy, Hydrogen storage, Hydrogen transportation, Hydrogen as an alternative fuel for vehicles, Safety and management, Hydrogen technology development in India and the world.	8
Total			**39**

4. Readings

4.1 Textbooks/ Reference Books:

1. G.D Rai, Non-Conventional Energy Sources, Khanna Publishers.
2. Subhas P Sukhatme, Solar energy, Tata McGraw Hill.
3. N.K. Bansal, Manfred Kleeman & Mechael Meliss , Renewable Energy Sources and Conversion Technology ,Tata McGraw Hill
4. John W. Twidell Anthony D. Weir, Renewable Energy Resources, Taylor & Francis
5. P.K. Nag, Solar Power Engineering, Tata McGraw Hill.

5. Outcome of the Course:

1) After attending the course, the student shall be able to calculate the amount of solar or wind energy that can be extracted at a given area from weather data and also calculate the specifications of the required equipment.
2) Being able to choose from the various energy storage methods available for intermitted power sources.
3) Understanding of the mechanism of direct use of solar energy in dryers, water heaters refrigerators etc.

Computer Aided Drafting Laboratory

1.1 Course Number- ME207L
1.2 Contact Hours- 0-0-2 Credits: 2
1.3 Semester Offered- 2nd Year Odd
1.4 Prerequisite: NA
1.5 Syllabus Committee members- Dr. Abhimanyu Kar, Dr. Sanat Kumar Singha, Dr Naveen Mani Tripathi, Dr. Karthik Babu NB

2. Objective:

i) To acquire practical skills in drawing 2D and 3D objects in CAD software
ii) To be able to make detail, assembly and 3D drawing of machines parts using software

3. Course Content:

Unit	Topics	Sub-topic	Lab Sessions
1	**2D Drawing**	2D Drawing commands – line, polyline, circle, polygon. Editing commands, Array and grouping	4
2	**Annotation**	Dimensioning in different ways – aligned, horizontal, baseline and continued dimensions, leader, single and multiline text	1
3	**3D Drawing**	Basic ways to generate 3D solids: Region, Extrude, Press pull, Revolve etc., 3D editing commands, viewports, UCS and projections.	4
4	**Blocks and Layers**	Blocks, layers, line type and their uses	1
5	**Auto LISP**	Creating customized drawings as per user input, customized curves and shapes which are not available in AutoCAD commands	2
		Total	**12**

4. Readings

1. AutoCAD Tutorial

5. Outcome of the Course:

1) To be able to draw a 3D drawing from a model and dimensional information
2) To be able to produce complete drawing sheets from a rough sketch or design information of any machine part or assembly

Unit Operations Laboratory – I

1.1 Course Number: CE201L
1.2 Contact Hours: 0-0-2 Credits: 2
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: Diploma level Mathematics and Physics
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

i) The lab is to provide practical and theoretical experience in a number of important chemical engineering unit operations ensuring a thorough understanding of the principles of unit operation. The course includes experimental execution, data analysis and error analysis, skills development in oral presentation, technical report writing, and team-building.
ii) The experiments are designed to illustrate the principles of fluid and particle mechanics, separation processes.

3. Course Content:

Sl. No.	List of Experiments
1	To verify the Bernoulli's equation
2	To study the head losses due to various fittings in pipeline
3	To study different types of flow
4	To measure the viscosity of oil using Redwood Viscometer
5	To measure the discharge through Venturi meter, Orifice meter and Rotameter
6	To study the Reciprocating pump characteristics
7	To study the Centrifugal pump characteristics
8	To study the operation of ball mill
9	To study the operation of gyratory sieve shaker
10	To study the working principle of froth flotation cell
11	To study the operation of plate and frame filter press

4. Outcome of the Laboratory:

This lab will give the student a thorough knowledge of fluid and particle mechanics, separation processes. Understand to analyze experimental data and observed phenomena to write good technical report.