Semester III

Materials Engineering

1.1 Course Number: ME202
1.2 Contact Hours: 3-0-0 Credits: 9
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: Class 11th and 12th 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.
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)	12

		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 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	**Non-metals and Advanced Engineering Materials** [with special reference to the applications in chemical Industries]	Ceramics and refractories: Their definition, Properties, examples and applications [with special reference to the applications in chemical Industries] [3] Organic materials: polymers and plastics: Definition, Properties, Examples and Applications [with special reference to the applications in chemical and steel Industries] [4] Advanced materials: Nanomaterials and composites [with special reference to the applications in chemical and steel Industries] [3]	10
Total			**40**

4. Readings

4.1 Textbooks:

1. Callister's Materials Science and Engineering, W.D.Callister, Jr, R. Balasubramaniam Wiley India, 2010
2. Materials Science, V. Raghavan, PHI Learning Private Ltd., 2010.

4.2 Reference Books:

1. Engineering Materials: Polymers, Ceramics and Composites, A.K. Bhargava, PHI Learning (P) Ltd.
2. Raj, Baldev, Tammana Jayakumar, and M. Thavasimuthu. Practical non-destructive testing. Wood head Publishing, 2002.

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.

Unit Operations-I

1.1 Course Number- CE201
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	**Pipeline Systems**	Basic of pipe network system, Minor losses in pipes, Energy and hydraulic grade line, Valves used in pipelines – Flow control valve, Check valve, Pressure relief valve/ Safety valves	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.

Materials and Energy Balance

1.1 Course Number: CE202

1.2 Contact Hours: 3-1-0 Credits: 11

1.3 Semester-offered: 2nd Year –Odd

1.4 Prerequisite: Diploma level Physics, Chemistry & Mathematics

1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

i) To understand the concept of stoichiometry.

ii) To understand the streams involved in different unit operations and also the reactions in different unit processes.

iii) To learn the basic calculations related to material and energy flow in the processes.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Fundamental Concepts of Stoichiometry**	Mole concept, Composition of solids, Composition of liquids, Composition of gas and gas mixtures.	4
2	**Material Balance without Chemical Reaction**	Basic Material balance principles, Total and component balance, Steady state and Unsteady state process, Batch and continuous process, Tie element, Basis for calculation, Steps for solving Material Balance problems, Material Balance in Unit Operations.	10
3	**Material Balance with Chemical Reaction**	Classification of chemical reactions, Rate of chemical reaction, Rate expression, rate constant, Elementary and non-elementary reaction, Stoichiometry, Molecularity, Limiting Reactant and Excess Reactant, Conversion, Yield and Selectivity, Reaction coordinate, Equilibrium constant, Bypass Operations, Recycle Operations: Introduction, Application, Recycle Ratio, Purging Operation: Purge ratio, Combined feed ratio.	14
4	**Fuel and Combustion**	Combustion of Solid, Liquid and Gaseous fuel: Orsat Analysis, Proximate and Ultimate analysis of coal, GCV, NCV.	6
5	**Energy Balance**	Energy and its classification, Heat Capacity, Heat of Reaction, Heat of Formation, Heat of Combustion, Hess Law, Phase Change Operation.	6
TOTAL			**40**

4. Readings:

4.1. Textbooks:

1. D.M.Himmelblau and J. B.Riggs, Basic Principles and Calculations in Chemical Engineering, Pearson.
2. A.Olaf, K.M. Watson and R.A. R. Hougen, Chemical Process Principles, Part 1: Material and Energy Balances, John Wiley & Sons.

4.2 Reference Books:

1. K. A. Gavhane, Introduction to Process Calculation, Nirali Prakashan.
2. K. Narayanan and B Lakshmikutty, Stoichiometry and Process Calculation, Eastern Economy Edition.
3. B. I. Bhatt and S M Vora, Stoichiometry, Tata McGraw Hill Edition.

5. Outcome of the Course:

The students completing the course will be able to formulate and solve mass and energy balance problems concerning different unit operation and processes in industries.

Mechanical Operations

1.1 Course Number: CE203
1.2 Contact Hours: 3-0-0 Credits: 9
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: Diploma level Mathematics
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

To learn about operations related to size reduction, size separation, filtration, mixing, transportation and storage which are important in many chemical and metallurgical industrial practices from the point of view of consequence and process economy. It is therefore, important to study the principles of operation of different equipment and selection of equipment for specific purpose from host of different alternatives.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Properties and Storage of Solids**	Characteristics of Solid Particles, Particle Shape, Particle Size, Average Particle sizes. Solids in Bulk, Angle of Repose, Angle of Internal Friction, Storage of Bulk Solids, Flow of Bulk Solids.	6
2	**Size Reduction of Solids**	Objectives and Methods of size reduction, Impact, Attrition, Compression, Shear Properties of Solids, Energy and Power consumption, Crushing Efficiency, Laws of Communition, Rittinger's Law, Kick's law, Bond's Law. Size Reduction Equipments and their Classification.	8
3	**Separation and Transportation of Solids**	Introduction, Purpose of separation, Different methods of separation, Screening and types of screens, Description Screening Equipments, Different methods of transportation of solids- pneumatic conveying, vertical and horizontal, Hydraulic conveying. Description of different conveying equipment's -Belt Conveyors, Screw Conveyors, Bucket Elevators.	6
4	**Filtration**	The theory of filtration, relation between thickness of cake and volume of filtrate, flow of liquid through the cloth, flow of filtrate through the cloth and cake combined, compressible filter cakes, Filtration practice, washing of filter cake, Different Filtration equipment	8
5	**Mixing and**	Agitation of liquids, Purpose of agitation equipment,	5

	Agitation	Impellers, Flow patterns in agitation vessels, effect of system geometry.	
6	**Motion of particles in a fluid**	Free settling and Hinderd settling, Stock's law & Newton's law regimes of settling, Gravity settling processes, gravity classifiers, sorting classifiers: sink-and-float methods, differential settling methods. Clarifiers and thickeners, Cyclones, hydro cyclones.	7
TOTAL			**40**

4. Readings:

4.1 Textbooks:

1. W.L. McCabe, J.Smith and P.Harriot,Unit Operations of Chemical Engineering, McGraw-Hill, International Edition.

Reference Books:

1. W.L. Badger and J.T. Banchero, Introduction to Chemical Engineering, Tata McGraw-Hill, International Edition.
2. C.J. Geankoplis, Transport Processes and Unit Operations, Prentice Hall, India.
3. B.K. Dutta. Principles of Mass Transfer and Separation Processes Phi Learning Private Ltd.

5. Outcome of the Course:

On completion of this course, the student will be able to understand and operate the various equipment used for different operations like size reduction, size separation, filtration, mixing, transportation and storage and solve simple problems.

Chemical Technology

1.1 Course Number: CE204
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 2nd Year –Odd
1.4 Prerequisite: Diploma level Chemistry
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:
To study the process technologies of various process industries involving process technology, flow sheets of process, raw material availability, production pattern, engineering problems.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Sugar & Fermentation Industry**	Manufacturer of cane sugar, Various engineering problems encountered in sugar industry, Pollution abatement in sugar industry. Introduction of fermentation industry, Fermentation processes for the production of ethyl alcohol, Various engineering problems encountered in fermentation industry, Pollution abatement in fermentation industry**.**	10
2	**Pulp and Paper Industries**	Methods of pulp production, manufacture of pulp by Kraft process, recovery of chemicals from black liquor, various engineering problems encountered in paper industry & Pollution abatement in pulp and paper industry.	8
3	**Fertilizer Industry**	Chemical fertilizers: Definition, Types, Nitrogeneous fertilizers, Phosphoric fertilizers, Potassium fertilizers, mixed fertilizers, Manufacture of Ammonia by Habers process, Manufacture of urea, and its major industrial problems.	8
4	**Cement Industry**	Cement: Definition, properties, methods of production, types of Portland cement, manufacturing of Portland cement and its major industrial problems.	6
5	**Oil & Soaps Industry**	Refining of edible oils and fats, fatty acids, Manufacturing of soap, glycerin as by products from soap, Various engineering problems encountered in oil & soaps Industry.	6
TOTAL			**38**

4. Readings:

4.1 Textbooks:

1. C. L. Dryden, Outlines of Chemical Technology, Edited and Revised by M. Gopala Rao and S. Marshall, Affiliated East West, New Delhi.
2. T. G. Austin and S. Shreve, Chemical Process Industries. McGraw Hill, New Delhi.

4.2 Reference Book:

1. R. E. Kirk, and D. F. Othmer, Encyclopaedia of Chemical Technology, Interscience, New York.

5. Outcome of the Course:

After completion of this course, students will be able to

1) Identify different unit operations and unit processes in a given process flow diagram.

2) Understand the role of chemical process engineer in chemical industry.

3) Ability to understand the process flow diagram and various process parameters.

4) Identify and solve engineering problems during manufacturing of the above-mentioned products.

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.