GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150502
Semester –V
Subject Name:Mechanical Operations

Type of course: Professional elective course

Prerequisite: Chemical engineering consists of several unit operations and unit processes. Before the reaction step, the raw materials should be processed through various unit operations and similarly after the reaction step as well the products are passed through various unit operations either for product separation or for purity. Thus unit operations are very essentially part of the chemical engineering; and hence, basic knowledge about the principles and equipment of solid-solid unit operations and solid-liquid unit operations is mandatory for any professional chemical engineer.

Rationale:
The main objective of this subject is to study the basic mechanical operation (crushing, grinding, screening, filtration, etc.) takes place during the process in chemical industry. It also provides platform to study and analyze various properties associated with the solid when it is in flow condition. This subject provides the fundamental knowledge regarding to particle size reduction and enlargement by various methods and also deals with the detail construction & working of equipment's used for mechanical operations.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination marks				Total marks
				Theory marks		Practical marks		
L	T	P	C	ESE (E)	PA (M)	PA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Content:

Sr. No.	Content	Total Hrs
1	**Solids and Its Flow Properties:** Solids, Characteristics of Solid particles, Properties of particulate masses, Particle size, mixed particle size analysis, Average particle size, Specific surface area of mixture, No of particles in mixture, Screen analysis, Standard screens, Capacity and effectiveness of screen, Ideal and actual screens, Screening Equipment – Grizzly screens, Gyrating screens, Trommels, Shaking screens, Oscillating screens.	8
2	**Size Reduction, Enlargement, Screening:** Principles of comminution,Rittinger's and kick's laws, Bond's crushing law and work index,Size reduction equipments, crushers, grinders, Ultra fine grinders,Dry versus wet grinding, Cutting machines, Open circuit and closed circuit operation,	10

	Screening equipment, Comparison of ideal and actual screens, Screen effectiveness.	
3	**Fluidization and Conveying:** Conditions for Fluidization, Types of fluidization, minimum fluidization velocity and pressure drop in fluidised bed, Equations for Kozeny–Carman, Burke – Plummer, Ergun, liquid – solid and gas solid systems, Applications of batch and continuous fluidization, Slurry and pneumatic transport, mechanical and pneumatic conveying, elevators, storage bins and silos for solid/liquid/gases.	**12**
4	**Filtration and Sedimentation :** Introduction, Cake filters, Filter media, Filter aids, principles of cake filtration,Filter press, Shell and leaf filters, Rotary drum vacuum filters, Centrifuges, Gravity classifiers, clarifying filter, Sink and float method, Clarifiers and thickeners, Batch sedimentation, Rate of sedimentation, Differential settling methods, sedimentation zones in continuous thickeners, Cyclones, Hydrocyclones.	**7**
5	**Mixing and Agitation:** Different types of agitators and their selection criteria,Types of Impellers, flow patterns in un-baffled and baffled tanks, Calculation of power required for agitation, Scale up of agitated vessel. Mixing of pastes/liquid/dry powder, pony mixer, ribbon blender, tumbler mixer, and static mixers.	**8**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**20**	**15**	**10**	**10**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Foust A. S. & associates, "Principles of Unit Operations" John Wiley and Sons (1980).
2. McCabe Smith, "Unit Operation in Chemical Engineering" 5th ed. McGraw Hill (1985).
3. Perry R.H. & Chilton C.H., "Chemical Engineers Hand Book", 7th ed. McGraw hill.
4. Badger and Bencharo, "Introduction to Chemical Engineering". Tata McGraw hill.
5. Coulson and Richardson: Chemical Engineering, Vol. 2.Butterworth Heinemann Pub
6. Welty, Wicks, Wilson &Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th ed. Wiley Narayanan C.M.& Bhattacharya B.C. "Mechanical Operations for Chemical engineers", Khanna Publishers. 3 rd Ed.1999

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Sr. No.	CO statement	Marks % weightage
CO-1	To characterize particles and perform size reduction and size analysis of particles to meet the need of chemical industries	20
CO-2	To review the practical importance and relevance of unit operations used for crushing, grinding and size separation in chemical industry.	20
CO-3	To understanding fluid flow through fluidized bed	20
CO-4	To evaluate the parameters of various filtration equipment and sedimentation	25
CO-5	To identify the different types of mixing, agitation and conveying of solids and estimating the power requirement	15

List of Experiments: (Minimum 08 experiments need to be performed)

1. To determine the screen efficiency for the given sample by sieve analysis
2. To determine the screen efficiency for the given sample by vibrating screen
3. To determine nip angle, Reduction Ratio, Ribbon Factor, Rittinger's constant, Bond's constant, Kick's constant , Work Index as well as Theoretical & Actual Capacity using roll crusher.
4. To determine Rittinger's constant, Bond's constant, Kick's constant and Work Index using jawCrusher
5. To calculate the overall efficiency of the cyclone separator.
6. To carry out the batch sedimentation tests.
7. To carry out gravity filtration test
8. To determine Rittinger's constant, Bond's constant, Kick's constant and Work Index for ball mill
9. To study filter press
10. To study size reduction of material by drop weight crusher
11. To determine separation efficiency by using froth flotation cell

Major Equipments

Jaw crusher, Gyratory crusher, Roll crusher, Ball mill, Cyclone separator, Plate & Frame filter press, Sieve shaker apparatus etc.

List of Open Source Software/learning website:

Reference to NPTEL lectures can be made for a better understandingregarding mechanical operation done in industriesunder different conditions.