GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Chemical Engineering

Course / Subject Code : DI02005021

Course / Subject Name : Mechanical Operation

w. e. f. Academic Year:	2024-25
Semester:	2nd
Category of the Course:	PCC

Prerequisite:	**NA**
Rationale:	The operations of chemical plants require use of material handling and size reduction equipments, screens, agitator, mixers, centrifuges, cyclones, filters, storage & conveying of solids and other mechanical separation equipments. Therefore, students must have information about the principles, construction, working and application of these equipments so that they can plan for their efficient use in plants. In this course the students would also learn simple calculations to judge the performance of these equipments.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Use fundamentals of mechanical operation.	R
02	Apply concept of size reduction, separation, agitation-mixing, Storage and Conveying of Solid.	U, A
03	Operate size reduction equipment, separators, agitators, mixers and conveyors.	R, U
04	Calculate & Derive properties of solid particles, angle of nip, critical speed, power consumption, mixing index, crushing law constants, efficiency, material balance etc.	U, A

**Revised Bloom's Taxonomy (RBT)*

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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	50	50	200

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
Unit – I Fundamental of Mechanical Operation	1.1. Fundamentals of Unit Operation and Unit Process 1.2. Examples of Unit Operation and Unit Process 1.3. Define & Calculate • Particle density and Bulk density • Sphericity • Equivalent diameter • Specific surface area • Volume surface mean diameter • Mass mean diameter • Number of particles in solid	4	10
Unit– II Size Reduction	2.1. Principles of Size reduction and its application 2.2. Factors for selection of size reduction equipment 2.3. Energy and power requirement in comminution 2.4. Laws of size reduction: i. Rittinger's law ii. Bond's law iii. Kick's law 2.5. Calculate Power required for size reduction using empirical laws and calculation of work Index. 2.6. Principle, construction, working and application of • Jaw crusher • Gyratory crusher • Roll Crusher • Ball mill • Hammer mill	10	24

	2.7. Derive equation of angle of nip 2.8. Calculation of angle of nip for Roll crusher 2.9. Derivation of equation of critical speed for Ball Mill 2.10. Calculation of operating speed, critical speed for Ball Mill 2.11. Difference between open circuit and close circuit grinding		
Unit– III Solid-Solid separation	3.1. Basics of Ideal and Actual Screen 3.2. Types of Screen Analysis • Cumulative analysis • Differential analysis 3.3. Capacity and effectiveness of screen • Derivation of formula for overall effectiveness of screen • Calculation of capacity and effectiveness of screen 3.4. Principle, Construction, Working & Application of • Trommel • grizzlies • vibrating screen 3.5. Principle, Construction, Working & Application of • Hydraulic Jig • Double cone classifier • Electrostatic precipitator • Magnetic separator • Froth flotation cell 3.6. Factors affecting selection of equipment for solid separation	7	16
Unit– IV Solid- fluid Separation	4.1 Basics of filtration • Constant Rate filtration • Constant Pressure filtration 4.2 Filter media and its characteristics 4.3 Filter Aid & its application 4.4 Cake Resistance, Filter medium Resistance 4.5 Principle, construction, working and application of • Filter Press • Rotary Drum Filter • Leaf Filter • Basket Centrifuge	10	24

	4.6 Basic of Sedimentation • Hindered settling • Free settling • Terminal settling Velocity 4.7 Batch Sedimentation Experiment Interphase height Vs Time curve for batch sedimentation 4.8 Principle, construction, working and application of Gravity Thickener 4.9 Principle, construction, working and application of Cyclone Separator		
Unit– V Agitation and mixing	5.1 Define agitation and mixing 5.2 Classification of Impellers and brief explanation 5.3 Vortex formation and swirling 5.4 Methods for Prevention of Vortex 5.5 Factors affecting on agitation and Mixing 5.6 Calculation of Mixing index & Power Consumption 5.7 Principle, construction, working and application of Agitated vessel 5.8 Principle, construction, working and application of • Ribbon blender • Double arm Kneader (Sigma mixer) • Banbury mixer • Muller mixer	7	16
Unit VI Storage & Conveying of Solid	6.1 Angle of repose 6.2 Bulk storage 6.3 Storage in bins and silos 6.4 Types of Conveyors • Screw conveyors • Belt conveyors • Bucket elevators • Pneumatic conveying	4	10
	Total	**42**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
26%	**34%**	**40%**	**-**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Introduction to chemical engineering	Badger W. L. and Banchero J. T	McGraw Hill Book Company, New York, 1961,ISBN-10 : 0070016070
2	Unit Operations of Chemical Engineering	McCabe and Smith	McGraw Hill Publications, New Delhi
3	Mechanical Operations	Swain A.K., G.K.Roy	Tata McGraw Hill Publications, New Delhi
4	Unit Operation –I	Gavhane K. A.	Nirali Prakashan, Pune
5	'Chemical Engineering' Vol.- II,	J.M. Coulson & J.F. Richardson	'Chemical Engineering' Vol.- II, 6th Ed. Elsevier, 2003
6	Transport Processes and Separation Process Principles'	C.G. Geankopolis.	4th Ed, Prentice Hall India, 2003.
7	Perry's Chemical Engineers' Handbook	Don W. Green, Robert H. Perry	The McGraw-Hill Companies, Eighth Edition, ISBN: 9780071422949

(b) Open source software and website:

a) **https://ndl.iitkgp.ac.in**
b) **https://onlinecourses.nptel.ac.in**
c) **https://swayam.gov.in/explorer**
d) **www.cheresources.com**

Suggested List of Practical:

Sr. No.	Practical Outcome	CO1	CO2	CO3	CO4	Hours
1.	Measure volume surface mean diameter, mass mean diameter, number of particles using a sieve shaker.	√			√	2
2.	Perform differential and cumulative screen analysis.	√	√			2
3.	Test Kick's law for crushing in Jaw crusher.			√	√	2
4.	Test Bond's law for crushing in a Roll crusher.			√	√	2
5.	Test Rittinger's law for grinding in a Ball mill.			√	√	2
6.	Measure Critical Speed of Ball mill.			√	√	2
7.	Measure efficiency of Cyclone Separator.		√		√	2
8.	Determine rate of settling by sedimentation at ultimate height.		√		√	2
9.	Measure rate of filtration in Gravity filtration.			√	√	2
10.	Measure rate of filtration in vacuum filtration.			√	√	2
11.	Measure rate of filtration, cake resistance, filter media resistance in Centrifuge.			√	√	2
12.	Measure efficiency of separation in froth flotation cell.			√	√	2
13.	Measure efficiency of separation in Magnetic separator.			√	√	2
14.	Evaluate mixing index in mixer.			√	√	2
15.	Measure power consumption in baffled Agitation vessel.			√	√	2
16.	Prepare a chart for comparison of different conveyors. OR Prepare a working model of any conveyor.	√		√		2

Suggested Activities for Students:

Following is the list of proposed student activities like:

1. Assignments
2. Technical Quiz/MCQ Test
3. Presentation on some course topic
4. I-net based assignments
5. Students are encouraged to register themselves in various MOOCS such as: Swayam, edx, Coursera, Udemy etc to further enhance their learning

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