GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (05)
MECHANICAL OPERATION
SUBJECT CODE: 2150502
B.E. 5th SEMESTER

Type of course: Chemical Engineering.

Prerequisite: Heat, Mass and Momentum transfer

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)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	3	7	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Solids and Its Flow Properties:** Characterization of solid particles, Mixed particles sizes and analysis, Screen analysis, properties of particulate masses, Mixing of solids, Mixer for cohesive solids, Mixer for free flowing solids.	08	15
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, Cutting machines, Open circuit and closed circuit operation, Screening equipment, Comparison of ideal and actual screens, Screen effectiveness.	12	22
3	**Fluidization and Conveying:** Conditions for Fluidization, Types of fluidization, Applications of fluidization, Slurry and pneumatic transport, Conveyers.	10	19
4	**Filtration and Sedimentation :** Introduction, Cake filters, Filter press, Shell and leaf filters, Discontinuous vacuum filters, Continuous vacuum filters, Centrifugal filters, Filter media, Filter aids, Principles of cake filtration, Clarifying filters, Gravity classifiers, Sink and float method, Differential settling methods, Clarifiers and thickeners, Batch sedimentation, Rate of sedimentation, Thickeners, sedimentation zones in continuous thickeners, Cyclones, Hydrocyclones, Cenrifuges.	15	28

5	**Mixing and Agitation:** Different types of agitators and their selection criteria, Calculation of power required for agitation, Scale up of agitated vessel, Static mixers.	**09**	**16**

Suggested Specification table with Marks (Theory):

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

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. S. K. Gupta, "Momentum Transfer Operation". Tata McGraw Hill (1979)
6. Davidson J.F. &Harrison D."Fluidization" Academic press (1985)
7. Kunni & Levenspiel "Fluidization engineering "Wiley (1962) 8. Brown, G.G. and associates "Unit operations" Wiley, New York, (1950).
8. Coulson and Richardson: Chemical Engineering, Vol. 2.Butterworth Heinemann Pub
9. 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

Course Outcome:

After learning the course the students should be able to:

1. To build basic knowledge of various mechanical operations.
2. To review the practical importance and relevance of unit operations used for crushing, grinding and size separation in chemical industry.
3. To utilize the technological methods related to unit operations in process plant.
4. To study a detailed overview of equipment used to perform various mechanical operations and problems associated during the implementation and applications.
5. To build a bridge between theoretical and practical concept used in industry

List of Experiments and Open Ended Projects:

Minimum **5** practicals to be performed and remaining time should be allotted to open-ended projects / study reports / latest outcomes in technology study:-

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Project / Study Report / Latest outcome in technology.

2. Literature survey including patents and research papers of fundamental process
- Design based small project **or**
- Study report based on latest scientific development **or**
- Technology study report/ modeling/ simulation/collection report **or**
- Computer based simulation/ web based application/ analysis presentations of basic concept field which may help them in chemical engineering.

3. These can be done in a group containing maximum **three** students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
5. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
6. In the semester student should perform **minimum** 5 set of experiments and complete **one small open ended dedicated project** based on engineering applications. This project along with any performed experiment should be **EVALUATED BY EXTERNAL EXAMINER.**

PRACTICALS (ANY FIVE):

Sr. No.	List of experiments
1.	To carry out the batch sedimentation tests.
2.	To study the effect of forth flotation in the recovery of given sample from the solution.
3	To calculate the overall efficiency of the cyclone separator.
4.	To find mixing index.
5.	To determine Critical index, Work Index, Bond's Law, Rittinger's Law and Kick's Law for Ball mill.
6.	To determine the screen efficiency for the given sample.
7.	To determine Rittinger's constant, Bond's constant, Kick's constant and Work Index.
8.	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.
9.	To Study how the power consumption of an agitator changes with Reynolds and Froude numbers.
10.	To study the Filter Press.

Design based Problems (DP)/Open Ended Problem:

Students are free to select any area of science and technology based on chemical engineering applications to define Projects.

Some suggested projects are listed below:

- Preparation of working / non working models of filtration equipments, mixing / agitation tanks, grinding / crushing unit and its industrial importance.
- Practical importance of various and various analogies associated with it.

Major Equipment:

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

List of Open Source Software/learning website:

1) Literature available in any laboratory manual of Mechanical Operation.
2) NPTEL
3) MIT Open course lecture available on Internet etc…

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.