

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

MECHANICAL OPERATIONS

(Code: 3330502)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	3 rd Semester

1. RATIONALE

The operations of chemical plants require use of material handling and size reduction equipments, screens, agitator, mixers, centrifuges, cyclones, filters and other mechanical separation equipments. Therefore students must have information about the principles, construction and working 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.

2. COMPETENCY (Programme Outcome according to NBA Terminology):

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

- **Plan and supervise operation of mechanical operation equipments.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	200
4	0	4	8	70	30	40	60	

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit; ESE - End Semester Examination; PA - Progressive Assessment

4. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Properties of Particulate Solids	1a. Differentiate Unit operation and Unit process	1.1 Fundamentals of Unit operation and Unit process
	1b. Describe specific properties of solids	1.2 Specific properties of solids : Particle density and Bulk density, diameter, sphericity, equivalent diameter, specific surface area, volume surface mean diameter, mass mean diameter, and shape factor
	1c. Calculate specific property parameters of solids	1.3 Calculation of particle diameter, sphericity, equivalent diameter, specific surface area, volume surface mean diameter, mass mean diameter, and shape factor, numbers of particles in solid
Unit – II Screen Analysis	2a. Explain Screen	2.1 Basics of Ideal and actual screen
	2b. Compare types of screen analysis	2.2 Types of screen analysis 2.2.1 Cumulative analysis 2.2.2 Differential analysis 2.3 Applications of screen analysis
	2c. Derive formula for effectiveness of screen	2.4 Capacity and effectiveness of screen
	2d. Calculate capacity and effectiveness of screen	2.5 Derivation of formula for overall effectiveness of screen 2.6 Calculation of capacity and effectiveness of screen
	2e. Identify faults in screen	2.7 Faults in screening
	2f. Describe types of screening equipment	2.8 Types of screen: Trommel, Grizzlies, Vibrating screen
Unit – III Size Reduction	3a. Explain size reduction with applications	3.1 Principles of Size reduction and its application
	3b. Describe working of size reduction equipments	3.2 Classification, comparison and selection of size reduction equipments based on size reduction principle
	3c. Characterise the comminution products	3.3 Characteristics of comminution products
	3d. Explain energy and power requirement in comminution.	3.4 Energy and power required in comminution
	3e. Explain empirical laws of size reduction	3.5 Laws of size reduction: (i) Rittingers law (ii) Bond's law (iii) Kick's law
	3f. Compute the energy and power requirement for size reduction	3.6 Calculation of power required for size reduction using empirical laws
	3g. Calculate work index	3.7 Work index

Unit	Major Learning Outcomes	Topics and Sub-topics
	3h. Explain different size reduction equipment	3.8 Principle, construction and working of Jaw crusher, Gyratory crusher, Fluid Energy mill, Ribbon Blender, Roll crusher, and Ball Mill
	3i. Calculate angle of nip	3.9 Derivation of equation of angle of nip, Calculation of angle of Nip for Roll crusher
	3j. Calculate critical speed	3.10 Derivation of equation of critical speed of Ball mill and its calculations
	3k. Differentiate between open and close circuit grinding	3.11 Difference between open and close circuit grinding
Unit – IV Sedimentation	4a. Explain sedimentation 4b. Draw batch sedimentation curve	4.1 Fundamentals of sedimentation 4.2 Batch sedimentation 4.3 Inter phase height Vs time curve for Batch sedimentation
	4c. Describe principle of flocculation and thicker	4.4 Principle of flocculation 4.5 Principle, construction and working of Gravity thicker
	4d. Explain and compare settling	4.6 Fundamentals of free and hindered settling
	4e. Explain Tubular Centrifuge	4.7 Construction and working of Tubular centrifuge
	4f. Describe Cyclone separator 4g. Calculate Cut diameter and efficiency of cyclone	4.8 Principle, construction and working of Cyclone separator 4.9 Cut diameter and efficiency of cyclone
	4h. Explain Terminal settling velocity, Stoke's law, Newton's law	4.10 Terminal settling velocity Stoke's law and Newton's law
	Unit –V Filtration	5a. Describe filtration 5b. Classify equipments for liquid-solid separation
5c. Explain types of filter		5.3 Principle, construction and working of filter press, leaf filter, rotary vacuum filter, cartridge filter
5d. Characterise filter media		5.4 Filter media and its characteristics
5e. Explain filter aids 5f. Describe method of application		5.5 Basics of Filter aids 5.6 Method of application
5g. Differentiate constant rate and constant pressure filtration		5.7 Constant rate filtration and constant pressure filtration

Unit	Major Learning Outcomes	Topics and Sub-topics
	5h. Explain cake resistance, filter media resistance for various conditions	5.8 Brief description of specific cake resistance and filter media resistance for constant rate, constant pressure and vacuum filtration (without numerical)
	5i. Classify centrifugal equipments	5.9 Classification of centrifugal equipments
	5j. Explain batch centrifuge	5.10 Principle, construction and working of batch centrifuge
	5k. Compare centrifuge and filter press	5.11 Advantages and disadvantages of centrifuge over filter press
Unit –VI Separation of Solid Particles	6a. Define solid separation	6.1 Definition and application of solid separation
	6b. Describe factors affecting selection of equipment	6.2 Factors affecting selection of equipment for solid separation
	6c. Explain types of solid separation equipments	6.3 Working principle and construction of a) Jigging b) Elutriation c) Double cone classifier d) Electrostatic precipitator e) Magnetic separator f) Froth flotation cell
	6d. Explain differential settling methods	6.4 Differential settling methods, sink and float method
Unit VII Agitation and Mixing	7a. Describe agitation and mixing	7.1 Define agitation and mixing, give their applications
	7b. Classify impellers	7.2 Classification of Impellers and brief explanation
	7c. Compare various impellers	
	7d. Explain vortex formation and prevention	7.3 Vortex formation and swirling 7.4 Methods of Vortex prevention
	7e. Explain agitation vessel	7.4 Construction and working of agitation vessel
	7f. Derive equation for power consumption	7.5 Derivation of equation for power consumption in agitation vessel
	7g. Calculate power consumption	7.6 Calculations of power consumption in baffled and unbaffled tank
	7h. Describe flow number	7.7 Flow number
	7i. Explain factors affecting agitation	7.8 Factors affecting agitation
	7j. Explain purpose of mixing	7.9 Purpose of mixing solids and pastes
7k. Describe factors for selection of equipments	7.10 Factors affecting selection of mixing equipments	

Unit	Major Learning Outcomes	Topics and Sub-topics
	7l. Explain rate of mixing and mixing index 7m. Compute mixing index	7.11 Rate of mixing and mixing index for pastes & powder 7.12 Calculation of mixing index
	7n. Describe types of mixers	7.12 Construction and working of a) Ribbon blender b) Kneaders c) Pug mill d) Banbury mixer e) Muller mixer

5. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Properties of Particulate Solids	07	2	5	2	09
II	Screen Analysis	05	1	2	3	06
III	Size Reduction	10	2	5	5	12
IV	Sedimentation	06	2	3	2	07
V	Filtration	10	2	7	3	12
VI	Separation of Solid Particles	06	2	4	2	08
VII	Agitation and Mixing	12	2	6	8	16
Total		56	13	32	25	70

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised 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.

6. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (**Course Outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies (**Programme Outcomes**). Following is the list of practical exercises for guidance.

Note: Here only Course Outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of Programme Outcomes/Course Outcomes in affective domain as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

Sr. No.	Unit No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Apprx. Hrs. Required
1.	I	Measure volume surface mean diameter, mass mean diameter, number of particles using sieve shaker	4
2.	II	Carry out differential and cumulative screen analysis	4
3.	III	Test Rittinger's law for grinding in ball mill and measure critical speed	4
4.	III	Test Kicks law for crushing in jaw crusher	4
5.	III	Test Bond's law for crushing in roll crusher	4
6.	IV	Measure efficiency of cyclone separator	4
7.	IV	Determine rate of settling by sedimentation	4
8.	V	Measure cake resistance, filter media resistance in filter press.	4
9.	V	Measure rate of filtration, cake resistance, filter media resistance in basket centrifuge	4
10.	V	Measure rate of filtration in gravity filtration	4
11.	V	Measure rate of filtration in vacuum filtration	4
12.	VI	Measure efficiency of separation in froth flotation cell	4
13.	VII	Evaluate mixing index in double cone mixer	4
14.	VII	Measure power consumption in baffled and unbaffled agitation vessel	4
Total			56

7. SUGGESTED LIST OF STUDENT ACTIVITIES

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

8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

1. Working of different equipment should be demonstrated using chart and models or with help of video/animation films.
2. Expert Lecture (by persons working in Industry) may be organised.
3. Visit to nearby industries where such equipment are being used may be arranged.

9. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Unit Operations of Chemical Engineering	McCabe and Smith	McGrawhill Publications, New Delhi
2	Introduction to Chemical Engineering	Badger W. L. and Banchemo J. T	McGrawhill Publications, New Delhi
3	Unit Operation –I	Gavhane K. A.	Nirali Prakashan, Pune

B. List of Major Equipment/Materials

- a. Sieve shaker – Sieve dia – 100 mm to 200 mm, no of sieve – 6-8, Opening – as per requirement (micro or coarse particle)
- b. Laboratory Ball mill - 5kg capacity, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
- c. Jaw crusher – 10-50 kg/hr capacity, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
- d. Laboratory Roll crusher – 5-25 kg/hr capacity, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
- e. Agitation vessel setup – 20-50 liter capacity - Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
- f. Cyclone separators – Product Particle as per requirement, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
- g. Froth flotation Cell, 5-15 kg/hr capacity, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
- h. Gravity filter
- i. Vacuum Filter
- j. Laboratory filter Press - Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
- k. Basket centrifuge - Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
- l. Double cone mixer - Suitable for operation on 415V, 50Hz, 3 Phase, AC supply

C List of Software/Learning Websites

- a. www.sciencedirect.com
- b. www.cheresources.com
- c. <http://nptel.iitm.ac.in/courses.php>
- d. <http://engineershandbook.com/unit.operations>

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE**Faculty Members from Polytechnics**

- **Prof. P. K. Patel**, Lecturer in Chemical Engineering , Govt. Polytechnic Gandhinagar
- **Prof. M. R. Acharya**, Lecturer in Chemical Engineering, Govt. Polytechnic, Gandhinagar
- **Prof. R. P. Hadiya**, Lecturer in Chemical Engineering , Govt. Polytechnic Rajkot.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof Bashir Shaikh**, Assistant Professor, Department of Applied Sciences.
- **Prof Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat