GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

FLUID FLOW OPERATION
(Code: 3330503)

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

1. RATIONALE

In almost every chemical plant fluids have to be handled and hence study of fluids at rest and in motion is important. The information about the basic concepts and principles of hydrostatics, hydrodynamics and their applications in handling various fluids like gases, vapors, liquids and slurries are provided in this course which is required for smooth and proper operation of fluid transportations machineries. Using these concepts power requirement for pumps, blowers and compressors can be determined and friction losses through pipes and fittings can also be calculated. Therefore this course is one of the important courses since it attempts to develop these skills in students.

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

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

- **Maintain flow of different fluids in the chemical plants according to the process requirement.**

3. TEACHING AND EXAMINATION SCHEME

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

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 (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Fluid Statics and its Applications	1a. Define Ideal fluid and Real fluid 1b. Differentiate between fluid statics and dynamics	1.1. Ideal fluid and Real fluid 1.2. Fundamentals of fluid statics and dynamics
	1c. Classify the types of pressure	1.3. Definitions of pressure concept, Static head, Static pressure, Gauge pressure, Absolute pressure, Dynamic pressure, Total pressure, Vacuum(negative pressure)
	1d. Compare compressible and incompressible fluids	1.4. Compressible and incompressible fluids
	1e. Derive equation of pressure in static fluid	1.5. Derivation of equation of pressure in static fluid
	1f. Explain manometers 1g. Derive equation of pressure difference	1.6. Principle construction and working of Manometers with equation of pressure difference - Simple U tube manometer, Inclined manometer, Piezometer, Two fluid manometer, Micro-manometer
Unit– II Fluid–Flow Phenomena	2a. Explain velocity change across cross section	2.1 Velocity field, velocity gradient, shear stress and rate of shear
	2b. Explain effect of solid boundary	2.2 Boundary layer, it's separation and wake formation
	2c. Define steady state and unsteady state conditions	2.3 Steady state and unsteady state conditions
	2d. Describe types of viscosities	2.4 Viscosity : Absolute, Kinematic and Relative
	2e. Classify fluids	2.5 Classification of fluids : Newtonian and Non-Newtonian with examples
	2f. Describe Reynold's experiment	2.6 Reynold's experiment and Reynolds number, turbulent flow, laminar flow, transition flow
Unit– III Basic Equations of Fluid Flow	3a. Define velocities	3.1 Average velocity and mass velocity
	3b. Derive continuity equation	3.2 Continuity equation for mass balance in steady flow
	3c. Derive Bernoulli's equation and explain corrections	3.3 Bernoulli's equation and corrections in Bernoulli's equation like kinetic energy correction, correction for fluid friction, correction for Pump work
	3d. Use Hagen-Poiseuille's Equation	3.4 Hagen-Poiseuille's Equation
Unit– IV Friction in	4a. Describe roughness of pipe	4.1 Roughness of pipe

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Flowing Fluid	4b. Explain hydraulic radius and equivalent diameter	4.2 Hydraulic radius and equivalent diameter
	4c. Compare skin and form friction	4.3 Skin friction and form friction
	4d. Use friction factor chart	4.4 Friction factor chart
	4e. Calculate friction losses	4.5 Friction from changes in velocity or direction (a) Friction loss from sudden expansion of cross section (b) Friction loss from sudden contraction of cross section 4.6 Friction loss in fittings and valves
Unit– V Transportation of fluid	5a. Compare pipe and tube	5.1 Introduction of pipe and tube
	5b. Describe fittings & joints	5.2 Types and uses of fittings and joints
	5c. Describe valves	5.3 Construction and working of various types of valves like (a) Gate valve (b) Globe valve (c) Check valves (d) Control valve
	5d. Classify pumps	5.4 Classification of pumps
	5e. Explain pumps	5.5 Construction and working of centrifugal, reciprocating and rotary pump
	5f. Explain characteristics of centrifugal pump 5g. Calculate NPSH, head and power	5.6 Developed head and power requirement in centrifugal pump
		5.7 NPSH, Suction lift and Cavitation in centrifugal pump
		5.8 Characteristic curves of Centrifugal pump
		5.9 Numerical based on NPSH, efficiency, head and power
	5h. Explain construction, working and uses of fluid moving machineries	5.10 Construction, working and uses of Compressor, Fan, Blower, Vacuum pump and Jet ejectors
Unit– VI Flow Measurement	6a. Describe methods of flow measurement	6.1 Methods of flow measurement
	6b. Classify flow measuring devices	6.2 Classification of flow measuring devices
	6c. Explain flow meters	6.3 Construction, working principles and application of flow meters like Rotameter, Orifice meter, Venturi meter, Pitot tube, weirs, Coriolis meter, Magnetic meter, Ultrasonic meter
	6d. Derive equation of flow rate	6.4 Derivation of equation of flow rate through Orifice meter, Venturi meter, Pitot tube and weirs
	6e. Solve simple numerical	6.5 Numerical of Orifice meter, Venturi meter

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit– VII Conveying and Fluidization	7a Explain conveying	7.1 Pneumatic and Hydraulic conveying with industrial applications
	7b Explain Fluidization	7.2 Fluidization and its industrial applications
	7c Explain Porosity	7.3 Porosity of static bed, Porosity of fluidized bed, Minimum porosity
	7d Describe minimum fluidization velocity	7.4 Minimum fluidization velocity
	7e Explain relation between bed pressure drop and bed height	7.5 Relation of bed pressure drop and bed height with graph

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fluid Statics and its Applications	06	02	03	02	07
II	Fluid–Flow Phenomena	06	02	03	02	07
III	Basic Equations of Fluid Flow	07	02	06	02	10
IV	Friction in Flowing Fluid	07	02	06	02	10
V	Transportation of Fluid	12	04	07	04	15
VI	Flow Measurement	12	03	07	04	14
VII	Conveying and Fluidization	06	02	03	02	07
	Total	**56**	**17**	**35**	**18**	**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)	**Approx. Hrs Required**
1.	II	Identify types of flow by using Reynolds's apparatus	4
2.	II	Measure absolute and kinematic viscosity using Oswald viscometer	4
3.	III	Use Bernoulli's apparatus for mechanical energy balance	4
4.	III	Estimate viscosity of water using Hagen-Poiseuille's equation	4
5.	IV	Measure friction losses through pipe, fittings and valves	4
6.	IV	Measure friction losses through packed bed	4
7.	V	Measure pressure developed by reciprocating pump	4
8.	V	Measure head developed by centrifugal pump	4
9.	V	Measure friction losses through fittings and valves	4
10.	VI	Measure flow through pipe using venturimeter	4
11.	VI	Measure flow through pipe using orifice meter	4
12.	VI	Measure flow through pipe using rotameter	4
13.	VI	Measure flow through open channel using notches	4
14.	VII	Measure minimum fluidization velocity through fluidized bed	4
		Total	**56**

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like: course/topic based presentations, internet based assignments, and teacher guided self learning activities, MCQ/Quiz. These could be individual or group-based.

8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

i. Working of different equipment and fluid transport systems should be demonstrated using chart and models or with help of video/animation films.
ii. Expert Lecture (by persons working in Industry) may be oragnised.
iii. Visit to nearby industries where such fluid flow operations are in use 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, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004 (Seventh Edition)
2	Introduction to Chemical Engineering	L.Badger, Julius T. Banchero	McGraw Hill Publication, New York 2004 (Seventh Edition)
3	Unit Operations of Chemical Engineering Vol-I	Chattopadhyay, P.	Khanna Prakashan, New Delhi, 1996
4	A text book of Fluid Mechanics	Khurmi, R.S.	S. Chand Publication, New Delhi 2002
5	Unit Operation –I	Gavhane, K.A.	Nirali Prakashan, Pune 2009

B. List of Major Equipment/Materials with Major Specification

i. Venturimeter assembly for fluid flow measurement(Minimum flow rate – 05 lit/min, mercury manometer)
ii. Orifice meter assembly for fluid flow measurement(Minimum flow rate – 05 lit/min, mercury manometer)
iii. Rota meter assembly for fluid flow measurement(Minimum flow rate – 05 lit/min, minimum 1 in. transparent tube)
iv. V Notch, Rectangular Notch assembly for flow measurement in open channel (Minimum notch size 5 cm)
v. Reynold's Experiment setup for studying types of flow (Minimum pipe dia. –0.5 in transparent pipe)
vi. Bernoullies experiment setup for mechanical energy balance in flowing fluid with transparent channel of at least 1 in ID.
vii. Reciprocating Pump Assembly with pump & motor of minimum 0.25 HP
viii. Centrifugal Pump Assembly with pump & motor of minimum 0.25 HP
ix. Fluidized bed setup made of glass pipe with minimum 2 in ID
x. Friction through Pipes, Fittings and Valves setup (0.5 in ID pipe with elbow, Tee, Square, Reducer, Enlarger, Glob valve, Gate valve)
xi. Packed bed setup to measure friction losses with minimum 2 in ID transparent pipe
xii. Oswald viscometer and stopwatch

C List of Software/Learning Websites

i. http://www.nzifst.org.nz/unitoperations/flfltheory.htm

ii. http://books.google.co.in/books?id=K4almhE5BoAC&pg=PP1&lpg=PP4&ots=1XDNGSxMsY&dq=Unit+Operation-1+nirali+Prakashan+published+year

iii. http://www.chemicalprocessing.com/whitepapers/fluid-handling/

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. J. R. Vadher**, Lecturer in Chemical Engineering, Govt. Polytechnic, Gandhinagar
- **Prof. M. R. Acharya**, Lecturer in Chemical Engineering, Govt. Polytechnic, Gandhinagar
- **Prof. P. M. Gadhiya**, Lecturer in Chemical Engineering, Govt. Polytechnic, Rajkot
- **Prof. N. N. Hansalia**, 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