

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: UTILITIES AND INSTRUMENTATION IN CHEMICAL
PLANT
(COURSE CODE: 3350504)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5 th Semester

1. RATIONALE

Diploma chemical engineer has to ensure smooth and proper operation of utilities and auxiliaries' plants such as steam, compressed air, instrumental air, inert gases, DM water and chilled water. These utilities are essential for manufacturing different chemical products. Use of measuring devices for the measurement of parameters like temperature, pressure, flow, level, viscosity, specific gravity, humidity are necessary for controlling chemical plant for producing materials of desired quality and to maintain plant safety. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

2. COMPETENCY

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

- **Operate different utility plants and various types of instruments**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Use various methods for water softening and purification
- Operate different types of steam generators
- Operate compressors, blowers for handling air and inert gases
- Use Refrigeration for Various applications
- Measure temperature, pressure, flow, level and viscosity
- Operate various control valves and control systems

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
L	T	P		Theory Marks		Practical Marks		Total Marks
				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

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Water as Basic Utility	1a. Explain role of Utilities in Chemical Plant 1a.1 List various utilities in chemical plant & uses	1.1 List and use of various utilities in chemical plant
	1b. List sources of Water	1.2 Sources of water
	1c. Differentiate types of Water	Types of Water 1.3 Hard & Soft water 1.4 Boiler Feed water and demineralized water
	1d. Compare Softening processes of water	1.5 Methods of water softening processes <ul style="list-style-type: none"> • Lime soda process (Hot & Cold) • Zeolite process • Ion exchange process • Phosphate process
	1e. Explain the process of Purification of water from raw water with sketches.	1.6 Purification of water <ul style="list-style-type: none"> • Screening • Sedimentation • Coagulation • Filtration • Sterilization
Unit – II Steam, Air & Inert Gases	2a. Explain uses of utilities - Steam, Air & Inert Gases	Utilities : 2.1 Use of Steam, Air & Inert Gases as utilities
	2b. Define properties of steam	2.2 Properties of steam <ul style="list-style-type: none"> • Enthalpy • Wet steam • Saturated Steam • Superheated steam • Specific volume of steam
	2c. Label the different part of steam generator 2d. Classify steam generator 2e. Select steam generator 2f. compare steam generators 2g. List the Factors affecting selection of Boiler	2.3 Steam Generator : Classification , comparison , components 2.4 Factors affecting selection of Boiler
	2f. Describe construction and Working of Locomotive Fire tube boiler ,Lancashire boiler	2.6 Construction and working of (a) Locomotive Fire tube boiler (b) Lancashire boiler
	2g. Discuss utility air	2.7 Utility air <ul style="list-style-type: none"> • Compressed Air • Blower Air • Fan Air • Instrumental air
	2h. Describe the working principle, application of Air compressors – (a) Reciprocating Air compressors (b) Multistage compressors (c) Rotary compressors	2.11 Types of Air compressors <ul style="list-style-type: none"> • Reciprocating Air compressors • Multistage compressors • Rotary compressors

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	2i. Describe properties of Inert gases	2.12 Inert gas - Nitrogen, Argon
Unit – III Refrigeration	3a. Explain the working principle of refrigeration	3.1 Concept of refrigeration
	3b. Distinguish methods of Refrigeration	3.2 Methods of Refrigeration <ul style="list-style-type: none"> • Ice Refrigeration • Evaporative Refrigeration • Vapor Refrigeration System
	3c. Describe COP and TOR of refrigeration	3.3 COP and TOR of refrigeration
	3d. Use primary and secondary Refrigerants	3.4 Types of Primary Refrigerants <ul style="list-style-type: none"> • Ammonia • Halo Carbons (Freon of Different type) • HFC (Hydro Fluorocarbon) 3.5 Types of secondary Refrigerants <ul style="list-style-type: none"> • Water • Brine 3.6 Selection of Refrigerants
Unit – IV Basics of Instrumentation	4a. Classify instruments in chemical plant	4.1 Importance of instrumentation in chemical plant 4.2 Classification of instruments
	4b. Describe Basic elements of instruments	4.3 Basic elements of instruments
	4c. Compare Static and Dynamic Characteristics of instruments	4.4 Static and Dynamic Characteristics of instruments
	4d. Differentiate First and second order system	4.5 First order system and second order system
Unit- V Measuring Devices	5a. Explain Temperature scale	5.1 Different Temperature scale
	5b. Compare thermometers 5b.1 Explain Principle, Construction & Working of : Mercury in glass, Bi-metallic, pressure spring, resistance thermometers	5.2 Definition of thermometer 5.3 Principle, Construction & Working of : Mercury in glass thermometer, Bi-metallic thermometer, pressure spring thermometer, resistance thermometer,
	5c. Describe Principles of thermoelectricity and See-back effect, Peltier effect and Thomson effect	5.4 Principles of thermoelectricity 5.5 See-back effect, Peltier effect and Thomson effect
	5d. Describe principle, construction, working range, lead wires of thermocouple and Thermowells	5.6 Industrial thermocouple: their principle, construction, working range, lead wires 5.7 Thermowells in details
	5e. Explain principle, construction, and working of Radiation and optical Pyrometers	5.8 Radiation and optical Pyrometers
	5f. Differentiate pressure gauges	1. Pressure gauges - diaphragm, Bourdon tube gauge, Dead weight Gauge, Strain gauge
	5g. Describe principle,	5.10 Target meter, Vortex Shredding meter,

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	construction, and working of Target meter, Vortex Shredding meter, Turbine meter	Turbine meter
	5h. Classify and explain level measuring devices	5.11 Classify: Liquid level measuring devices 5.12 Direct level measuring devices <ul style="list-style-type: none"> Probe and tape Sight glass Floats 5.13 Indirect level measuring devices. <ul style="list-style-type: none"> Air trap box method Diaphragm box method Bellow system Differential pressure manometer
	5i. Compare viscosity measurement methods	5.14 Viscosity measurement by <ul style="list-style-type: none"> Capillary tube method Rotating cylinder method Torsion viscometer
	5j. Explain principle, construction, and working	5.15 measurement of <ul style="list-style-type: none"> Specific gravity by hydrometer Humidity by hygrometer pH by pH meter
Unit – VI	6a. Explain Function of relays and interlocks	6.1 Function of relays and interlocks
Control Valves, Control Loops & Control System	6b. Explain schematic control loops for -Temperature control -Pressure control - Flow control - Level control	6.2 Control loops <ul style="list-style-type: none"> Temperature control Pressure control Flow control Level control
	6c. Describe process control modes with sketches	6.6 Process control modes : P , P+I , P+I+D, ON -OFF
	6d. Explain uses of PLC and DCS System	6.7 PLC and DCS system

6. 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	Water as Basic Utility	7	3	3	3	9
II	Steam, Air & Inert Gases	14	6	6	6	18
III	Refrigeration	7	3	3	3	9
IV	Basics of Instrumentation	4	2	2	1	5
V	Measuring Devices	18	7	8	7	22
VI	Control Valves, Control Loops & Control System	6	2	2	3	7
Total		56	23	24	23	70

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

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

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

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

Note: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of Course Outcomes related to affective domain. Thus over all development of Programme Outcomes (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr. No.	Unit No.	Practical/Exercise (Major outcomes in psychomotor domain)	Apprx. Hrs. Required
1	I	Operate water treatment in water treatment plant	4
2	I	Treat water using lime soda process	4
3	II	Generate steam in laboratory using baby boiler	4
4	II	Operate and test the working of air compressor	4
5	III	Demonstrate different refrigeration cycles	4
6	V	Measure Temperature by thermometer and thermocouple	4
7	V	Measure Temperature by Bi-metallic thermometer	4
8	V	Measure Pressure by mechanical pressure gauge	4
9	V	Measure gas flow rate	4
10	V	Measure level using direct method	4
11	V	Measure viscosity by capillary tube method	4
12	V	Measure specific gravity by Hydrometer	4
13	V	Measure humidity by Hair hygrometer	4
14	V	Measure pH by pH meter	4
15	VI	Prepare a chart of components of DCS system	4
16	VI	Demonstrate working of control valves and actuators using chart	4
Total (perform any practical for total 56 hours so that most units are covered)			64

8. SUGGESTED LEARNING RESOURCES

(A) List of Books:

S. No.	Title of Books	Author	Publication
1	Industrial instrumentation,	Donald P. Eckman.	JohnWiley and Sons, New York, 2004
2	Industrial Instrumentation & Control	S. K. Singh	3rd edition Tata-McGrawHil, 1987
3	Process Instrumentation and Control	A P Kulkarni	15 th Edition, April 2011, Nirali Prakashan, Pune
4	Unit operation of chemical Engineering.	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004, 7 th Edition
5	Plant utilities	D. B. Dhone	2 nd Edition, 2012 Nirali Prakashan, Pune
6	Process System Analysis & Control	Donald R. Coughnour.	2 nd edition, 1991, McGraw Hill Publication, Newyork

B. List of Major Equipment/Materials

- i. Bi metallic thermometer – Metal Brass/Invar, Range – 40 ° F 800 ° F, 1 % span
- ii. Thermo Couple – Thermocouple Wire: Pt/Rh or Fe/Constantan or Copper/Constantan, Range – Suitable to Material used, Lead Wire- Copper/Constantan, with suitable sheathing, with milivoltmeter, 1.5% accuracy
- iii. Burdon Pressure Gauge – Arc Length – 270°, Brass or Bronze or Copper or SS, Range 0-14 Kg/cm²
- iv. Gas Flow measurement Assembly
- v. Level Measurement Assembly
- vi. Capillary tube viscometer – Oswald viscometer
- vii. Hair hygrometer
- viii. Hydrometer
- ix. Digital pH meter - Range 1-14 pH

C List of Software/Learning Websites

- i. <http://nptel.ac.in/courses/103103037/>
- ii. http://www.silbert.org/MSA_WT_Manual.pdf
- iii. <http://ppuchem.blogspot.in/2013/02/unit-1-notes.html>
- iv. http://www.tecmaservice.it/pdf/wika_%20brochure_chimica.pdf
- v. <http://www.npti.in/Download/Thermal/BoP/13%20Sulakshana%20Sule.pdf>
- vi. <http://www.isu.edu/estec/ic-ed-modules/Module-10-Flow-Measurement.pdf>
- vii. http://www.betterbricks.com/sites/default/files/operations/om_of_boilers_final.pdf
- viii. http://solve.nitk.ac.in/dmdocuments/electrical/DCS_write_up.pdf
- ix. https://www.idc-online.com/technical_references/pdfs/instrumentation/
 - a. Industrial_Instrumentation%20-%20Flow.pdf

9. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

- i. Course/topic based presentation
- ii. Explore internet and visit websites of different chemical industries/supplier of plants and prepare reports on latest trends in utilities.
- iii. MCQ/Quiz

10. SPECIAL INSTRUCTIONAL STRATEGY (If Any)

- i. Show animated and real videos/pictures of different plants
- ii. Demonstrate different measuring instruments/sensors in class.
- iii. Industrial visit of plant consisting water treatment plant and Boilers, Refrigeration and Control system
- iv. Arrange lectures of persons from industry.

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Ms. Yamini S. Patel**, Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar
- **Mr. M. R. Acharya**, Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar
- **Prof. N. N. Hansalia**, Lecturer in Chemical Engineering, Government Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur**, Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh**, Assistant Professor, Department of Applied Sciences