GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Cryogenic Engineering

Subject Code : ME02074021

Subject Name : Cryogenic Plants and Equipment

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

Prerequisite:	Knowledge of physics, thermodynamics, pressure vessel design and heat and mass transfer
Rationale:	The course is formulated to impart detailed study of cryogenic plants and equipment which can be utilized for the different cryogenic applications.

Course Outcome:

On successful completion of the course, the students will be able to

No	Course Outcomes	RBT level
1	Apprise basics of gas separation process and designing of rectification column.	Apply
2	Learn about various gas separation and purification systems for different gases.	Understand
3	Design various dewars and cryogenic storage vessels including transfer lines and valves.	Apply
4	Learn about various fabrication techniques for cryogenic equipment.	Understand
5	Design and test different kinds of heat exchangers.	Analyze

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	20	30	150

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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	Gas separation and gas purification system : Thermodynamically Ideal separation system, general characteristics of mixtures , temperature composition diagram for cryogenic gas mixtures , fugacity , enthalpy composition diagrams, Simple condensation and evaporation, principles of rectification, theoretical plate calculations for columns, Mecabe – Thiele method for theoretical plate calculation, types of rectification columns	10	20
2	Air separation and purification systems: Linde single column, double column, Linde-Frank1 and Heylandt systems, argon, xenon and krypton. 'L' Air liquede systems for hydrogen, hydrogen – deuterium in separation systems, helium separation system, separation of helium isotopes, purification of helium. Modern air liquefaction, liquid nitrogen and oxygen plants.	10	25
3	Dewars, classification of Dewars, static and chassis mounted cryogenic liquid storage and transport tanks LNG storage tanks, construction Liquid and vapour shielded vessels, cryogenic liquid transfer pumps, liquid transfer lines their design, vacuum insulated line joints, and cryogenic valves liquid transfer systems.	12	25
4	Fabrications and jointing techniques, flanged and bolted joints, joining of dissimilar metals , welding of stainless steel and alloy steels	6	10
5	Design of regenerative type heat exchanger for single and multistage, Philips, Gifford single volume, double volume, cryo refrigerators. Finned tube and plate type heat exchangers, different configuration heat transfer coefficients and friction coefficient for various configuration. Single tube Linde exchanger, double tube type, three channel heat exchanger. Linde multiple tube type , Giauque Hampson, Collin's, Plate fin heat exchanger, different fin configuration, heat transfer coefficients, and friction factors for various configurations. Testing of heat exchangers as per standards.	7	20
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40	**20**	**20**	**20**	**00**	**00**

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:

1. Cryogenic Systems, Barron, McGraw Hill Book Co.
2. Theory and design of cryogenic systems : A.Arkherov
3. Cryogenic process engineering Timmerchand & Flynn

(b) Open-source software and website:

NPTEL lectures of Prof. M. D. Atrey, IIT Bombay, Software for plate calculations for rectification column

Suggested Course Practical List:

1. Study of cryogenic storage vessels.
2. Study of separation system for O_2 and N_2
   a) Linde single column system
   b) Linde double column system
   c) Linde Frankle system
   d) Heylandt system
3. Study and design of rectification column.
4. Study of cryogenic fluid transfer line vacuum insulated line joints.
5. Cryogenic valves & design of transfer line.
6. Study of the various fabrication techniques applied to cryogenic plant & equipments.
7. Study of Philips LN_2 plant.
8. Study the salient design feature of a cryostat & its construction & equipments.
9. Study of separation system for H_2 & He.

List of Laboratory/Learning Resources Required: LN_2 dewar, Cryostats for specific applications

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