



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code: 3721002

Semester – II

Subject Name: CRYOGENIC PLANTS AND EQUIPMENTS

Type of course: Core Subject IV

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 equipments which can be utilized for the different cryogenic applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
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	8
2	Air separation and purification systems: Linde single column, double column, Linde-Frankl 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.	8
3	Modern air liquefaction, liquid nitrogen and oxygen plants.	3
4	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.	4
5	Fabrications and jointing techniques, flanged and bolted joints, joining of dissimilar metals , welding of stainless steel and alloy steels	4



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6	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	5
7	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.	5
8	Testing of heat exchangers as per standards.	2

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	20	20	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. Cryogenic Systems, Barron, McGraw Hill Book Co.
2. Theory and design of cryogenic systems : A.Arkerov
3. Cryogenic process engineering Timmerchand & Flynn

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To separate and purify the different gases with the help of cryogenic process	20
CO-2	To design, analysis and fabrication of the different size and shapes of storage tanks and process vessels	40
CO-3	To design the different kind of highly efficient heat exchangers	40

List of Tutorials:

1. Study of cryogenic storage vessels.
2. Study of separation system for O₂ and N₂
 - 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.



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7. Study of Philips LN2 plant.
8. Study the salient design feature of a cryostat & its construction & equipments.
9. Study of separation system for H₂ & He.

Equipment / Computational facility:
LN2 dewar, Cryostats for specific applications

List of Open Source Software/learning website: NPTEL lectures of Prof. M. D. Atrey, IIT Bombay,
Software for plate calculations for rectification column