GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code:3721001
Semester – II
Subject Name: CRYOGENIC SYSTEMS

Type of course: Core Subject III

Prerequisite: Fundamental knowledge of physics and thermodynamics

Rationale: The course is formulated to impart detailed study of cryogenic systems which can be utilized for the different cryogenic applications.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**Cryogenic Refrigeration System:** Ideal isothermal and reversible isobaric source refrigeration cycles, Joule Thomson system, cascade or pre-cooled joule–Thomson refrigeration systems, expansion engine and cold gas refrigeration systems, Philips refrigerators, Importance of regenerator effectiveness for the Philips refrigerators, Gifford single volume refrigerator, Gifford double volume refrigerators analysis, COP, FOM, regenerators, pulse tube refrigerators, various types of pulse tube refrigerator	15
2	**Refrigerators using solids as working media:** Magnetic cooling, magnetic refrigeration systems, thermal; valves, nuclear demagnetization	5
3	**Gas liquefaction systems:** Introduction, thermodynamically ideal systems ,joule Thomson effect, liquefaction systems such as Linde Hampton ,precooled Linde Hampson ,linde dual pressure ,cascade, Claude, Kapitza, Heyland systems using expanders, comparison of liquefaction systems .liquefaction systems for neon ,hydrogen & helium	12
4	**Adsorbents**: various adsorbents, salient features – properties, determination of mass of absorbents for the adsorption of gases	5
5	**Adsorption processes:** Physical principles of adsorption , BET equation for single and multiple layer , Use of sorption process in cryogenics static and dynamic arrangement for the sorption processes , Adsorption columns , PSA and VSA adsorption systems, isotherms, reactivisation	5

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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.Arkherov
3. Cryogenic process engineering Timmerchand & Flynn
4. "Theory and design of cryogenic systems", Mikulin, MIR Publication, 2002

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To develop or modify the cryogenic refrigeration system for the particular application	30
CO-2	To design and analysis the different temperature production technics and the processes	35
CO-3	To build up the skills in the understanding of phenomena to produce the low temperature cryogenic systems	25
CO-4	To build the fundamental knowledge for further study of Cryocoolers	10

List of Tutorials:

1. Study and analysis of cryo refrigeration system. – isothermal source system, isobaric source system.
2. Study and analysis of Philips refrigeration system.
3. Study and analysis of precooked cycle of refrigeration
4. Study and analysis of GM refrigerator.
5. Study and analysis of Vuilleumier and Solvay refrigerators.
6. Study and analysis of magnetic refrigerator and thermal valves.
7. Study and analysis of dilution refrigerator.
8. Study of ideal liquefaction system.
9. Study of Linde dual pressure system.
10. Study of hydrogen liquefaction system.
11. Study of pulse tube refrigeration system

Equipment / Computational facility:
Liquid nitrogen plant, pulse tube cryocoolers, GM cryocoolers, Stirling cryocooler

List of Open Source Software/learning website: NPTEL lectures of Prof. M. D. Atrey , IIT Bombay