

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL (CRYOGENIC ENGINEERING) (10)

CRYOGENIC SYSTEM

SUBJECT CODE: 2721001

SEMESTER: II

Type of course: Core Subject III

Prerequisite: Fundamental knowledge of physics and thermodynamics

Rationale: NA

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)			
					ESE	OEP	PA	RP		
3	2#	0	4	70	30	30	0	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
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	35
2	Refrigerators using solids as working media: Magnetic cooling, magnetic refrigeration systems, thermal; valves, nuclear demagnetization	5	10
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	30
4	Adsorbents: various adsorbents, salient features – properties, determination of mass of adsorbents for the adsorption of gases	5	10
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, reactivation	5	15

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 Outcome:

After learning the course the students should be able to:

Know about different methods of producing cryogenic temperature, types of cryocoolers, Liquefaction of gases.

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 precooled 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

Major Equipment:

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

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website