

# GUJARAT TECHNOLOGICAL UNIVERSITY

## MECHANICAL (THERMAL ENGINEERING) (21)

CRYOGENIC ENGINEERING

SUBJECT CODE: 2722110

SEMESTER: II

**Type of course:** Applied Engineering (Advanced)

**Prerequisite:** Fundamental knowledge of low temperature refrigeration

**Rationale:** The course is designed to give knowledge of cryogenics engineering, cryo fluid, properties of material and its behavior under various conditions

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	PA (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	<b>Introduction to Cryogenic:</b> Properties of engineering materials at cryogenic temperatures, mechanical properties, thermal properties, electric & magnetic properties, super conducting materials, thermo electric materials, composite materials, cryo metallurgy, properties of cryogenic fluids, super fluidity of He3 & He4.	7	16
2	<b>Cryogenic Insulation:</b> expanded foams, gas filled & fibrous insulation, vacuum insulation, evacuated powder & fibrous insulation, opacified powder insulation, multilayer insulation, comparison of performance of various insulations	5	14
3	<b>Applications of Cryogenic Systems:</b> Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions	6	15
4	<b>Cryogenic Refrigeration System:</b> 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	7	16
5	<b>Advanced Cryo coolers:</b> 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	10	21
6	<b>Gas Liquefaction Systems:</b> Introduction, thermodynamically ideal systems, Joule Thomson effect, liquefaction systems such as Linde	7	18

	Hampton, Pre-cooled Linde Hampson, Linde dual pressure, cascade, claude, kapitza, heyland systems using expanders, comparison of liquefaction systems, introduction to cryogenics vessels		
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**Reference Books:**

1. Cryogenic process engineering, Thomas M Flynn, Informa Health Care, 2004
2. Miniature refrigerators for cryogenic sensors and cold electronics, Graham Walker, Clarendon Press, 1989
3. Cryogenic technology & applications, A R Jha, Butterworth-Heinemann, 2006,
4. Cryocooler, Fundamentals Part I &II, Graham Walker, Plenum Press, New York
5. Cryogenic Regenerative Heat Exchangers, R.A. Ackermann, Springer, 1997
6. Cryogenic systems, R F Barron, Oxford University Press,
7. Cryogenic heat transfer, R F Barron, Taylor & Francis Group

**Course Outcome:**

After learning the course the students should be able to:

- Understand the concept of cryogenic fundamental.
- Learn the requirement and use of proper insulation.
- Understand about the concept of cryocooler and application in various fields
- Select the proper cryogenic fluid for particular applications like, cryometallurgy, medical applications etc.
- Learn about the cryogenic refrigerators for different applications.

**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.