RKUNIVERSITY

SYLLABUS

Course Title	THEORY AND DESIGN OF CRYOGENIC SYSTEMS (ELECTIVE –I)
Course Code	TH912
Course Credit	Lecture : 04
	Practical : 01
	Tutorial : 00
	Total : 05

Course Objective

- To familiarize the students behind the latest topics of cryogenics in which the study of the production of very low temperature (below −150 °C, −238 °F or 123 K) and the behavior of materials at those temperatures is considered.
- To make the students familiar with the industrial applications of cryogenic systems for the production of liquefied gases like nitrogen, helium and air.
- To study the working, construction and operation of different cryogenic cycles like joule-thomson, Gifford-mcmohan, sterling etc.
- To study the specialized design of heat exchangers and regenerators used in cryogenic application.
- To study the storage, handling and transportation system for cryogenic fluids.
- To study the importance of lockhardt-martinelli correlations for pressure drop in two phase fluid systems.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Introduction and application:**	3
2	**Cryogenics Fluids:** • Properties of air, Oxygen, Nitrogen, Hydrogen, Helium and its isotopes.	4
3	**Cryogenics refrigeration systems :** • Recuperative & regenerative cycles, Joule Thomson cycle ; • Gifford, Mcmohan cycle, Stirling cycle, Pulse Tube refrigeration, Magneto caloric refrigeration, • Vuilleumier refrigerator.	6
4	**Gas liquefaction systems:** • Ideal systems, Linde, Linde dual pressure system, Claude, Heylandt, Kapitza systems, Cascade cycle.	4
	Cryogenic insulation: • Vacuum insulation, Multilayer insulation (MLI).	6

	• Methods of measuring effective thermal conductivity of MLI, Liquid & vapour shield. • Evacuated porous insulation, Gas filled powders and fibrous materials, Solid foams.	
6	**Cryogenic instrumentation:** • Peculiarities of cryogenic strain measurement, Pressure, Flow. • Density, Temperature and liquid level measurement for cryogenic application.	**5**
	Total	**28**
	SECTION-II	
7	**Purification and separation of gases, Liquefied natural gas:** • Principles of gas separation. • Separation by condensation & flashing, Separation by distillation. • Air separation system: Linde single column system. Linde double, Column systems etc, Liquefaction of Natural Gas.	**6**
8	**Storage & handling systems:** • Dewar vessel design, Piping, Support systems, Vessel safety devices and storage systems, Industrial storage systems.	**3**
9	**Transfer systems:** • Transfer from storage, Un-insulated transfer lines, Insulated lines, Transfer system components.	**4**
10	**Properties and selection of Materials:** • Study of material properties. • Their selection for cryogenic application.	**6**
11	**Vacuum Systems, Cryo pumping:**	**4**
12	**Equipments for low temperature systems:** • Heat exchangers, Compressor, Expanders.	**5**
	Total	**28**

Instructional Method and Pedagogy:

- At the beginning of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, blackboard, OHP etc.
- Attendance is compulsory in lectures and laboratory.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

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Students Learning Outcomes:

At the end of the course the students will be able to understand,

- The concept of cryogenic systems and its application in the latest technological up gradation in space applications.
- And design the special heat exchangers and regenerators used in cryogenic systems.
- And select the material and system for the liquefaction of different gases and also understand the importance behind the liquefaction of gases.

Reference Books:

1. Hastlden, C., "Cryogenic Fundamentals", Academic Press, 2001.
2. Barron R., "Cryogenic Systems", Plenum Press, 2001 .
3. Walker, "Cryocoolers", Vol. 1 & 2, Plenum Press, 2000.
4. Mikulin, Y., "Theory and Design of Cryogenic systems", MIR Publication, 2002.
5. Barron, R. F., "Cryogenics Systems", Oxford Press., USA, 2002.