BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE – PILANI, HYDERABAD CAMPUS
FIRST SEMESTER 2020-2021
(COURSE HANDOUT: PART-II)

Date: 17/08/2020

In addition to Part-I (a general handout for all courses appended to the time-table), this handout provides the specific details of this course.

Course No. : ME G537
Course Title : CRYOGENIC ENGINEERING
Instructor-in-charge : R. PARAMESHWARAN

1. Course Description

Introduction to cryogenics and its applications, properties of cryogenic fluids, properties of materials at cryogenic temperature, gas-Liquefaction and refrigeration systems, gas separation, cryocoolers, cryogenic insulations, vacuum technology, instrumentation in cryogenics, safety in cryogenics.

2. Scope and Objective

The purpose of this course is to provide introductory knowledge of the cryogenic principles and the engineering aspects of low temperature applications. The course also gives detailed knowledge and state-of the-art review of a variety of cryogenic systems pertaining to the potential research and real-world applications. Besides the theoretical knowledge, the course will also embark with interactive approach to mathematically analyze the cryogenic systems design. The course will certainly interest students aiming to build-up a research career in Cryogenic Engineering.

3. Text Books:

T1. S. S. Thipse, Cryogenics: A Textbook, Narosa Book Distributors Pvt Ltd India, 2013.

Reference Books:

R1. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press, Springer Science+Business Media New York, 1989.

R2. Velery V. Kostiouk, Digumarti Bhaskara Rao, A Text Book of Cryogenics, Discovery Publishing House, India, 2015.

R3. Guglielmo Ventura, Lara Risegari, The Art of Cryogenics Low-Temperature Experimental Techniques, Imprint: Elsevier Science, First Edition, 2008.

4. Course Plan

Lecture No.	Learning objectives	Topics to be covered	Chapter
1-3	Introduction to fundamentals of Cryogenics and its applications	Overview of thermodynamics basics, refrigeration cycles, Cryogenics, and applications.	T1: 3 R1: 1
4-8	Properties of cryogenic fluids	Study of cryogenic fluids, types and their properties.	T1: 6 R1: 2
9-14	Material properties at cryogenic temperature	Mechanical, Thermal, and Electrical properties, Superconductivity.	T1: 5 R1: 3 R2: 3
15-21	Liquefaction cycles	Principles of refrigeration and liquefaction, Joule-Thomson expansion, Isentropic expansion, Cascade processes.	T1: 7 R1: 4 R2: 7

22-25	Cryo-refrigerators and its types	Types of cryo-refrigerators, Thermodynamic analyses of systems.	T1: 14 R2: 5
26-30	Critical components in liquefaction systems	Heat exchangers, Compressors, Expanders, Performance parameters of critical components, system optimization.	T1: 10 R1: 5
31-34	Cryogenic gas separation and rectification column analysis	Ideal separation of gases, characteristics of Mixtures, principles of gas separation, types of separation and purification systems.	T1: 11 R1: 6 R2: 11
35-37	Storage and transfer Systems	Storage systems for cryo-liquids, transfer systems, insulation concepts, Industrial storage and transfer, cooling of storage and transfer.	T1: 18 R1: 7 R2: 14
38-40	Cryogens design, instrumentation and safety	Properties, characterization, basic instrumentation concepts, safety in handling cryogenic fluids and systems.	T1: 17 R1: 8
41-42	On-going research in cryogenics	Recent trends in cryogenics, materials and applications.	T1: 22 R2: 14

5. Evaluation Scheme

Evaluation Component	Duration (minute)	Weightage (%)	Date & Time	Nature of Component
Test 1	30	15	September 10 –September 20 (During scheduled class hour)	OB
Test 2	30	15	October 09 –October 20 (During scheduled class hour)	OB
Test 3	30	15	November 10 – November 20 (During scheduled class hour)	OB
Assignments (Take Home and In-Class)	---	10	Will be conducted throughout the semester	OB
Performance During Lab Sessions & Reports	---	10	Will be conducted throughout the semester	
Term Papers* (Reports & Presentations)	---	10	Will be conducted throughout the semester	
Comprehensive Exam#	120	25	14/12 FN	OB

NOTE:

* Students shall submit two review reports (preliminary and final) on a **topic** of their choice that **aligns** with the **course description** and **course plan**. The preliminary and final reports (**softcopy** and **hardcopy**), not exceeding two and ten pages (A4 size) respectively, shall be submitted before the due dates. The reports will be evaluated based on the quality of the work, presentation and Turnitin index as well.

EDD Notes on "Thermodynamics Tables will be allowed in the open book tests. However, it should not be defaced by writing formula, equations, etc.

Laboratory Engagement through Online Mode

Week Number	Experimental Topics to be Covered
1	Introduction to cryogenics lab, properties and applications of liquid nitrogen (LN_2), overview about the safety and handling of LN_2
2	Experiment 1: Effect of cryogenic treatment on different materials
3	Experiment 2: Microstructural and thermal properties of different polymers
4	
5	Experiment 3: Microstructural and thermal properties of different metallic materials
6	
7	Experiment 4: Microstructural and mechanical properties of different insulation materials
8	
9	Experiment 5: Microstructural and mechanical properties of different fibers (natural and synthetic)
10	
11	Experiment 6: Microstructural and electrical properties of different semiconductors
12	

Experiments 1 to 6 involve laboratory testing and characterization of different materials. The demonstration of the experiments and the test reports will be shared with the students in the form of **videos & documents** after each experiment is completed. Students are expected to record their **scientific understanding and observations** about each experiment and **submit a lab report (max. 3 pages)** for evaluation. Format of lab report will be shared in due course of time.

6. **Chamber Consultancy Hour:** To be announced in the class room.

7. **Notices:** All notices concerning this course shall be displayed on the CMS (the Institute's web based course management system). Besides this, students are advised to visit regularly CMS for latest updates.

8. **Make-up Policy:** Make-up shall be given only to the genuine cases with prior confirmation. Request for the make-up tests, duly signed by the students, should reach the under signed well before the scheduled test.

9. **Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-Charge
ME G537