FACULTY OF ENGINEERING & TECHNOLOGY

First Year Master of Engineering

Semester II

Course Code: 102440205

Course Title: Cryogenic Engineering

Type of Course: Program Elective III

Course Objectives: The course is designed to provide knowledge about the different cryogenic systems and their applications in different fields.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Internal		External		Total
Lecture	Tutorial	Practical		Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	40/16	20/08	60/24	30 / 12	150/60

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	INTRODUCTION TO CRYOGENIC SYSTEMS Mechanical and thermal Properties at low temperatures. Properties of Cryogenic Fluids. Gas Liquefaction: Minimum work for liquefaction. Methods to protect low temperature. Super conducting materials, thermo electric materials, composite materials, cryo metallurgy.	7
2	STORAGE OF CRYOGENIC LIQUIDS Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems.	7
3	CRYOGENIC INSTRUMENTATION & CRYOGENIC EQUIPMENT Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats. Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization.	7
4	APPLICATIONS OF CRYOGENIC SYSTEMS Super conductive devices such asbearings, 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	8

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5	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	**6**
6	GAS LIQUEFACTION SYSTEMS Introduction, thermodynamically ideal systems, Joule Thomson effect, liquefaction systems such as Linde Hampton, Pre-cooled Linde Hampson, Linde dual pressure, cascade, claude, kapitza, heyland systems using expanders, comparison of liquefaction systems, introduction to cryogenics vessels	**4**
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						**R**: Remembering; **U**: Understanding; **A**: Application, **N**: Analyze; **E**: Evaluate; **C**: Create
R	**U**	**A**	**N**	**E**	**C**	
10%	25%	20%	20%	20%	05%	

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 process engineering, Thomas M Flynn, Informa Health Care
2	Miniature refrigerators for cryogenic sensors and cold electronics, Graham Walker, Clarendon Press.
3	Cryogenic technology & applications, A R Jha, Butterworth-Heinemann, 2006,
4	Cryogenic Regenerative Heat Exchangers, R.A. Ackermann, Springer, 1997
5	Cryogenic systems, R F Barron, Oxford University Press,
6	Cryogenic heat transfer, R F Barron, Taylor & Francis Group
7	Handbook of Cryogenic Engineering, Editor – J.G. Weisend II, Taylor and Francis
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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students able to know the cryogenic systems.	**25**
CO-2	Understand the properties of cryogenic fluids and their storage.	**15**
CO-3	Students able to identify the measuring instruments and components.	**20**
CO-4	Students able to demonstrate the cryogenic refrigeration system	**20**
CO-5	Students able to perform and apply the gas liquidification system.	**20**
CO-6	Click or tap here to enter text.	Click
CO-7	Click or tap here to enter text.	Click
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CO-9	Click or tap here to enter text.	Click
CO-10	Click or tap here to enter text.	Click

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List of Practicals / Tutorials:

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1	To Study properties of Cryogenic fluids and its effects on materials.
2	To compute the thermal conductivity at very low temperature.
3	To study and compare different insulating materials used in cryogenics applications.
4	To compare different insulating materials used in cryogenic applications based on Heat transferred through the insulation.
5	To Study about storage vessel used for cryogenic fluid (Dewar).
6	To study cryogenic instrumentation system.
7	To study various applications of cryogenic systems.
8	To Study various cryogenic refrigeration systems and compute different parameters associated with the system.
9	To Study various cryo coolers.
10	To Study various liquefaction systems and compute different parameters associated with the system.
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Supplementary learning Material:	
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Curriculum Revision:	
Version:	**1**
Drafted on (Month-Year):	Apr-20
Last Reviewed on (Month-Year):	Jul-20
Next Review on (Month-Year):	Apr-22

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