M.E Semester: 3 Mechanical Engineering (Thermal Engineering)
Subject Name: Cryogenic Engineering

A. **Course Objective**

- To present a problem oriented in depth knowledge of Cryogenic Engineering
- To address the underlying concepts and methods behind Cryogenic Engineering

B. **Teaching / Examination Scheme**

SUBJECT		Teaching Scheme				Total Credit	Evaluation Scheme					Total Marks
		L	T	P	Total		THEORY		IE	CIA	PR. / VIVO	
CODE	NAME	Hrs	Hrs	Hrs	Hrs		Hrs	Marks	Marks	Marks	Marks	
METH302-B	Cryogenic Engineering	4	1	0	5	3	3	70	30	20	30	150

C. **Detailed Syllabus**

1. Properties of engineering materials at cryogenic temperatures, mechanical properties, thermal properties, electric & magnetic properties, super conducting materials, thermo electric materials, composite materials, properties of cryogenic fluids, super fluidity of He3 & He 4.
2. Cryogenic insulation – expanded foams, gas filled & fibrous insulation, vacuum insulation, evacuated powder & fibrous insulation, opacified powder insulation, multilayer insulation, comparison of performance of various insulations .
3. Applications of cryogenic systems: 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.
4. 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,
5. Advanced Cryocoolers: 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.
6. Refrigerators using solids as working media: Magnetic cooling, magnetic refrigeration systems, thermal; valves, nuclear demagnetization.
7. 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.

D. **Lesson Planning**

Sr.No.	Date/Week	Unit No.	% Weightage	Topic No:
1	1^{st} ,2^{ed} ,3^{ed}	Unit 1	20 % .	1,2
2	4^{th} ,5^{th} ,6^{th}	Unit 2	20 %	3
3	7^{th} ,8^{th} ,9^{th}	Unit 3	20 %	4
4	19^{th} ,11^{th} ,12^{th}	Unit 4	20 %	5,6
5	13^{th} ,14^{th} ,15^{th}	Unit 5	20 %	7

E. **Instructional Method & Pedagogy**

1. At the start of course, the course delivery pattern , prerequisite of the subject will be discussed
2. Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal weightage should be given to all topics while teaching and conduction of all examinations.

3. Attendance is compulsory in lectures and laboratory, which may carries five marks in overall evaluation.
4. One/Two internal exams may be conducted and total/average/best of the same may be converted to equivalent of 30 marks as a part of internal theory evaluation.
5. Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.
6. Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overall internal evaluation.

F. **Students Learning Outcomes**

- The student can identify different areas of Cryogenic Engineering
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- Can find the applications of all the areas in day to day life.

G. **Recommended Study Materials**

- **Text & 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