

COURSE CODE	COURSE TITLE	L	T	P	C
1152AE114	Cryogenic Engineering	3	0	0	3

Course Category:

Programme Elective

a. Preamble :

This course deals with the Cryogenic fluids and their processing. It gives an understanding of manufacturing and storage techniques of cryogenic fluids

b. Prerequisite Courses:

Aero Engineering Thermodynamics

c. Related Courses:

- Rocket and space propulsion
- Ramjets and Scramjet propulsion

d. Course Educational Objectives :

- To learn about the Thermodynamics, Physics and Chemistry of Combustion.
- To understand the chemical thermal energy conversions in refrigeration system

e. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand the basic properties of cryogenic fluids	K2
CO2	Understand the basic concepts of refrigeration and liquefaction	K2
CO3	Understand the basic concepts cryogenic insulation	K2
CO4	Understand the principle of storage and processing of cryogenic liquids	K2
CO5	Understand the equipment in cryogenic liquids	K2

f. Correlation of COs with POs :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H				H				
CO2	H			H				H				
CO3	H			H				H				
CO4	H			H				H				
CO5	H			H				H				

H- High; M-Medium; L-Low

UNIT I INTRODUCTION TO CRYOGENIC ENGINEERING 9

Refrigeration and liquefaction principals - Joule Thomson effect and inversion curve - Adiabatic and isenthalpic expansion with their comparison - Properties of cryogenic fluids - Properties of solids at cryogenic temperatures - Superconductivity.

UNIT II REFRIGERATION AND LIQUEFACTION 9

Gas liquefaction systems: Recuperative – Linde – Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative – Stirling cycle and refrigerator, Slovaý refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas.

UNIT III CRYOGENIC INSULATION 9

Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.

UNIT IV STORAGE OF CRYOGENIC LIQUIDS 9

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.

UNIT V CRYOGENIC EQUIPMENT 9

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.

REFERNCES:

1. Cryogenics: Applications and Progress, A. Bose and P. Sengupta, Tata McGraw Hill.
2. Cryogenic Engineering, T.M. Flynn, Marcel Dekker
3. Handbook of Cryogenic Engineering, Editor – J.G. Weisend II, Taylor and Francis