INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

CRYOGENIC SYSTEMS								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAEE16	**Elective**	3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Aircraft Propulsion								

I. COURSE OVERVIEW:

A cryogenic engineering course overview covers the fundamentals of low-temperature science, including the properties of cryogenic fluids and materials, and the design of systems for liquefaction, refrigeration, and storage. This course provides a consolidated overview of cryogenic hydrogen production, storage, transportation, and its end use. The safety aspects of handling cryo-hydrogen and the necessary precautions will also be discussed.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Behavior of both cryogenic fluids and materials at very low temperatures.
II. Principles and design of gas liquefaction and refrigeration systems, including efficiency analysis and the use of various cycles.
III. Comprehend the role of insulation, vacuum technology, and instrumentation.

III. COURSE OUTCOMES:

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

CO 1 Apply the knowledge of combustion systems and feed systems of rockets for selecting the suitable component based on the mission requirement.
CO 2 Utilize the knowledge of aerodynamic forces and moments of Rockets and missiles for designing with optimum performance.
CO 3 Apply the concepts of 1-D, 2-D rocket motions in free space and gravitational fields for solving the problems in space.
CO 4 Analyze the combinations of trajectories, range, altitude and velocity of rockets and missiles for specific application.
CO 5 Categorize the staging and controls of planned rocket and missiles for providing sufficient capability such as speed, range, and maneuverability.
CO 6 Make use of the selection criteria of materials properties for designing new components under adverse conditions.

IV. COURSE CONTENT:

MODULE-I: CRYOGENIC FLUIDS AND THEIR APPLICATIONS (09)

Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics in Space Programs, Superconductivity, Cryo Metallurgy, Medical applications.

MODULE-II: LIQUEFACTION CYCLES (09)

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Ortho-Para hydrogen conversion, Eollins cycle, Simpson cycle, Critical Components in Liquefaction systems.

MODULE-III: SEPARATION OF CRYOGENIC GASES (09)

Cryocoolers- Introduction, Classification of Cryocoolers, Stirling Cryocooler, Gifford-McMahon Crycooler, Gas Cycle Refrigeration system- Classification of gas cycle refrigeration, Pulse tube refrigerator, Solvay cycle refrigerator, Vuilleumier refrigerator.

Cryogenic regenerators, Regenerators used in Cryogenic Refrigerators, Dilution refrigerators, Magnetic Refrigerators

MODULE-IV: CRYOGENIC REFRIGERATORS (09)

Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis - McCabe Thiele Method. Adsorption Systems for purification

MODULE-V: HANDLING OF CRYOGENS (09)

Cryogenic Dewar, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Instrumentation to measure Flow, Level and Temperature.

V. TEXT BOOKS:

1. Klaus D. Timmerhaus and Thomas M. Flynn, “Cryogenic Process Engineering, Plenum Press, New York, 1989.
2. Randall F. Barron, “Cryogenic Systems”, McGraw-Hill, 1985.
3. Scott R.B., “Cryogenic Engineering”, Van Nostrand and Co., 1962.

VI. REFERENCE BOOKS:

1. Robert W. Vance, Cryogenic Technology, John Wiley & Sons, Inc., New York, London
2. E.R. Parket, “Materials for Missiles and Space craft”, McGraw Hill Book Co., 2nd edition, 1982.
3. Gordon C. Oates, “Aerothermodynamics of Gas Turbine Rocket Propulsion” American Institute of Aeronautics and Astronautics, Inc. 3rd edition, 1997.

VII. ELECTRONICS RESOURCES:

1. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0470080248.html
2. https://archive.org/details/RocketPropulsionAndSpaceflightDynamics
3. http://rapidshare.com/files/163497637/The_Jet_Engine.rar
4. http://www.personal.utulsa.edu/~kenneth-weston/chapter5.pdf

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.