



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

JET AND ROCKET PROPULSION							
I Semester: AE							
Course Code	Category	Hours / Week		Credits	Maximum Marks		
BAEE02	Core	L	T	P	C	CIA	SEE
		3	-	-	3	40	60
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45		
Prerequisite: Aerospace propulsion							

I. COURSE OVERVIEW:

Aerospace propulsion focuses on fundamental knowledge of conceptual planetary and solar systems, propulsion, and control systems used in the mission design of launch vehicles. This subject motivates to gain knowledge of chemical rocket propulsion for scientific and practical purposes. The course includes the combustion process, propellants, and various components and applications of chemical rocket propulsion systems. This course deals with fundamental aspects of advanced rockets and the current trends in rocket propulsion.

II. COURSE OBJECTIVES:

The students will try to learn:

- I. The basic working principles of different types of airbreathing engines and their components.
- II. The ideal cycles analysis of jet engine.
- III. The operation of solid and liquid propellant rocket motors.
- IV. The operating principle of electric rocket motors.

III. COURSE OUTCOMES:

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

CO 1 Identify suitable air-breathing engine and operating system for the aircraft based on performance.

CO 2 Distinguish between the functions and performance parameters of inlets, nozzles, combustors and after burners for choosing desired devices to the aero engines.

CO 3 Identify the performance characteristics of turbo machineries for their suitable selection in aircraft engines

CO 4 Examine the working procedure of rocket propulsion system and components for selecting them based on mission profile

CO 5 Classify the propellant grain structure for solid propellants to increasing the performances level.

CO 6 Develop sub-systems and heat transfer systems in liquid propellant rocket for definitive deep space rocket propulsive design.

IV. COURSE CONTENT:

MODULE-I: JET ENGINE COMPONENT AND ANALYSIS (09)

Classification of jet engines turbojet, turbofan, turboprop, turboshaft, ramjet, scramjet, turbojet/ramjet combined cycle engine, thrust equation ;Ideal cycle analysis of turbojet with and without after burner and turbo fan engine; performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, engine overall efficiency and its impact on aircraft; Engine cycle analysis and performance analysis for turbojet, turbojet with afterburner, turbofan engine, turboprop engine.

MODULE-II: INLETS, NOZZLES AND COMBUSTORS PERFORMANCE (09)

Subsonic inlets: Function, design variables, operating conditions, inlet performance, performance parameters; Supersonic inlets: Compression process, types, construction, losses, performance characteristics; Exhaust nozzles: primary nozzle, fan nozzle, converging nozzle, converging-diverging nozzle, variable nozzle, and performance maps, thrust reversers and thrust vectoring, Combustors and Afterburners: Geometries, flame stability, ignition and engine starting, adiabatic flame temperature, pressure losses, performance maps, fuel types and properties.

MODULE-III: AXIAL FLOW COMPRESSORS AND TURBINES (09)

Axial flow Compressors: Operating Principle, Velocity triangle and pressure rise equation, stage parameters, cascade aerodynamics, aerodynamic forces on compressor blades, performance maps, single stage energy analysis, compressor instability, stall and surge control.

Axial Flow Turbines: Geometry, configuration, comparison with axial flow compressors, velocity polygons or triangles, single stage energy analysis, performance maps, thermal limits of blades and vanes, blade cooling, blade and vane materials, blade and vane manufacture.

MODULE-IV: SOLID AND LIQUID PROPELLANT ROCKET MOTORS (09)

Classification of rocket propulsion systems; Performance of an ideal rocket, rocket thrust equation, total and specific impulse, effective exhaust velocity, rocket efficiencies, characteristic velocity, thrust coefficient; Description of solid propellant rocket motor, solid propellant grain configurations, homogeneous propellant, heterogeneous or composite propellant, different grain cross sections, Types of igniters advantages of solid propellant rockets. Liquid propellant rocket: Bipropellant, monopropellant, cold gas propellant, cryogenic propellant, storable propellants, gelled propellant; Propellant Storage, different propellant tank arrangements, propellant feed system-pressure feed, turbopump feed

MODULE-V: ELECTRIC ROCKET PROPULSION (09)

Electric rocket propulsion, types of electric propulsion techniques, Ion propulsion, Nuclear rocket, comparison of performance of these propulsion systems with chemical rocket propulsion systems, future applications of electric propulsion systems, Solar sail.

V. TEXT BOOKS:

1. P Hill, P.G. and Peterson, C.R., Mechanics and Thermodynamics of Propulsion, Addison Wesley, 2nd Edition, 1992.
2. George P. Sutton, Oscar Biblarz, "Rocket Propulsion Elements", Wiley India Pvt. Ltd, 7th Edition, 2010.

VI. REFERENCE BOOKS:

1. Jack D. Mattingly, "Elements of Propulsion: Gas Turbines and Rockets", AIAA Education Series, Edition, 2006.
2. Saeed Farokhi, "Aircraft Propulsion", Wiley, 2nd Edition, 2014.
3. David R. Greatrix, "Powered Flight: The Engineering of Aerospace Propulsion", Springer, 3rd Edition, 2012.

VII. 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