COURSE CONTENT

JET AND ROCKET PROPULSION								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED02	Core	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerospace propulsion								

I. COURSE OVERVIEW:

An aerospace propulsion system is a device that generates forces to push the aerospace vehicles forward. This course discusses about the various Aerospace propulsive devices in micro level, it includes an overview of different types of propulsive system present in aircrafts and rockets such as turbojet, turboprop, turbofan, IC engine, solid propellant, hybrid propellant and liquid propellant engines. Along with that design and analysis will be discussed on the various parameters and components present in aerospace propulsive system.

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 (10)

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;Enginecycleanalysisandperformanceanalysisforturbojet,turbojetwithafterburner,turbofanengin, turboprop engine.

MODULE-II: INLETS, NOZZLES AND COMBUSTORS PERFORMANCE (10)
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 (10)
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