AEROSPACE PROPULSION

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB02	Core	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

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 course should enable the students to:

I. The basic working principles of different types of air breathing engines.
II. The design and analysis of IC engines.
III. The design of different components of gas turbine.
IV. The design of different components of solid and liquid propellant rockets.

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.	**Apply**
CO 2	**Distinguish** between the functions and performance parameters of inlets, nozzles, combustors and after burners for choosing desired devices to the aero engines.	**Apply**
CO 3	**Identify** the performance parameters for estimating the thrust and specific fuel consumption of an aircraft engine.	**Analyze**
CO 4	**Examine** the working procedure of rocket propulsion system and components for selecting them based on mission profile	**Analyze**
CO 5	**Make a use of** working principles of solid and hybrid rocket motors for increasing the performances level.	**Apply**
CO 6	**Develop** sub-systems and heat transfer systems in liquid propellant rocket for definitive deep space rocket propulsive design.	**Analyze**

IV. SYLLABUS:

UNIT-I	AIR-BREATHING ENGINES	Classes: 09

Classification, operational envelopes; Description and function of gas generator, turbojet, turbofan, turboprop, turboshaft, ramjet, scramjet, turbojet/ramjet combined cycle engine; Engine thrust, takeoff thrust, installed thrust, thrust equation; Engine performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, engine overall efficiency and its impact on aircraft range and endurance; Engine cycle analysis and performance analysis for turbojet, turbojet with afterburner, turbofan engine, turboprop engine.

UNIT-II	AIRCRAFT ENGINE INLETS, EXHAUST NOZZLES, COMBUSTORS AND AFTERBURNERS	Classes: 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.		
UNIT-III	**AXIAL FLOW COMPRESSORS AND TURBINES**	**Classes: 09**
Axial flow Compressors: Geometry, definition of flow angles, stage parameters, cascade aerodynamics, aerodynamic forces on compressor blades, rotor and stator frames of reference, compressor performance maps, velocity polygons or triangles, single stage energy analysis, compressor instability, stall and surge. 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.		
UNIT-IV	**SOLID-PROPELLANT ROCKET MOTORS**	**Classes: 09**
Background description: 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, propellant burning rate, combustion of solid propellants, physical and chemical processes, ignition process, combustion instability; Hybrid propellant rockets: Hybrid rocket operation and hybrid rocket characteristics.		
UNIT-V	**LIQUID PROPELLANT ROCKET ENGINES: PROPELLANT TYPES**	**Classes: 09**
Bipropellant, monopropellant, cold gas propellant, cryogenic propellant, storable propellants, gelled propellant; Propellant Storage,different propellant tank arrangements, propellant feed system-pressure feed, turbopump feed; Thrust chambers, injectors, combustion chamber, nozzle, starting and ignition, variable thrust; Combustion of liquid propellants: Combustion process, combustion instability, thrust vector control.		

Text Books:

1. Ronald D. Flack, "Fundamentals of Jet Propulsion with Applications", Cambridge University Press, 3rd Edition, 2011.
2. George P. Sutton, Oscar Biblarz, "Rocket Propulsion Elements", Wiley India Pvt. Ltd, 7th Edition, 2010.

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.

Web References:

1. http://www.aero.iisc.ernet.in/page/propulsion
2. https://afreserve.com/aerospace-propulsion
3. http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-50-introduction-to-propulsion-systems-spring-2012/Syllabus/

E-Text Books:

1. http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118307984.html
2. http://www.freeengineeringbooks.com/AeroSpace/Propulsion-Books.php
3. http://www.springer.com/us/book/9781447124849?token=prtst0416p