AEROSPACE PROPULSION

GROUP – I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB08	CORE	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

OBJECTIVES:

The students will try to learn:

I	The fundamentals of air-breathing propulsion system, their operating principles, and function of an individual component.
II	The geometry of flow inlets, combustion chambers, and factors affecting their performance.
III	The establishment of flow through various inlets and nozzles under different operating conditions.
IV	The operating principles of various compressors, turbines and performance characteristics under different flight conditions.

COURSE OUTCOMES:

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

CO 1	**Compare** the operating principles of various gas turbine engines and their components for selecting the suitable engine as per the mission requirements
CO 2	**Develop** the general thrust equation of gas turbine engine for estimating the specific thrust.
CO 3	**Utilize** the engine cycle analysis for studying the performance characteristics of various gas turbines.
CO 4	**Interpret** the flow pattern in subsonic and supersonic inlets for fixing the factors that impose practical limits on their performance.
CO 5	**Compare** the different types of combustion chambers for identifying the design variables affecting their performance.
CO 6	**Utilize** the flow through various nozzles under various operating conditions for selecting the suitable nozzle as per the mission requirement.
CO 7	**Illustrate** the working principle of various types of compressors and turbines used in air-breathing jet engines for identifying a suitable combination.
CO 8	**Make use of** the performance characteristics and efficiencies of different compressors and turbines for developing a better design.
CO 9	**Identify** the steps involved in the design of the compressor and turbine towards developing new conceptual designs.

MODULE-I	AIR-BREATHING ENGINES	Classes: 10

Classification, operational envelopes; Description and function of gas generator, turbojet, turbofan, turboprop, turbo shaft, 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.

MODULE-II	INLETS AND COMBUSTION CHAMBERS	Classes: 10
Internal flow and stall in subsonic inlets, relation between minimum area ratio and eternal deceleration ratio, diffuser performance, supersonic inlets, starting problem on supersonic inlets, shock swallowing by area variation; Classification of combustion chambers, combustion chamber performance, effect of operating variables on performance, flame stabilization.		
MODULE-III	**NOZZLES**	**Classes: 08**
Theory of flow in isentropic nozzles, nozzles and choking, nozzle throat conditions, nozzle efficiency, losses in nozzles. Over expanded and under expanded nozzles, ejector and variable area nozzles, interaction of nozzle flow with adjacent surfaces, thrust reversal.		
MODULE -IV	**COMPRESSORS**	**Classes: 09**
Principle of operation of centrifugal compressor and axial flow compressor, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant reaction designs of axial flow compressor, performance characteristics of centrifugal and axial flow compressors, stage efficiency calculations, cascade testing.		
MODULE -V	**TURBINES**	**Classes: 08**
Principle of operation of axial flow turbines, limitations of radial flow turbines, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant angle designs, performance characteristics, sample ramjet design calculations, flame stability problems in ramjet combustors, integral ram rockets.		

Text Books:

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" ,Addison Wesley Longman INC, 1999.
2. Mattingly J.D., "Elements of Propulsion: Gas Turbines and Rocket", AIAA, 1991.

Reference Books:

1. Cohen, H.Rogers, G.F.C. and Saravanamuttoo, H.I.H,"Gas Turbine Theory", Longman, 1989.
2. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.

Web References:

1. https://nptel.ac.in/courses/101/101/101101002/
2. https://nptel.ac.in/courses/112/103/112103281/

E-Text Books:

1. https://www.cambridge.org/in/academic/subjects/engineering/aerospace-engineering/jet-propulsion-simple-guide-aerodynamics-and-thermodynamic-design-and-performance-jet-engines-3rd-edition?format=PB
2. https://www.wiley.com/en-sg/Aircraft+Propulsion%2C+2nd+Edition-p-9781118806777
3. https://www.routledge.com/Aircraft-Propulsion-and-Gas-Turbine-Engines/El-syed/p/book/9781466595163