AIRCRAFT PROPULSION

V Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAE007	Core	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

COURSE OBJECTIVES:

The course should enable the students to:

I. Analyze parametric cyclic analysis, performance parameters, efficiency, specific impulse of all air breathing engines.

II. Know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors.

III. Discuss the types of nozzles, flow conditions in nozzles, interaction of nozzle flow with adjacent surfaces and thrust reversal

IV. Explain different types of compressors and turbines, work done, velocity diagrams and stage efficiency calculations.

COURSE OUTCOMES (COs):

CO 1: Describe the various types, basic function, and performance analysis of air-breathing engine.
CO 2: Understand the various inlets and combustion chamber performance parameters affecting it.
CO 3: Explain theory of flow in isentropic nozzles and variable area nozzle.
CO 4: Describe principle operations of compressors, with work done and pressure rise explaining the design and performance parameters.
CO 5: Determine the various types of turbine, understand configuration associated.

COURSE LEARNING OUTCOMES (CLOs):

1. Apply knowledge and understand the essential facts, concepts and principles of thermodynamics.
2. Understand the basic function of all aircraft engine components and how they work.
3. Analyze the engine performance parameters and parameters influencing them.
4. Understand the impact of performance parameters on endurance and range how they affect the aircraft performance.
5. Demonstrate different type's aircraft engine operating principle.
6. Understand step by step procedure of engine parametric cycle analysis.
7. Understand steps involved in performance analysis of all aircraft engine.
8. Describe operational modes of subsonic inlets and parameters influencing it.
9. Analyze diffuser performance, losses in it and their impact on engine performance.
10. Describe supersonic inlets, starting problem in it and their operating modes.
11. Understand different types of combustion chamber and functions of all the components.
12. Analyze combustion chamber performance and parameters influencing them.
13. Describe theory of flow in isentropic nozzle and physics behind nozzle operation.
14. Understand different nozzle operating conditions for convergent and divergent nozzle.

15. Describe principle of operation of axial and centrifugal compressor.
16. Understand different design of compressor and limitations of each method.
17. Analyze performance characteristics of axial and centrifugal compressor.
18. Describe principle of operation of centrifugal and axial flow turbine.
19. Understand different design of axial and centrifugal turbine.
20. Design of ramjet engine and steps involved in it.

UNIT-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.

UNIT-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.

UNIT-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

UNIT-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.

UNIT-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/101101002/
2. https://nptel.ac.in/courses/112106073/

E-Text Books:

1. https://as.wiley.com/WileyCDA/WileyTitle/productCd-1118806778.html
2. https://www.scribd.com/document/63588270/Aerospace-Propulsion-Systems
3. https://www.crcpress.com/Aircraft-Propulsion-and-Gas-Turbine-Engines/ElSayed/p/book/9780849391965