

SEMESTER 5**AIR BREATHING PROPULSION**

Course Code	PCAOT503	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Fluid Mechanics, Engineering Thermodynamics	Course Type	Theory

Course Objectives:

1. To understand the basic working principles of different types of air breathing engines.
2. To understand different components of a gas turbine.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Aircraft Engines: Classification of propulsion, Description of piston engines, turbojet engines—derivatives and hypersonic air-breathing engines. Types of propellers, thrust generation in propeller driven aircraft. General Thrust equation for jet engine, Engine performance parameters-altitude, density. Effect of parameters on aircraft range and endurance. Engine thrust, take-off thrust, installed thrust, operational envelopes for jet engines and propeller engines, Engine cycle analysis and performance analysis for turbojet, turbojet with afterburner, turbofan engine, turboprop engine, ramjets. (Numerical)	10
2	Aircraft Engine Inlets, Exhaust Nozzles, Combustors: Subsonic inlets: Function, design variables, operating conditions, inlet performance, performance parameters; Starting of Supersonic inlets: Compression process, types, construction, losses, performance characteristics; Exhaust nozzles: primary nozzle, fan nozzle, converging nozzle, variable nozzle, and performance maps, thrust reversers and thrust vectoring, Combustors and Afterburners: Types, flame stability, ignition and engine starting, pressure losses, performance maps, fuel types and properties.	8
3	Axial and Centrifugal Flow Compressors: Axial flow Compressors: Geometry, Velocity diagram, Work done and pressure rise, degree of reaction, compressor performance maps, compressor instability, stall and surge. efficiency calculations. Centrifugal Compressor: Principle of operation of centrifugal compressor	9

	Work done and pressure rise, Blade types, Performance characteristics of centrifugal compressors efficiency calculations.	
4	Axial Flow and Radial Flow Turbines: Principle of operation of axial flow turbines and radial flow turbines - Work done and pressure rise - Velocity diagrams – Degree of reaction – Free vortex and constant nozzle angle designs - Stage efficiency calculations – Basic blade profile design considerations – Matching of compressor and turbine - Performance characteristics of axial flow turbine– Turbine blade cooling methods. Cascades and cascade testing - Design of blades. (Numerical problems). Engines component matching and sizing.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the various types, working and performance of air-breathing engines.	K2
CO2	Understand the design consideration required for inlets and combustion chamber performance parameters affecting it.	K2
CO3	Calculate the performance parameters- pressure ratio, efficiency of compressors used for aircraft propulsion.	K3
CO4	Solve problems related to performance parameters of turbines used for aircraft propulsion.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	1	1	-	-	-	-	2
CO2	3	2	2	2	-	1	1	-	-	-	-	2
CO3	3	3	2	2	-	1	1	-	-	-	-	2
CO4	3	3	2	2	-	1	1	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Jet Propulsion with Applications	Ronald D. Flack,	Cambridge University Press, 3rd Edition,	2011
2	Gas Turbine Theory	H Cohen. G F C Rogers HIH Saravanamuthoo	Pearson	2008
3	Turbines, Compressors and Fans	S M Yahya	McGraw- Hill & Co.	1997

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Elements of Propulsion: Gas Turbines and Rockets	Jack D. Mattingly	AIAA Education Series, 3rd Edition,	2006
2	Aircraft Propulsion	Saeed Farokhi	Wiley, 2nd Edition	2014

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/101/112101004/