Course code	Course Name	L-T-P-Credits	Year of Introduction
AO206	PROPULSION -1	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To introduce basic concepts and salient features of engine components of jet propelled engines which are operated in atmosphere.
- To familiarize advanced jet propulsion methods like hypersonic propulsion.

Syllabus

Piston engines – Gas turbine engines – thrust augmentation –inlets – nozzles -thrust reversal- combustion chamber - axial flow compressor- centrifugal compressor – axial flow turbine – ram jet engine – performance characteristics of GT engines.

Expected Outcome

The students will be able to

i. identify the engine components of jet propelled engines
ii. know the details of advanced Jet propulsion and hypersonic propulsion

Text Books:

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Addison – Wesley Longman INC, 1999.
2. James Award, "Aerospace Propulsion System"

References:

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.
3. Rolls Royce, "Jet Engine”, 5th Edition, Rolls Royce Technical Publications, 2005.
4. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 1999.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Operating principles of piston engines – thermal efficiency calculations – classification of piston engines.	1	15%
	Propeller geometry, types, material for propellers, selection of propellers.	1	
	Propeller theories Ideal Momentum and Blade element, Numerical problems on the performance of propellers using propeller charts.	2	
	Illustration of working of gas turbine engine-the thrust equation.	1	
	Factors affecting thrust – effect of pressure, velocity and temperature	2	

	changes of air entering compressor – methods of thrust augmentation.		
II	Internal flow and Stall in subsonic inlets.	1	15%
	Relation between minimum area ratio and eternal deceleration ratio, Diffuser performance.	1	
	Supersonic inlets – starting problem on supersonic inlets,shock swallowing by area variation.	1	
	Real flow in nozzles and nozzle efficiency – losses in nozzles – equilibrium flow and frozen flow in nozzles- two phase flow in nozzles.	1	
	Ejector and variable area nozzles - interaction of nozzle flow with adjacent surfaces, Thrust reversal.	1	
	Classification of combustion chambers – combustion chamber performance.	1	
	Effect of operating variables on performance – flame stabilization.	1	
FIRST INTERNAL EXAM			
III	Principle of operation of axial flow compressor.	1	15%
	Work done and pressure rise – velocity diagrams.	2	
	Degree of reaction – free vortex and constant reaction designs of axial flow compressor.	2	
	Performance characteristics of axial flow compressors– stage efficiency calculations - cascade testing.	2	
IV	Principle of operation of centrifugal compressor.	1	15%
	Work done and pressure rise – velocity diagrams – degree of reaction.	3	
	Performance characteristics of centrifugal compressors	1	
	Stage efficiency calculations.	2	
SECOND INTERNAL EXAM			
V	Principle of operation of axial flow turbines– limitations of radial flow turbines- Work done and pressure rise.	2	20%
	Velocity diagrams – degree of reaction – free vortex and constant nozzle angle designs.	2	
	Performance characteristics of axial flow turbine– turbine blade cooling methods.	1	
	Stage efficiency calculations – basic blade profile design considerations – matching of compressor and turbine.	2	
VI	Operating principle of ramjet engine.	1	20%
	Various components of ramjet engines and their efficiencies.	1	
	Combustion in ramjet engine – critical, subcritical and supercritical	2	

	modes of operation -ramjet engine and its performance characteristics.		
	Sample ramjet design calculations – flame stability problems in ramjet combustors –integral ram rockets.	2	
	Characteristics of turboprop, turbofan and turbojet – performance characteristics.	1	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100, Time: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.