Propulsion and Power Plants

Code	Credit Hours
AE- 338	3-1

Course Description:

This course covers basic principles and working of various types of propulsion systems used in the aerospace industry. It has two parts – air breathing engines and the rocket propulsion. In the air breathing category both reciprocating and jet engines are discussed. Whereas basic understanding of the reciprocating engine is developed first, the main area of attention is the jet engine comprising of thermodynamic analysis of ramjet, turbojet, turbo-fan, and turbo-prop engines. The course also covers discussion on jet engine turbomachinery that includes stage dynamics and characteristic performance of centrifugal compressor, single stage and multistage axial flow compressor and the radial and axial turbine. In the lab work pertinent experiments are also performed.

Text Book:

1. "Mechanics and Thermodynamics of Propulsion" by Hill & Peterson
2. Latest Available Edition, Pearson Publishing Company
3. Aircraft Powerplants Latest Available Edition by Thomas W. Wild (Author), Michael J. Kroes (Author)
4. Gas Turbine Engine by Aviation Maintenance Technician Certification Series, Latest Available Edition
5. Propulsion by Aviation Maintenance Technician Certification Series, Latest Available Edition

Reference Books:

1. 'Turbines Compressors and Fans' by S M Yahya, Tata Mac-Graw Hill Inc, 2006.
2. 'Gas Turbine Theory' by H Cohan, G F C Rogers & H I H Saravanamuttoo, John Wiley& Sons Inc.
3. 'Fluid Mechanics, Thermodynamics of Turbomachinery' by S L Dixon, Pergamon Press.
4. 'Rocket Propulsion Elements' by George P Sutton, Oscar Biblarz, 6th Ed. John Wiley, NY, 1992

PREREQUISITE:

Thermodynamics-II
Compressible Aerodynamics

ASSESSMENT SYSTEM FOR THEORY

Quizzes	10%
Assignments	10%
Mid Terms	30%
ESE	50%

ASSESSMENT SYSTEM FOR LAB:

Quizzes	10%-15%
Lab Work and Report	70-80%
Lab ESE/Viva	20-30%

Teaching Plan

Week No	Description	Ref Book Chapter Number
1	Introduction to Propulsion What and why of propulsion Types of propulsion system Air breathing engines Operational limitations	Instructor's Notes
2	Construction and Working Principle Four stroke cycle Engine performance parameters	Chapter-9 (Ref 5)
3-6	Stream tube flow patterns Installed / uninstalled engine thrust Additive drag Thrust power, Engine power Thrust equation Engine performance parameters Propulsive efficiency, Thermal efficiency and Overall efficiency Aircraft range, Take-off thrust Ramjet Turbojet	Chapter-5 (Text)
7	Turbofan, Turboprop Typical engine performance	Chapter-5 (Text)
8	Introduction to Turbomachinery	Chapter-6

	Energy transfer in turbomachines Euler's energy equation	(Ref 1)
9	**MID TERM EXAM**	
10-11	**Axial Compressor:** Velocity triangles, Work and compression Boundary layer limitations Compressor efficiency	Chapter-7 (Text)
12-13	Stage dynamics Degree of reaction Dimensionless parameters Stage efficiency	Chapter-7 (Text)
14-15	**Centrifugal Compressor:** Elements of the stage Impeller configurations Flow analysis through compressor Stage work, pressure rise Slip factor and its determination techniques Performance parameters Losses	Chapter-12 (Ref 1)
16	**Radial Turbine:** Stage element Stage velocity triangles Work output and efficiency Incidence losses	Chapter-13 (Ref 1)
17	**Rocket Propulsion:** Types of Rocket Propulsion Static performance Thrust, specific impulse Vehicle acceleration	Chapter-10 (Text)

LAB WORK

Lab No	Experiment No	Description
1	-	Visit to lab and introduction to all aero-engines and turbomachinery (Written Quiz Assessment)
2-4	1	To observe the type of flame at different air flow rates for Kerosene and Diesel liquid fuels.
	2	Determination of the effect of inlet pressure on mass flow rate, at a variety of constant back pressure.
	3	Determination of velocity of the jet leaving nozzle at variety of back pressures. Calculation of Nozzle Efficiency.

5-8	4	To determine the heat transfer balance for Kerosene and Diesel liquid fuels at different air flow rates and calculate plant efficiency.
	5	Determination of jet reaction and specific thrust at variety of inlet and back pressures.
	6	To obtain the characteristics curves of a water turbine operating at a range of fluid flow rates.
	7	To show the difference in performance between throttle control and nozzle control of turbine speed.
9-11	8	To determine the heat transfer balance for LPG at different air flow rates and calculate plant efficiency.
	9	Evaluation of the performance of axial flow compressor and to formulate the characteristic map of the axial flow compressor
	10	Determination of several Turbofan Performance Parameters
12-15	11	To determine the heat transfer balance for JP8 at different air flow rates and calculate plant efficiency.
	12	Determination of complete compressor performance spectrum
	13	Comparison of turbofan power requirements under various load conditions
	14	Analysis of Gas Turbine Cycle using Gas Turb Software.
16	15	Open Ended Lab