Approval: 6th Senate Meeting

Course Number: ME 621

Course Name: Aircraft Propulsion

Credit: 2-1-0-3

Prerequisites: Thermodynamics

Students intended for: UG?MS/PhD

Elective or Core: Elective

Semester: Even

Preamble:

The course begins with an introduction to the various propulsive devices used to power aircraft /helicopters, for generating thrust-characteristic as per the mission requirement. Since Gas Turbines Engines(GTE) have almost completely replaced reciprocating piston engines, their application for aircraft propulsion is covered at length. Thermodynamic design point analysis of shaft-power cycle (for helicopter engine) & jet-engine cycle, for estimation of thrust, specific thrust, propulsive efficiency, & specific fuel consumption will be studied. The thermodynamic processes (ideal & real) in various components in aircraft gas turbine engine, from intake (at inlet) up to nozzle / free turbine (at exit), will be examined. Because GTEs mostly operate away from the design point, procedure for prediction of performance parameters during off-design operation (using component maps) will also be covered.

Course Modules:

Aircraft propulsive devices / engines (basic principle of operation) (3 L)

 brief information on - piston-prop, turbo-prop, turbojet, turbofan, turbo-shaft, ramjet, scramjet, vectored thrust (incl. lifting engines)

Aircraft gas turbine engine vs. Industrial gas turbine engine (contrast) (1 L)

Thermodynamic, aerodynamic, & mechanical design considerations in aircraft gas turbine engine (3 L)

Aircraft propulsion mechanics, concepts, & performance measures (2 L)

 Thrust (F), Specific Thrust (F sp), Propulsive efficiency (pr), Overall efficiency (o), Thrust specific fuel consumption (sfc)

Gas turbine cycle (Joule) for Aircraft / Helicopter propulsion (2 L)

 open cycle single shaft & twin shaft arrangements, multi-spool arrangements

Thermodynamic analysis of ideal shaft power cycles (3 L)

 T-S diagram, cycle efficiency, specific work output (derivations)

Thermodynamic analysis of ideal reheat cycle (4 L)

 T-S diagram, optimum point of reheat, cycle efficiency & specific work output (derivations)

 thrust augmentation using afterburner & water injection in compressor inlet

Methods for accounting for component losses (with illustrations on T-S diagram) (4 L)

 compressor & turbine efficiencies [isentropic & polytropic (incl. indices for compression &

expansion)], intake & propelling nozzle efficiencies, mechanical losses

 fuel / air ratio, combustion efficiency (& relation with thermal efficiency)

Simple Turbo-Jet Engine (TJE) cycle (3 L)

 calculation of F, F sp , pr , sfc

 variation of F, F sp , pr , sfc, with flight conditions for given TJE

Analysis of flow thru' - compressor, turbine, combustion chamber, afterburner, nozzle (2 L)

Variable area nozzle, thrust spoiler & reverser, engine noise suppressor (2 L)

Bypass engines (6 L)

 Turbo-Fan Engine (TFE) configurations, thermodynamic design point performance prediction of TFE, turbo-prop engine & its propeller efficiency

 Optimization of TFE cycle for minimizing sfc & maximizing F sp , based on bypass ratio & fan

pressure ratio

Off-design performance prediction of aircraft gas turbine engines based on component characteristics (8 L)

 relations based on work, flow, rpm compatibilities between components

 single shaft engine delivering shaft power, free turbine engine (incl. - matching of two turbines in series, study of variation of power output & sfc with rpm of free turbine)

 jet engine (incl. - matching of gas-generator turbine with nozzle, study of variation of F with engine rpm, forward speed, altitude)

Textbooks:

1) H.I.H. Saravanamuttoo, G.F.C. Rogers, H. Cohen, P. Straznicky, Gas Turbine Theory (6 th edition), Prentice Hall / Pearson Education, Singapore, 2009.

2) P.G. Hill, C.R. Peterson, Mechanics and Thermodynamics of Propulsion (2 nd edition), Addison-

Wesley Co. Reading MA USA, 1992.

3) R.D. Flack, Fundamentals of Jet Propulsion with Applications, Cambridge Univ. Press, Cambridge, 2005.