COURSE CODE	COURSE TITLE	L	T	P	C
1152AE132	PROPELLER THEORY	3	0	0	3

Course Category:

Programme Elective

a. Preamble :

This course deals with various propeller theories and thrust production in Aircraft engines by means of propellers

b. Prerequisite Courses:

- Incompressible flow Aerodynamics
- Aircraft Gas Turbine Propulsion

c. Related Courses:

- Helicopter Aerodynamics

d. Course Educational Objectives :

- To gain knowledge on various propeller theories and propeller simulations
- To familiarize with thrust production using propellers

e. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand the concept of Airscrew theory and thrust production	K2
CO2	Understand the concept of axial momentum theory and to estimate the efficiency related to it.	K3
CO3	Understand the concept of blade element theory and to estimate the efficiency related to it.	K3
CO4	Analyze the vortex theory and the effect of various parameters on thrust	K3
CO5	Discuss the experimental and simulation techniques of propeller performance estimation	K3

f. Correlation of COs with POs :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	**H**	**H**	**H**				H	H			
CO2	H		**H**	**H**				H	H			
CO3	H		**H**	**H**				H	H			
CO4	H	**H**	**H**	**H**				H	H			
CO5	H	**H**	**H**	**H**				H	H			

H- High; M-Medium; L-Low

g. Course Content :

UNIT I AIR SCREW THEORY 8

Introduction – Non-Dimensional Coefficients – Air screw design – development of airscrew theory. The actuator- disc theory, working states of rotor, optimum rotor, Efficiency of rotor.

UNIT II THE AXIAL MOMENTUM THEORY 10

The rankine-Froude theory- The momentum Equation – Ideal efficiency of a propeller. The general momentum theory- General equations – constant circulation- approximate solution- minimum loss of energy- constant efficiency. Propeller efficiency- Energy equation – approximate solution- efficiency- numerical results.

UNIT III THE BLADE ELEMENT THEORY 9

Primitive Blade Element Theory- Efficiency of the blade element- Blade interface- The vortex system of a propeller- induced velocity- The airfoil characteristics- Multi plane Interference- cascade of airfoils – Airfoil characteristics in a cascade.

UNIT IV THE VORTEX THEORY 9

The propeller blades- Energy and Momentum- Propeller characteristics – The application of the Vortex theory- The effect of solidity and pitch – Approximate method of solution- Effective Aspect ratio of the blades. Propellers of highest efficiency- Minimum loss of energy- Lightly loaded Propellers- Effect of profile drag- The effect of number of blades- Application of Prandtl's Formula.

UNIT V EXPERIMENTAL AND SIMULATION APPROACH OF PROPELLERS 9

Experimental Methods- Wind tunnel interference- Thrust and Torque distribution-Scale effect- Compressibility Effect. Basics of propeller simulations- Domain selection- Grid independency study- Turbulence model investigation

Total : 45 Hrs

Learning Resources

i. Reference:

1. Durand, W.F., "Applied Aerodynamics- Volume IV", Stanford University, California, 1934.
2. Seddon, J., "Basic Helicopter Aerodynamics", BSP Professional Books, Oxford London, 1990.
3. Kerwin, Justin, "lecture Notes on Hydrofoils and Propellers", Cambridge, 2001.
4. "Modeling Propeller Flow-Fields Using CFD" – AIAA 2008-402.