INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

HELICOPTER AERODYNAMICS								
VII Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AAED51	**Elective**	3	0	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

This course provides a comprehensive study of the aerodynamics principles specific to helicopters. Students will explore the fundamental concepts underlying rotary-wing flight, including lift generation, rotor dynamics, and control mechanisms. The course aims to equip students with the theoretical knowledge and practical skills necessary to understand, analyze, and design helicopter systems.

II. COURSES OBJECTIVES:

The students will try to learn

I. Understand the elements of helicopter aerodynamics and ground effect machines, their components and methods of control.
II. Formulate the mathematical model using simple blade element theory, analyze its figure of merit and evaluate power estimations.
III. Evaluate performance and its effect on altitude and understand the preliminary stability aspects of helicopters.
IV. Apply the aerodynamics, propulsion and control concepts for various VTOL and STOL aircraft and ground effect machines.

III. COURSE OUTCOMES:

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

CO1 Demonstrate a comprehensive understanding of the fundamental principles of aerodynamics as they apply specifically to helicopters, including lift generation, drag forces, and rotor dynamics.
CO2 Evaluate the performance characteristics of different helicopter designs, considering factors such as maximum speed, payload capacity, and fuel efficiency.
CO3 Analyzing rotor dynamics, including the study of main rotor and tail rotor interactions, autorotation, and the impact of different rotor configurations on helicopter stability and control.
CO4 Develop the ability to predict and calculate aerodynamic loads on helicopter components under various flight conditions, considering factors such as forward flight, hover, and maneuvers.
CO5 Acquire knowledge and skills related to the design considerations in helicopter aerodynamics, encompassing aspects such as blade design, rotorcraft stability, and the impact of aerodynamic forces on the structural integrity of the helicopter.
CO6 Demonstrate the ability to apply theoretical knowledge to solve practical problems in helicopter aerodynamics, considering real-world challenges faced by engineers and designers in the field.

IV. COURSE CONTENT:

MODULE-I: ELEMENTS OF HELICOPTER AERODYNAMICS (10)
Configurations based on torque reaction, jet rotors and compound helicopters, methods of control, collective and cyclic pitch changes, lead and lag, flapping hinges.

MODULE-II: IDEAL ROTOR THEORY (10)
Hovering performance, momentum and simple blade element theories, figure of merit, profile and induced power estimation, constant chord and ideal twist rotors.

MODULE-III: POWER ESTIMATES (10)
Induced, profile and parasite power requirements in forward flight. Performance curves with effects of altitude, preliminary ideas on helicopter stability.

MODULE-IV: LIFT, PROPULSION AND CONTROL OF VSTOL AIRCRAFT (10)
Various configurations: propeller, rotor, ducted fan and jet lift, tilt wing and vectored thrust, performance of VTOL and STOL aircraft in hover, transition and forward motion.

MODULE-V: GROUND EFFECT MACHINES (08)
Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machine, drag of hovercraft on land and water, applications of hovercraft.

V. TEXT BOOKS:

1. Gessow A and Myers G.C, "Aerodynamics of Helicopter", Macmillan & Co,1st Edition 1987.
2. McCormick BW, "Aerodynamics of V/STOL Flight", Academic Press,1st Edition,1987.

VI. REFERENCE BOOKS:

1. Johnson W, "Helicopter Theory", Princeton University Press, 1st Edition, 1980.
2. McCormick B.W, "Aerodynamics, Aeronautics and Flight Mechanics" John Wiley, 1st Edition, 1995.
3. Gupta L, "Helicopter Engineering", Himalayan Books, 1st Edition,1996.

VII. ELECTRONICS RESOURCES:

1. https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/helicopter_flying_handbook/media/hfh_ch02.pdf
2. https://www.mionome.com/Uni/Helicopter%20Aerodynamic.pdf
3. https://itlims.meil.pw.edu.pl/zsis/pomoce/WTLK/ENG/Sup/Aerodynamics_of_a_Helicopter_Rotor_in_Forward_Flight.pdf

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation