Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, DEC 2020

SUB: HELICOPTER AERODYNAMICS [AAE 4102]

REVISED CREDIT SYSTEM
(26/12/2020)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A.	Write a short note on the helicopter swashplate mechanism.	**(2)**
1B.	With the help of neat diagrams explain the concept of helicopter rotor flapping, feathering, and teetering.	**(3)**
1C.	A helicopter rotor radius of 1.5 m produces a thrust of 9 kN while flying at 90 m/s, at sea level. Find the diameter of the flow field in the far wake of the disc, assuming that the perturbation to the flow due to the helicopter is negligible.	**(5)**
2A.	The rotor of a helicopter of mass 1100 kg, hovering at sea level rotates at 225 rpm. If the rotor radius is 6 m, determine the thrust coefficient.	**(2)**
2B.	What is the physical significance of Blade Element Theory (BET)? Also, derive the steps for the performance of ideally twisted constant chord blade	**(3)**
2C.	Calculate the power required for a helicopter rotor with four ideally twisted blades of diameter 12 m to hover at a height of 5 m above the ground, if the solidity is 0.060, lift curve slope is 5.73, the rotational speed is 25 rad/s, thrust coefficient is 0.0060 and the profile-drag coefficient given by $C_{do} = 0.0087 - 0.0216\alpha_r + 0.400\alpha_r^2$	**(5)**
3A.	A helicopter of rotor diameter 5.2 m descends at 4 m/s in free sea-level air. If the thrust generated by the rotor is 250 N, determine the drag coefficient.	**(2)**
3B.	Explain with suitable diagrams the types of helicopter rotor hub systems.	**(3)**
3C.	A helicopter rotor of radius 2 m rotating at 180 rpm has the blades at an angle of attack 4^0 and induced velocity 0.9 m/s. (a) If the forward speed of the rotor is 18 m/s, determine the thrust coefficient. (b) what will be the value of thrust coefficient, if the helicopter is hovering?	**(5)**
4A.	List all the advantages of turboshaft engine helicopters.	**(2)**
4B.	Derive an expression for momentum theory in hovering of the helicopter	**(3)**
4C.	A helicopter of mass 1100 kg and rotor radius 6 m steadily climbs at 2.3 m/s at sea level. If the rotor is rotating at 2100 rpm and the actual power measured in hover is 125 hp, determine the induced velocity and the power to be supplied to the rotor while climbing. Also, find the power rate.	**(5)**

5A. Determine the maximum thrust that can be produced by a helicopter rotor of diameter 12 m, run by a 150 hp engine of that hovers at sea level. Also, find the power loading and disc loading of the rotor. **(2)**

5B. Derive the expressions for parasitic power and climb power in helicopter forward flight. **(3)**

5C. The inflow factor of a helicopter flying at 22 m/s is 0.015. If the rotor of radius 7 m is rotating at 200 rpm has an induced velocity of 4 m/s, determine the angle between the flight direction and blade tip-path plane. . **(5)**