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17AE743

Seventh Semester B.E. Degree Examination, Feb./Mar.2022
Helicopter Dynamics

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Explain with neat diagram, momentum theory for hovering flight. (04 Marks)
- b. Define, Figure of Merit (FM) rotor solidity and blade loading coefficient. (06 Marks)
- c. A tilt rotor aircraft has a gross weight of 20,400 kg. The rotor diameter is 11.58 m. On the basis of momentum theory, estimate the power required for the aircraft to hover at sea level on a standard day, where the density of air is 1.225 kg/m³. Assume that the figure of merit (FM) of the rotor is 0.75 and transmission losses amounts to 5%. (10 Marks)

OR

- 2 a. Using blade element analysis, derive expression for one increment in Thrust coefficient and Rotor Torque coefficient. (08 Marks)
- b. Explain equilibrium about the flapping hinge and prove that coning angle,

$$\beta_0 = \frac{3 \int_0^R Ly dy}{M \Omega^2 R^2 (1 + e)} \quad (12 \text{ Marks})$$

Module-2

- 3 a. Describe in details with neat diagram, forward flight performance and prove that $T V_\infty \alpha_{TFP} = W V_c + D V_\infty$. (10 Marks)
- b. Explain with neat graph:
 - (i) Effect of density altitude. (10 Marks)
 - (ii) Effect of gross weight. (10 Marks)

OR

- 4 a. Explain with neat diagram, ground effect. (05 Marks)
- b. Explain with neat diagram, helicopter forward flight near ground. (05 Marks)
- c. Obtain expression for the speed for minimum power. (10 Marks)

Module-3

- 5 a. Explain with neat graph, rotor air foil requirements. (05 Marks)
- b. Explain with neat diagram, pitching moment. (05 Marks)
- c. Define critical pressure coefficient and prove that

$$C_{P^*} = \frac{2}{\gamma (M^*)^2} \left[\left((M^*)^2 \left(\frac{\gamma-1}{\gamma+1} \right) + \frac{2}{\gamma+1} \right)^{\frac{\gamma}{\gamma-1}} - 1 \right] \quad (10 \text{ Marks})$$

OR

- 6 a. What are the flow visualization techniques used to find rotor wake? (10 Marks)
- b. Explain the characteristics of Rotor wake in Forward flight. (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg. 42+8 = 50, will be treated as malpractice.

Module-4

- 7 a. Explain static and dynamic stability of Helicopter. (10 Marks)
b. Explain the following: (04 Marks)
 (i) Forward speed disturbances. (03 Marks)
 (ii) Side slip disturbance. (03 Marks)
 (iii) Yawing disturbance. (03 Marks)

OR

- 8 a. Explain flight test requirements in details. (10 Marks)
b. What is meant by Cooper Harper scale? (10 Marks)

Module-5

- 9 a. Explain in details, Military derivatives of Civil rotor craft. (10 Marks)
b. Explain rotor craft vibration and its reduction method. (10 Marks)

OR

- 10 Explain briefly, (05 Marks)
a. Design of main rotor diameter. (05 Marks)
b. Design of Tip speed. (10 Marks)
c. Design of fuselage. (10 Marks)
