

# CBCS SCHEME

15AE743

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## Seventh Semester B.E. Degree Examination, Dec.2019/Jan.2020 Helicopter Dynamics

Time: 3 hrs.

Max. Marks: 80

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

### Module-1

- Show that for a hovering rotor with blades that operate at constant lift and drag coefficient, the thrust on the rotor is proportional to the square of the tip speed, and power is proportional to the cube of the tip speed (05 Marks)
  - Define disk loading, power loading and figure of merit. (06 Marks)
  - A tilt rotor aircraft has a gross weight of 20,400kg. The rotor diameter is 11.58m. 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  $1.225\text{kg/m}^3$ . Assume that the figure of merit (FM) of the rotor is 0.75 and transmission losses amounts to 5%. (05 Marks)

OR

- Prove that for increment in thrust coefficient :

$$dC_T = \frac{1}{2} \left( \frac{N_b C}{\pi R} \right) C_{\ell} r^2 dr .$$

(03 Marks)

- Prove that for rotor torque coefficient increment.

$$dC_Q = \frac{1}{2} (\phi C_{\ell} + C_d) r^3 dr .$$

(03 Marks)

- Explain with neat diagrams types of rotor. (08 Marks)
- Define tip loss factor. (02 Marks)

### Module-2

- Briefly explain forces acting on helicopter during forward flight. (08 Marks)
  - Explain in detail swash plate and cyclic pitch controlling. (08 Marks)

OR

- Describe in details with neat figure forward flight performance and prove that :

$$W V_{\infty} \theta_{FP} + D V_{\infty} = W V_C + D V_{\infty} .$$

(08 Marks)

- Explain :
  - Effect of gross weight
  - Effect of altitude (Density).

(08 Marks)

### Module-3

- Explain with neat graph rotor air foil requirement. (08 Marks)
  - Define critical pressure coefficient and prove that :

$$C_p^* = \frac{2}{\gamma(M^*)^2} \left[ \left( (M^*)^2 \left( \frac{\gamma-1}{\gamma+1} \right) + \frac{2}{\gamma-1} \right)^{\frac{\gamma}{\gamma-1}} - 1 \right] .$$

(08 Marks)



OR

- 6 a. Explain in details flow visualization technique. (08 Marks)  
b. Discuss about characteristics of rotor wake in hover with neat diagram. (08 Marks)

Module-4

- 7 a. Define static and dynamic stability of helicopters. (08 Marks)  
b. Explain :  
i) Main rotor control  
ii) Tail rotor control. (08 Marks)

OR

- 8 Explain flight test requirements. (16 Marks)

Module-5

- 9 a. Explain rotor craft vibration in details. (08 Marks)  
b. Briefly explain structural strength design. (08 Marks)

OR

- 10 Briefly explain :  
a. Design of main rotor diameter (08 Marks)  
b. Design of Tip speed. (08 Marks)

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