

VTU B.E/B.TECH QUESTION PAPER SET

CBCS SEMESTER VII

HELICOPTER DYNAMICS

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15AE743

Seventh Semester B.E. Degree Examination, Dec.2018/Jan.2019
Helicopter Dynamics

Time: 3 hrs.

Max. Marks: 80

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

Module-1

- 1 a. Define rotor solidity, blade loading and figure of merit. (06 Marks)
 b. Derive momentum theory analysis during hovering flight. (10 Marks)

OR

- 2 a. Explain Blade flapping, lead-lag and coning of blades. (04 Marks)
 b. Derive blade element theory. (12 Marks)

Module-2

- 3 a. Explain with a neat sketch, the forces acting on a helicopter during forward flight. (06 Marks)
 b. Explain the working principle of cyclic pitch in a helicopter. (04 Marks)
 c. What is ground effect? What are the precautions to be taken during take-off and landing? (06 Marks)

OR

- 4 a. What is the effect of gross weight during forward flight? (08 Marks)
 b. Explain helicopter turn with and without coning. (08 Marks)

Module-3

- 5 a. What are the effects of Mach number and Reynold's number on rotor airfoil dynamics? (04 Marks)
 b. Explain with a neat sketch the spanwise pressure distribution over a twisted and untwisted blade. (08 Marks)
 c. Draw a sketch of the total wake during hovering and explain the phenomena. (04 Marks)

OR

- 6 a. What are the flow visualization techniques used to find rotor wakes? (08 Marks)
 b. What are the characteristics of rotor wake in forward flight? (08 Marks)

Module-4

- 7 a. What are the disturbances that affect the stability of helicopter? (10 Marks)
 b. Explain the main rotor and tail rotor control. (06 Marks)

OR

- 8 a. What are the levels of Handling Qualities? (08 Marks)
 b. Describe the Hover flight test and the limitations if any. (08 Marks)

Module-5

- 9 a. What are the differences between civil and military derivative of a helicopter? (06 Marks)
 b. What is the effect of blade twist? (04 Marks)
 c. Explain the various vibration of helicopter. (06 Marks)

OR

- 10 a. What are the empanages used in helicopter and explain their function? (08 Marks)
 b. What are the safety equipments required to be carried on board of helicopter and their function? (08 Marks)

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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.

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15AE743

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

- 1 a. 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)
- b. Define disk loading, power loading and figure of merit. (06 Marks)
- c. 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 1.225kg/m³. Assume that the figure of merit (FM) of the rotor is 0.75 and transmission losses amounts to 5%. (05 Marks)

OR

- 2 a. i) Prove that for increment in thrust coefficient :
- $$dC_T = \frac{1}{2} \left(\frac{N_b C}{\pi R} \right) C_l r^2 dr. \quad (03 \text{ Marks})$$
- ii) Prove that for rotor torque coefficient increment.
- $$dC_Q = \frac{1}{2} (\phi C_l + C_d) r^3 dr. \quad (03 \text{ Marks})$$
- b. Explain with neat diagrams types of rotor. (08 Marks)
- c. Define tip loss factor. (02 Marks)

Module-2

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

OR

- 4 a. Describe in details with neat figure forward flight performance and prove that :
- $$W V_\infty \theta_{FP} + D V_\infty = W V_C + D V_\infty. \quad (08 \text{ Marks})$$
- b. Explain :
- i) Effect of gross weight
- ii) Effect of altitude (Density). (08 Marks)

Module-3

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

$$C_p^* = \frac{2}{\gamma (M^*)^2} \left[\left((M^*)^2 \left(\frac{\gamma-1}{\gamma+1} \right) + \frac{2}{\gamma-1} \right)^{\frac{\gamma}{\gamma-1}} - 1 \right]. \quad (08 \text{ Marks})$$

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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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15AE743

Seventh Semester B.E. Degree Examination, Aug./Sept.2020
Helicopter Dynamics

Time: 3 hrs.

Max. Marks: 80

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

Module-1

- 1 a. Give a brief note on rotor blade design and rotor configuration. (10 Marks)
 b. Brief on following concepts:
 (i) Power loading
 (ii) Momentum theory of hovering flight
 (iii) Disc loading (06 Marks)

OR

- 2 a. Explain the major components of helicopter mentioning their applications over fixed wing aircraft and write its advantages. (10 Marks)
 b. With the help of neat diagram, briefly explain the function of tail rotor. (06 Marks)

Module-2

- 3 a. Mention forces acting on helicopter on forward flight and describe how translatory flight is achieved and its methods. (06 Marks)
 b. Derive an expression for a relationship between the induced velocity and in the plane of the rotor and the velocity on the vena contracta. (10 Marks)

OR

- 4 a. What are the factors affecting forward speed and ground effects? Explain. (04 Marks)
 b. Write short notes on:
 (i) Total power required in forward flight performance
 (ii) Speed for minimum power and maximum range
 (iii) Effects of gross weight on flight performance (12 Marks)

Module-3

- 5 a. Explain possible dynamic behavior of typical helicopter with the help of suitable graphs. (08 Marks)
 b. What are rotor airfoil requirements and how it affects Reynolds number and Mach number? (08 Marks)

OR

- 6 a. Describe flow visualization techniques used to measure rotor wakes and blade tip vortices. (12 Marks)
 b. Mention characteristics of rotor wake in hover and forward flight. (04 Marks)

Module-4

- 7 a. What do you mean by dynamic stability? Explain briefly general requirements of flight and ground handling qualities. (07 Marks)

- b. Elaborate on following:
- (i) Vertical speed disturbance
 - (ii) Side-slip disturbance
 - (iii) Yawing disturbance

(09 Marks)

OR

- 8 a. Describe the general maintenance requirement that must taken into account for an helicopter. (06 Marks)
- b. Mention and brief the factors that can affect the handling characteristics during take-off hover and landing for which flight test must be carried out. (10 Marks)

Module-5

- 9 a. Mention the advantages of rotorcraft on conventional aircraft and explain about general and operational requirement of civil rotorcraft. (10 Marks)
- b. Classify and explain rotorcraft vibration and its reduction methods. (06 Marks)

OR

- 10 Explain conceptual design of helicopters starting from aerofoil selection, blade twist, fuselage Empennage and tail rotors design. (16 Marks)
