

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER-VIII • EXAMINATION – SUMMER 2013

Subject Code: 180102**Date: 13-05-2013****Subject Name: Helicopter Engineering****Time: 10.30 am - 01.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1 (a)** A tandem rotor helicopter having a diameter of 12 m and weighing 25,000 kg is operating at a Figure of Merit of 0.7. Find out the power required to hover and also the wake velocity. Comment on the wake velocity obtained, whether it is high or low and what will be its effect. **07**
- (b)** Draw a very clear picture of the velocity profile in hover and forward flight for the following flight condition: **07**
 $V = 400\text{m/sec}$, $R = 12\text{m}$ and $\dot{\alpha} = 360\text{ rpm}$. Write point-wise, the characteristics of both these velocity profiles.

- Q.2 (a)** Explain the requirements of an airfoil to be used in a rotor. Describe the concept of boundary layer on an airfoil surface. **07**
- (b)** Describe blade element theory in forward flight with a neat sketch of the forces/velocities acting on the blade. **07**

OR

- (b)** Describe blade element theory in hover and axial flight with a neat sketch of the forces/velocities acting on the blade. **07**

- Q.3 (a)** Explain the importance of Radius, Twist and Taper in a helicopter rotor blade from the perspective of conceptual design. **07**
- (b)** Describe momentum theory in axial climb along with all its assumptions and a neat sketch **07**

OR

- Q.3 (a)** Describe the flow conditions around the rotor in axial flight, in detail and with neat sketches. **07**
- (b)** Describe momentum theory in axial descent along with all its assumptions and a neat sketch **07**

- Q.4 (a)** State True or False and Justify (Only True or False is not to be stated): **07**
1. Sikorsky S64A is a US make helicopter
 2. Low disc loading leads to better hover efficiency
 3. Chord of blade varies from 1.5 m to 3 m
 4. $1\text{ KNOT} = 0.6\text{ m/sec}$
 5. Root-cutout normally varies in the range of 0 to 15 percent
 6. Profile power losses are more at high speed
 7. Range of diameter in a helicopter main rotor varies from 20 m to 50 m

- (b)** Describe momentum theory in hover along with all its assumptions and limitations. Explain Bernoulli's theorem with equation. Draw neat sketches to support the theory. **07**

OR

- Q.4 (a)** State True or False and Justify (Only True or False is not to be stated): **07**
1. Combat helicopters have low disk loading
 2. It is not convenient to fly a helicopter at very high speeds because of engine limitations
 3. Ground effect leads to a requirement in power reduction
 4. High pitching moment is favorable for airfoils used in main rotors
 5. Power coefficient is higher than torque coefficient in a helicopter rotor
 6. Rotor disk loading is given by T/A
 7. Momentum theory over-estimates the required power
- Q.4 (b)** Describe momentum theory in forward flight along with all its assumptions and limitations. Explain Bernoulli's theorem with equation. Draw neat sketches to support the theory. **07**
- Q.5 (a)** Write a short note on (Draw neat sketches wherever relevant): **07**
1. Coping up with power failure
 2. Ground effect
- (b)** Explain different main rotor configurations and explain their advantages and disadvantages. Draw a schematic of all these main rotor configurations **07**
- OR**
- Q.5 (a)** Write a short note on (Draw neat sketches wherever relevant): **07**
1. Coriolis effect
 2. Explain Reverse flow region
- (b)** Sketch the degrees of freedom of a rotor blade. Explain and expand these degrees of freedom and show how they behave in steady state. Explain the meaning of steady state. Explain the physical significance of the terms occurring in the equation of steady state. **07**
