Code No: RR422107 **Set No.1**

IV B.Tech. II Semester Regular Examinations, April/May -2006
HELICOPTER AERODYNAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. What are the basic controls of helicopter? Describe, with the help of sketches, how the pilot uses these controls to acheive various desired flight conditions? [16]

2. (a) What do you mean by disk loading? What are the advantages and disadvantages of having rotor with low and high disk loading? [8]
   (b) A tilt-rotor aircraft has a gross weight of 27,000 kg. The rotor diameter is 11.5 m. On the basis of momentum theory, estimate the power required for the aircraft to hover at sea level. Assume that the figure of merit of the rotors in 0.75 and transmission losses amount to 5 percent. [8]

3. Derive the expressions for rotor thrust coefficient and rotor power coefficient in vertical flight using blade element theory. [16]

4. Explain with the help of sketches, how in various types of helicopter configurations the torque balance and yaw control is attained? [16]

5. (a) Distinguish between VTOL and STOL aricraft. [4]
   (b) Describe in detail the design considerations in selecting main rotor blade airfoil, tip speed and twist distribution. [12]

6. (a) What do you understand by 'ground effect machines and how do you classify it. [8]
   (b) Explain the term hover ceiling. How is it estimated for a hovercraft? [8]

7. Explain the following phenomena. How these phenomena can be taken care of?
   (a) Coriolis Effect
   (b) Gyroscopic precession
   (c) Dissymmetry of lift
   (d) Stalling. [4×4]

8. Write notes on any two of the following:
   (a) Longitudinal stability characteristics of helicopter
   (b) Autorotation
   (c) Working states of rotor. [8×2]

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Code No: RR422107 **Set No.2**

IV B.Tech. II Semester Regular Examinations, April/May -2006
HELICOPTER AERODYNAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain briefly, with the help of a sketch, the three fundamental rotor blade motions taking the rotor shaft as the reference axis. [5]
   (b) What is figure of merit and how disk loading affects figure of merit? [5]
   (c) A helicopter of 1000 kg has a rotor diameter of 10m. The rotor rotates at 250 rpm and is operating at sea level conditions. Find the disk loading, induced velocity and rotor thrust coefficient for hovering flight. [6]
2. (a) Identify various components of power required for operating a helicopter in forward flight. Show the typical curve of total power required with forward speed. [8]
   (b) Explain differences between momentum theory and blade element theory as applied to the lifting rotors. Also state their assumptions. [8]
3. Distinguish between the following:
   (a) Dual rotor configuration - Lateral and tandem arrangement
   (b) Articulated and Rigid Rotor system
   (c) Collective and cyclic pitch control. [6+6+4]
4. (a) What is the need of tail rotor? Explain the various types of tail rotors with the help of sketches [10]
   (b) Write a note on 'solidity'. [6]
5. (a) Differentiate between a helicopter and hovercraft. How will you estimate the drag of hovercraft on water? List the application of hovercraft. [10]
   (b) Write a note on 'tip speed' of a rotor blade. [6]
6. (a) Explain the working of various configurations of V/STOL aircraft with respect to control and lift production. [10]
   (b) Write short note on 'Coriolis Effect'. [6]
7. Describe the stability response of a helicopter to the following forms of disturbances
   (a) Incidence
   (b) Forward speed
   (c) Angular speed (pitch or roll rate)
   (d) Sideslip and yaw. [16]

8. Write notes on the following:
   (a) Performace curves with effect of altitude
   (b) Vortex ring state
   (c) Tilt wing rotorcraft
   (d) Compressibility effects. [4×4]

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Code No: RR422107 **Set No.3**

IV B.Tech. II Semester Regular Examinations, April/May -2006
HELICOPTER AERODYNAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Describe the different types of rotor systems with the help of sketches. Explain how pitch control is obtained in each type. [16]

2. Explain the components of power requirement with the help of a diagram between power requirement and forward speed. Also derive the expression for total power requirement for helicopter during forward flight. [16]

3. (a) A two bladed rotor helicopter weighing 1200 kg and rotating at 250 rpm is flying at sea level. Tip speed and lift coefficient of rotor are 160 m/s and 0.5 respectively.
   Calculating the following for hovering flight.
   i. Thrust coefficient
   ii. Solidity of main rotor
   iii. chord of the rotor blade. [6]
   (b) Explain the importance of tail rotor. How ring guard tail rotor system in different from conventional tail rotor? [10]

4. Write notes on the following:
   (a) Blade loading
   (b) Cryroscopic precession
   (c) Rotor efficiency
   (d) Blade stalling. [4×4]

5. (a) How the proximity of ground affects the performance of helicopter during hovering and forward flight? [8]
   (b) Explain autorotation with the help of Schrenk's diagram. [8]

6. (a) Explain the mechanism of control and lift production of V/STOL aircraft using following aids. [12]
   i. Propellers
   ii. Rotor ducted fan
   iii. Jet lift
   (b) Write a short note on 'thrust vectoring' of V/STOL aircraft. [4]

7. (a) Derive the following relationship for hovering flight using momentum theory V_i = induced velocity = $\sqrt{\frac{T}{2PA}}$. [6]

(b) What do you understand by compound helicopters? Explain the merits and demerits of different types of compound helicopters. [10]

8. How the following factors effect the performance of a helicopter.

(a) Airfoil section of blade

(b) Altitude

(c) Tip speed ratio

(d) Twist of blade. [4×4]

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Code No: RR422107 **Set No.4**

IV B.Tech. II Semester Regular Examinations, April/May -2006
HELICOPTER AERODYNAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Sketch and label a fully articulated rotor blade. [3]
   (b) Using momentum theory, derive an equation for induced power per unit thrust for a typical rotor system, in hovering flight. [9]
   (c) Differentiate between conventional and dual rotor (tandem configuration) helicopeter. [4]

2. (a) Explain cyclic pitch control system of a conventional helicopter with the help of a neat sketch. [8]
   (b) A three bladed rotor having single blade area and chord length of $3m^2$ and 0.52m respectively is hovering at sea level. The rotational speed and lift coefficient are 190 rpm and 0.5 respectively. Calculate
      i. Solidity ratio
      ii. Thrust coefficient
      iii. Power loading assuming momentum theory. [8]

3. (a) Explain various types of tail rotor systems with the help of sketches. [10]
   (b) Write a note on 'Disk loading'. [6]

4. (a) Explain, with the help of sketches and applicable curves, the ground effect in hovering as well as in forward flight. [10]
   (b) Explain with sketches, why a portion of the main rotor always remains stalled, while in flight. [6]

5. How will you estimate hovering,transition and forward flight performance of a typical V/STOL aircraft? [16]

6. Differentiate between a hovercraft and helicopter. How drag estimates of hovercraft on ground and water are different from that of helicopteer? [16]

7. (a) Explain 'Figure of merit' and derive the relationship for it. [8]
   (b) Explain the 'Figure of Eight' with the help of sketch and explain its importance. [8]

8. Write notes on any four of the following:
   (a) Vortex ring state
   (b) Relation betweem main rotor torque and tail rotor thrust.

(c) Longitudinal stability characteristics

(d) Ideal twist rotors

(e) Lift augmentation of hovercraft. [4×4]

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