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HLK201 HELICOPTER DESIGN

QUESTIONS SET 2

ROTORCRAFT PERFORMANCE AND CONTROL

Q1. (7 p) Why does a helicopter require **maximum power in hover?**

- a) Parasite drag is maximum
 - b) Translational lift is absent
 - c) Profile power is zero
 - d) Engine efficiency is lowest
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Q2. (8 p) In forward flight, which blade experiences **higher relative velocity?**

- a) Retreating blade
 - b) Advancing blade
 - c) Root section
 - d) Hub region
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Q3. (15 p) As altitude increases, a helicopter will first lose its ability to:

- a) Fly forward
 - b) Hover
 - c) Autorotate
 - d) Produce lift
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Q4. (8 p) Induced power in hover is: $P_i = T\vartheta_i$

If $T = 15\ 000\ N$ and $\vartheta_i = 6\ m/s$, what is P_i ?

- a) 45 kW
- b) 60 kW
- c) 90 kW
- d) 120 kW

Q5. (8 p)

Which aerodynamic theory treats the rotor as an **actuator disk**?

- a) Blade Element Theory
 - b) Momentum Theory
 - c) CFD
 - d) Lifting Line Theory
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Q6. (15 p)

Which quantity **cannot** be obtained from Momentum Theory alone?

- a) Induced velocity
 - b) Induced power
 - c) Thrust
 - d) Blade twist distribution
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Q7. (8 p)

Disk loading is defined as:

- a) Power per unit area
 - b) Thrust per unit area
 - c) Torque per unit radius
 - d) Lift per blade
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Q8. (8 p)

Which control input mitigates **overturning moment** in forward flight?

- a) Pedals
- b) Throttle
- c) Cyclic
- d) Collective

Q9. (15 p)

Which power component mainly depends on **rotor blade drag**?

- a) Induced power
 - b) Profile power
 - c) Parasite power
 - d) Excess power
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Q10. (8 p)

Why are rotor blades thicker near the root?

- a) To reduce induced power
 - b) To reduce tip Mach number
 - c) To carry higher structural loads
 - d) To reduce parasite drag
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Q11. (+20 p – Bonus Question)

At sea level, a helicopter has:

- Available power: $P_{ava,0} = 900 \text{ kW}$
- Required power: $P_{req,0} = 780 \text{ kW}$

At altitude, available power scales with density ratio:

$$P_{ava}(h) = P_{ava,0} \left(\frac{\rho}{\rho_0} \right)$$

Assume at that altitude the density ratio is:

$$\frac{\rho}{\rho_0} = 0.82$$

and required power increases by 6% due to performance degradation:

$$P_{req}(h) = 1.06 P_{req,0}$$

Excess power:

$$P_{exc} = P_{ava} - P_{req}$$

What is the new **excess power**?

- a) $P_{exc} \approx -6 \text{ kW}$
 - b) $P_{exc} \approx 0 \text{ kW}$
 - c) $P_{exc} \approx +32 \text{ kW}$
 - d) $P_{exc} \approx +96 \text{ kW}$
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