



**B.E DEGREE EXAMINATIONS: NOV/DEC 2024**

(Regulation 2018)

Sixth Semester

**AERONAUTICAL ENGINEERING**

U18AET6001: Flight Dynamics

**COURSE OUTCOMES**

- CO1:** Calculate atmospheric properties at various altitudes.  
**CO2:** Calculate the performance of an airplane for non-accelerating flight conditions.  
**CO3:** Solve accelerated performance equations to get Take-off and landing distances  
**CO4:** Estimate Longitudinal static stability and trim requirements for an aircraft  
**CO5:** Assess lateral and directional stability requirements for an aircraft

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 2 = 20 Marks)**

**(Answer not more than 40 words)**

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|--|-----|-------------------|
| 1. What causes induced drag?                             | CO1 | [K <sub>2</sub> ] |
| 2. Differentiate between streamlined body and bluff body | CO1 | [K <sub>2</sub> ] |
| 3. Define Range and Endurance                            | CO2 | [K <sub>2</sub> ] |
| 4. Define Hodograph                                      | CO2 | [K <sub>2</sub> ] |
| 5. Compare approach distance and flare distance          | CO3 | [K <sub>2</sub> ] |
| 6. Define Bank angle and load factor                     | CO3 | [K <sub>2</sub> ] |
| 7. Distinguish between static and dynamic stability      | CO4 | [K <sub>2</sub> ] |
| 8. Define neutral point and static margin                | CO4 | [K <sub>2</sub> ] |
| 9. Explain the phenomenon of rudder lock                 | CO5 | [K <sub>2</sub> ] |
| 10. What is meant by autorotation?                       | CO5 | [K <sub>2</sub> ] |

**Answer any FIVE Questions:-**

**PART B (5 x 4 = 20 Marks)**

**(Answer not more than 80 words)**

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|--|-----|-------------------|
| 11. An airplane has a wing loading of 2400 N/m <sup>2</sup> , and its drag equation is $C_D = 0.016 + 0.055 C_L^2$ . Calculate its maximum lift / drag ratio and the minimum drag speed. | CO1 | [K <sub>3</sub> ] |
| 12. The drag polar of an airplane is of the form $C_D = C_{D0} + KC_L^2$ . Show that the lift/drag ratio at  | CO1 | [K <sub>3</sub> ] |

minimum power is given by  $\sqrt{\frac{3}{16KC_{D_0}}}$  for steady level flight

13. A propeller driven airplane has a gross take-off weight of 4905 N with a wing area of 6.84 m<sup>2</sup>. Assume that the wings are operating at the maximum  $C_L^{3/2}/C_D$  of 13, the propeller efficiency is 0.9 and the specific fuel consumption of the engine is 0.76 kg/kW-hr. Given that the density of air at sea level is 1.225 kg/m<sup>3</sup> and the acceleration due to gravity is 9.81 m/s<sup>2</sup>, Find the weight of the fuel required for an endurance of 18 hours at sea level. CO2 [K<sub>3</sub>]
14. An aeroplane weighs 160 kN and has a wing area of 42 m<sup>2</sup>. At a flight speed of 100 m/s the engines give a thrust of 27 kN. If the aircraft drag equation is  $C_D = 0.014 + 0.05 C_L^2$ . Find the angle and rate of climb at 100 m/s flight speed. Assuming the angle of climb to be small. CO3 [K<sub>3</sub>]
15. A wing body model is tested in a subsonic wind tunnel. The lift is found to be zero at a geometric  $\alpha = -1.5^\circ$ . At  $\alpha = 5^\circ$ , the  $C_L$  is measured as 0.52. Also at  $\alpha = 1^\circ$  and  $7.88^\circ$ , the  $C_{M_{cg}}$  are measured as -0.01 and 0.05 respectively. The c.g is located at 0.35 C. calculate the location of Aerodynamic Center and the value of  $C_{M_{ac,wb}}$  CO4 [K<sub>3</sub>]
16. The design of an airplane is modified to increase the vertical tail area by 20% and decrease the moment arm from the aerodynamic centre of the vertical tail to the airplane centre of gravity by 20%. Assuming all other factors remains unchanged, find the ratio of the modified to the original directional static stability ( $C_{N\beta}$  due to tail fin)? CO5 [K<sub>3</sub>]

**Answer any FIVE Questions:-**  
**PART C (5 x 12 = 60 Marks)**  
**(Answer not more than 300 words)**

17. Explain Drag polar. Describe the various types of drag in an airplane and methods of minimizing the drag. 12 CO1 [K<sub>3</sub>]
18. a) Explain the forces and moments acting on the flight vehicle 6 CO1 [K<sub>3</sub>]  
 b) Compare Indicated Air Speed (IAS), Calibrated Air Speed (CAS), Equivalent Air Speed (EAS) and True Air Speed (TAS). 6 CO1 [K<sub>3</sub>]
19. a) Derive the Breguet Range equations for a jet propelled and propeller driven aircraft 6 CO2 [K<sub>3</sub>]  
 b) Show that the velocity corresponding to minimum power condition is 76% of the velocity corresponding to minimum thrust required condition in steady and level flight. 6 CO2 [K<sub>3</sub>]

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| 20. | a) | Estimate the total take-off distances for an aircraft and describe various methods to reduce the take-off and landing distances                    | 6 | CO3 | [K <sub>3</sub> ] |
|     | b) | Illustrate the V-n diagram and mention its significances   | 6 | CO3 | [K <sub>3</sub> ] |
| 21. | a) | Explain the various types of aerodynamic balancing of a control surface with neat sketches   | 6 | CO4 | [K <sub>4</sub> ] |
|     | b) | List the criteria for longitudinal static stability. Explain the contributions of fuselage and nacelles to $C_{m\dot{\alpha}}$ and $C_{m\alpha}$ . | 6 | CO4 | [K <sub>4</sub> ] |
| 22. | a) | Briefly explain the effect of dihedral on static lateral stability with a neat sketch  | 6 | CO5 | [K <sub>4</sub> ] |
|     | b) | Explain: Weather cocking effect and One engine inoperative condition   | 6 | CO5 | [K <sub>4</sub> ] |

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