Reg. No. | | | | | | | | | | |

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SECOND SEMESTER M.TECH. (AEROSPACE ENGG.)

END SEMESTER DEGREE EXAMINATION, APRIL/MAY - 2019

SUBJECT: FLIGHT MECHANICS [ICE 5202]

TIME: 3 HOURS MAX. MARKS: 50

Instructions to candidates :*Answer ALL questions and missing data may be suitably assumed.*

1A Define three aircraft axis systems with illustration of vectors which are conveniently expressed in each of these axis systems.

1B Illustrate the development of aircraft force equations highlighting response and applied force components.

1C With necessary diagrams and conventional notations express the components of forces acting on the aircraft flying in a curvilinear path. Hence arrive at conditions for the case of straight, level, unaccelerated flight.

(2+4+4)

2A Define lateral and directional static stability derivatives. How do they ensure stability?

2B Following data apply to a turbojet aircraft. $C_D = 0.02 + 0.057C_L^2$; Initial weight=6000lb; S=184ft^2; TSFC=c=1.25/h at sea level. Find the range for this jet at 30,000 ft if the pilot is flying for max range and has 1000lb of fuel available. At 30,000 ft ρ_∞ is 0.0008893 slugs/ft^3 and temperature ratio θ is 0.7938.

2C Explain various phases of take-off of an aircraft. Derive an expression for ground roll acceleration and ground roll distance.

(3+3+4)

3A Define maneuver point and neutral point in an aircraft. What is their significance in static stability analysis?

3B Express aircraft aerodynamic pitching moment. What are the contributing factors for pitching moment coefficient? How stabilizer incidence angle and elevator deflection affect C_m vs α graph.

3C Explain the contributing factors for and significance of following derivatives:

i) Mach tuck derivative C_{mu} ii) Roll damping derivatives C_{lp} iii) Cross derivative C_{np}

(2+3+5)

4A An aircraft has the following short period approximation:

$\frac{\alpha}{\delta_e} = \frac{-0.746s - 208.6}{675s^2 + 1361.6s + 5452.45}$. Find the natural frequency, damping ratio and the steady state value of AOA in response to a unit step input.

4B What are the factors contributing to i) Cross derivative C_{lr} ii) Yaw damping derivative C_{nr} . How do they contribute to lateral static stability?

4C Explain short period pitching mode and Dutch roll mode of dynamic performance of an aircraft.

4D Justify that instability in spiral mode is tolerable.

(2+3+4+1)

5A What is the necessity of outer loop autopilot/navigation control? Name four autopilot functions giving their significance briefly.

5B With block diagram, explain necessity and functioning of stability augmentation system.

5C What is a fly by wire system? Explain with the help of a simplified block diagram.

5D Discuss the significance of derivative of pitching moment coefficient with respect to angle of attack $C_{mT\alpha}$ and yawing moment coefficient with respect to sideslip angle $C_{nT\beta}$ in terms of static stability of an aircraft.

(2+3+3+2)

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