

FIRST SEMESTER M.TECH. (AEROSPACE ENGG.) END SEMESTER DEGREE EXAMINATIONS, FEBRUARY - 2021

AEROSPACE SYSTEM MODELING [ICE5171]

TIME: 3 HOURS

22-02-2021

MAX. MARKS: 50

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

- 1A Derive the hydrostatic equation and specify its significance.
- 1B What is Mach number? Classify aerodynamic flight regimes based on Mach number. Express dynamic pressure interms of Mach number.
- 1C Write mathematical model of the circuit shown in Figure Q 1C in the form of differential equation and state variable form. Derive the transfer function of the system relating $\frac{V_0(s)}{V_1(s)}$.



- 2A Distinguish laminar boundary layer and turbulent boundary layer.
- 2B What is skin friction drag and how is it developed? Comment on the effect of flow boundary layer on skin friction drag.
- 2C An aircraft is flying at a velocity of 50m/s at an altitude of 5 km on a standard day. At one point on the wing, the local velocity is 70m/s. Find the freestream dynamic pressure, the flowfield total pressure, and the local static pressure at the point where the velocity is 70 m/s.
- Standard atmosphere data for 5km altitude. Static pressure P=54019N/m², density 0.73612kg/m².
- 2D Explain the phenomenon of generation of lift over an airfoil.

(2+3+2+3)

(2+3+5)

- 3A Illustrate Pressure altitude and temperature altitude with an example.
- 3B Compare frequency domain modelling and time domain modelling of systems.
- 3C Derive the angular momentum equations of a missile. Hence, show how expression for rotational acceleration, angular velocity, Euler angle, Velocity in earth reference frame and altitude is obtained.

(2+3+5)

4A Classify guided missiles. Explain its applications.

1

- 4B What are the contributing factors of aerodynamic rolling moment in a missile? How do they affect rolling moment?
- 4C Given the translational equations of a missile. Highlight major contributing factors for translational force components on a missile in X, Y, and Z direction in body frame of reference. Define the coefficients using which they are defined. With necessary expressions specify the parameters affecting these coefficients.

$$\sum \Delta F_x = m(\dot{u} + wQ - vR),$$
$$\sum \Delta F_y = m(\dot{v} + uR - wP),$$
$$\sum \Delta F_z = m(\dot{w} + vP - uQ).$$

2+3+5

- 5A What is the function of tail rotor in a helicopter? Briefly explain the alternate methods used to achieve same functionality.
- 5B Express different forces and moments acting on a Quadrotor. How do they affect Quadrotor performance?
- 5C Derive expression for normalized rotor moment acting on a helicopter. How are they represented as actual moments?

2+3+5
