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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

FIFTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: SYSTEM MODELING AND SIMULATION [ICE 319]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitably assumed.

1A. Define transfer function? State whether transfer function modeling technique is applicable to non-linear system and whether the transfer function is independent of the input of a system. List the drawbacks in the conventional transfer function model. **4**

1B. A common example of a two-input control system is a home shower with separate valves for hot and cold water. The objective is to obtain (1) a desired temperature of the shower water and (2) a desired flow of water. Sketch a block diagram of the closed-loop control system. **3**

1C. Obtain the transfer function $X_2(s)/U(s)$ for the mechanical system shown in figure Q1C. **3**

2A. Derive transfer function model of armature controlled DC motor. **5**

2B. For a series RLC circuit, derive the differential equation of charge q. Determine the transfer function which relates source voltage and capacitor voltage. **3**

2C. What are analogous systems? Write the analogous electrical elements in torque – voltage analogy for the elements of mechanical rotational system (*viz*. torque, T; angular velocity, ω; angular displacement, θ; frictional coefficient, B; moment of inertia, J; and stiffness of spring, K). **2**

3A. Consider the liquid-level system shown in figure Q3A. In the system, $\bar{Q}_1$and $\bar{Q}_2$ are steady-state inflow rates and $\bar{H}_1$ and $\bar{H}_2$ are steady-state heads. The quantities q_{i1}, q_{i2}, h_1, h_2, q_1, and q_o are considered small. Obtain a state-space representation for the system when h_1 and h_2 are the outputs and q_{i1} and q_{i2} are the inputs. **5**

3B. A gear train consisting of two gears is used to drive a load. Primary gear consists of 20 teeth and secondary has 10 teeth. For the mentioned gear train system, compute the following: **3**

(a) The ratio of the diameters of the gear?

(b) If the angular speed of 1^0 primary gear is 30 rad/sec then what is the value of angular speed of 2^0 gear?

(c) If the angular speed of 1^0 primary gear is 5 N-m then find the torque on 2^0 gear?

3C. Define pneumatic resistance and pneumatic capacitance. **2**

4A. Derive transmissibility equation for motion excitation and calculate the magnitude of force transmitted to the foundation by a rotating machine with mass, M = 15kg, b = 450 N-s/m, K = 6000 N/m, unbalanced mass, m = 0.005kg, distance of unbalanced mass from center of rotation, r = 0.2m and ω = 16 rad/sec. **5**

4B. Consider the mechanical system shown in figure 4. If m = 10kg, b = 30 N-s/m, k = 500 N/m, P = 10N and $\omega = 2$ rad/s, what is the steady state output x(t)? The displacement x is measured from the equilibrium position before the input p(t) is applied. **5**

5A. With a schematic diagram, derive the equations of motion governing a level and steady flight. **5**

5B. Obtain the state space model for the single axis space craft as shown in figure Q5B, flying near-earth or an interplanetary trajectory. Moments acting on the spacecraft are control moment $M_C(t)$ and disturbance moment $M_D(t)$. **3**

5C. What are the different control surfaces of an aircraft? Define angle of attack. **2**

6A. Consider the inverted – pendulum system shown in figure Q6A. Assume that the mass of the inverted pendulum is m. The center of gravity of the pendulum is located at the center of the rod. Assuming that θ is small, derive the differential equation describing the whole system. **5**

6B. Write about the physical setup of a ball and beam system. Considering both rotational and translational motion of the ball, derive the differential equation governing the system. **5**

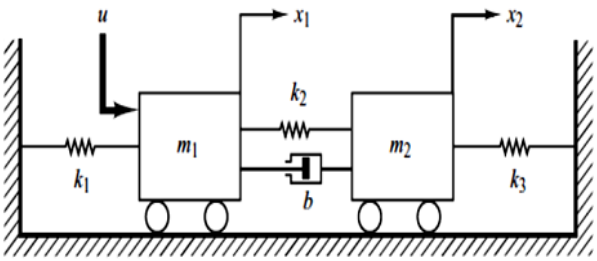

FIG: Q1C

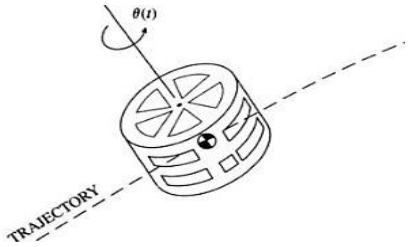

FIG: Q5B

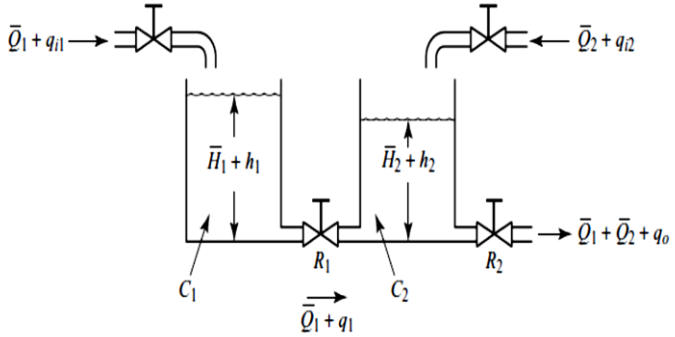

FIG: Q3A

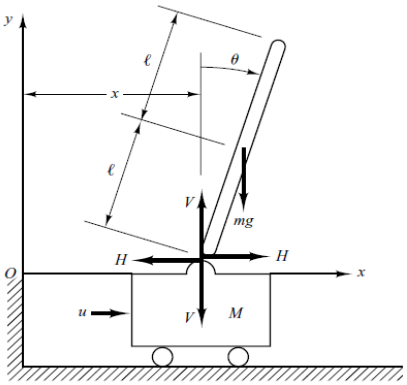

FIG: Q6A