Paper / Subject Code: 35001 / System Modeling & Analysis.

ME mech | sem II | CBCS | FH 2019 23|05|2019

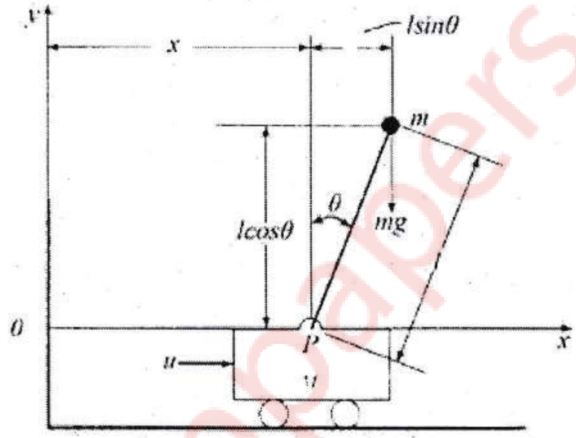
(3 HOURS) **TOTAL MARKS : 80**

N.B. : (1) Attempt any **four** questions.
(2) Assumptions made should be **clearly** stated.
(3) Use log/semi – log paper is permited.

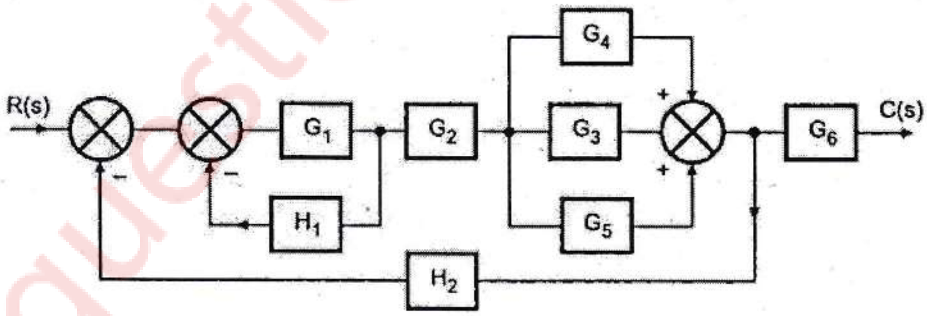
Q.1) (a) Find the range of k for stability of a unity feedback system. Also find k_{mar} and ω_{mar} (10)

$$G(s) = \frac{k}{s(s+2)(s+4)(s+6)}$$

(b) An inverted pendulum mounted on a motor-driven cart is shown in figure. Assume that the input to the system is the control force $\boldsymbol{u}$ applied to the cart and the two outputs are the angle Θ of the rod from the vertical axis and the position x of the cart. Obtain a state-space representation of the system. (10)



Q.2) (a) Simplify the block diagram shown in Figure below and obtain the closed-loop transfer function C(s)/R(s). (10)



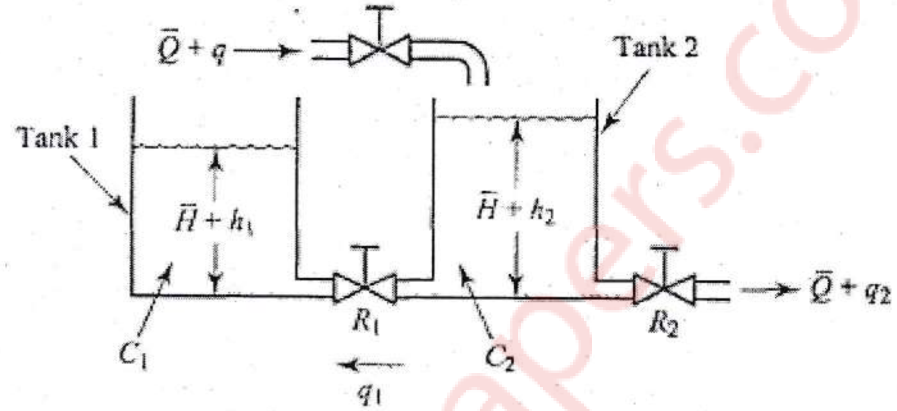
(b) Sketch the Nyquist plot of unity feedback system with (10)

$$G(s) = \frac{k(1+s)}{s(s+0.2s)(s+0.5s)}$$

Q.3) (a) (i) Write a note on Lyapunov stability theory and explain any nonlinear modeling technique considering structural and/or material nonlinearity (05)

(ii) Distinguish between Transfer function and state space representation (05)

(b) Consider the liquid-level system shown in Figure below. At steady state, the inflow rate and outflow rate are both $\bar{Q}$ and the flow rate between the tanks is zero. The heads of tanks 1 and 2 are both $\bar{H}$. At t = 0, the inflow rate is changed from $\bar{Q}$ to $\bar{Q}+q$, where q is a small change in the inflow rate. The resulting changes in the heads (h_1 and h_2) and flow rates (q_1 and q_2) are assumed to be small. The capacitances of tanks 1 and 2 are C_1 and C_2 respectively. The resistance of the valve between the tanks is R_1 and that of the outflow valve is R_2. Derive mathematical models for the system when (a) q is the input and h_2 the output, (b) q is the input and q_2 the output, and (c) q is the input and h_1 the output. (10)



Q.4) (a) Find state - space representation of the transfer function shown below. (10)

$$T(s)=\frac{s^2+3s+8}{(s+1)(s^2+5s+5)}.$$

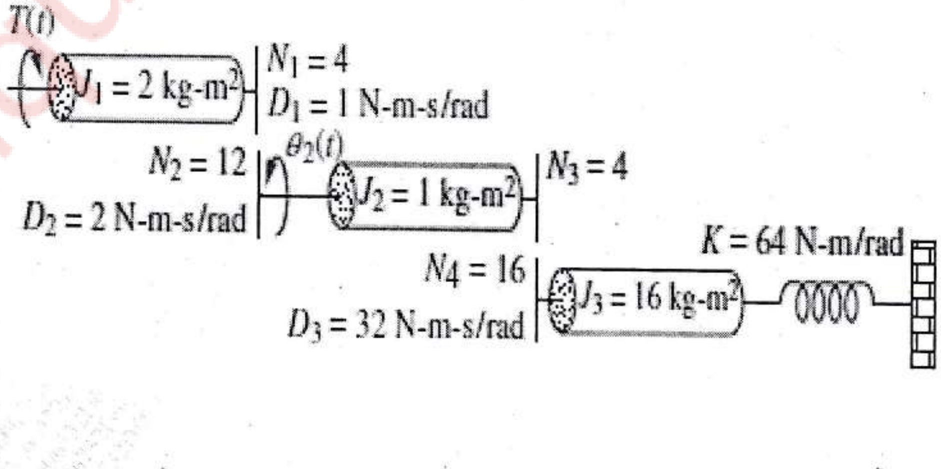
(b) Draw the complete root locus for the system (10)

$$G(s)H(s)=\frac{k}{s(s+3)(s^2+3s+4.5)}.$$

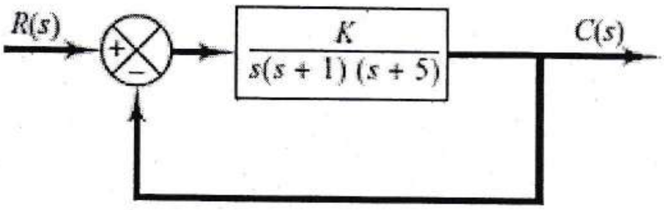
Deremine the value of k for marginal stability

Q.5) (a) Derive the step response of a second order system for the underdamped case. (10)

(b) For the rotational system shown in figure, find the transfer function, $G(s)=\frac{\theta_2(S)}{T(S)}$ (10)



Q.6) (a) Obtain the phase and gain margins of the system shown in figure below for the two cases where K=10 and K=100. (10)



(b) For the system shown in figure below, determine the values of gain K and velocity - feedback constant K_h so that the maximum overshoot in the unit-step response is 0.2 and the peak time is 1 sec. With these values of K and K_h, obtain the rise time and settling time. Assume that J = 1 kg m^2 and B = 1 N-m/rad/sec. (10)