

B.Tech II Year I Semester (R15) Regular Examinations November/December 2016

CONTROL SYSTEMS ENGINEERING

(Electrical and Electronics Engineering)

Time: 3 hours

Max. Marks: 70

PART – A

(Compulsory Question)

- 1 Answer the following: (10 X 02 = 20 Marks)
- Write the analogous electrical elements in force-current analogy for Mass (M), Friction (B), spring constant (K) and displacement(x).
 - What is synchro?
 - Mention any four time domain specifications.
 - What is the difference between type and order of a system?
 - State the necessary and sufficient conditions of Routh-Hurwitz criterion for stability.
 - What is the effect of addition of zero to the system?
 - Define 'resonant frequency'.
 - Write the transfer function of lag/lead compensator?
 - Define 'state' and 'state variables'.
 - Define 'controllability'.

PART – B

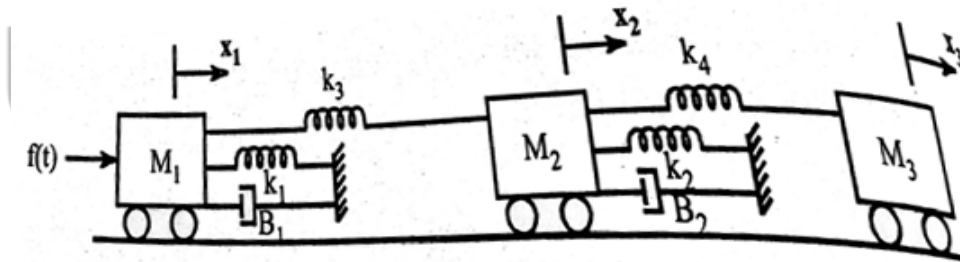
(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

- 2 (a) What are the effects of feedback on system performance? Explain.
 (b) Derive the transfer function of A.C servo motor.

OR

- 3 A mechanical translational system is shown in figure below. Write the analogous electrical equations based on force-voltage analogy and draw the corresponding electrical network.

**UNIT – II**

- 4 (a) What is the location of poles for different types of damped systems?
 (b) An experiment conducted on a servo mechanism shows the error response to be:

$$e(t) = 1.4 e^{-4t} \sin(2.86t + 43^\circ)$$

Where the input is a sudden unit displacement. Determine the natural frequency, damping ratio and damped angular frequency of the system.

OR

- 5 The open loop transfer function of a unity feedback control system is $G(s) = \frac{K}{s(1+sT)}$. When unit step input is given to system, the maximum value 1.26 is obtained at time 4sec. Find damping ratio, undamped natural frequency, K and T.

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UNIT – III

- 6 For the unity feedback system whose open loop transfer function is: $G(s) = \frac{K}{s(s+1)(s+2)(s+5)}$
- Find the range of 'K' for stability.
 - Find the value of 'K' for marginal stability.
 - Find the actual location of the closed loop poles when the system is marginally stable by using Routh-Hurwitz criterion.

OR

- 7 Sketch the Root locus of a feedback system whose open loop transfer function is given by:

$$G(s)H(s) = \frac{K}{s(s+3)(s+5)}$$

UNIT – IV

- Derive the expression for resonant peak in the frequency response of a second-order system.
- Sketch the polar plot of $G(s) = \frac{10}{s(s+1)}$.

OR

- 9 The open loop transfer function of a unity feedback system is:

$$G(s) = \frac{K}{s(1+0.02s)(1+0.04s)}$$

Draw the Bode plot & find the gain margin and phase margin. Also find the value of open loop gain so that the system has a phase margin of 45° .

UNIT – V

- State and prove the properties of state transition matrix.
- Test whether the following system is completely state controllable and observable or not.

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -3 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U$$

$$Y = [0 \quad 1 \quad -1] X$$

OR

- 11 Obtain the state variable representation of an armature-controlled D.C motor.

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