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Reg. No. : ....

Name : ....

Sixth Semester B.Tech. Degree Examination, June 2015
(2008 Scheme)
08.603 : CONTROL SYSTEMS (T)

Time : 3 Hours Max. Marks : 100

PART – A

Answer **all** questions : **(10×4 = 40 Marks)**

1. Given that the mechanical system is described by the equation,

   $M\frac{d^2x}{dt^2} + B\frac{dx}{dt} + Kx = F(t)$. Write down the differential equation that describe the analogous electrical system based on force-voltage analogy.

2. Find the value of damping ratio and natural frequency for the system whose transfer function is $\frac{C(s)}{R(s)} = \frac{10}{s^2 + 4s + 10}$.

3. Give the steady state error of a Type 1 system for a parabolic input.

4. Write down the state space representation of the system whose transfer function is as in Q-2.

5. How do you assess the stability of a system from Bode plots ?

6. If there are two sign changes in the first column of Routh array how many roots are there in the right half s-plane ?

7. List the frequency domain specifications.

8. Sketch the frequency response characteristics of a lead-lag controller.

9. What are the advantages of pole placement design ?

10. Check whether the following system is controllable or not.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

PART – B

Answer **any two** questions from **each** Module.

Module – 1

11. Write down the differential equations that govern the mechanical system shown in Fig. Q.–11 (a) and deduce the transfer function $X_1(s)/F(s)$. Also obtain the electrical network based on force-voltage analogy for this system. 10

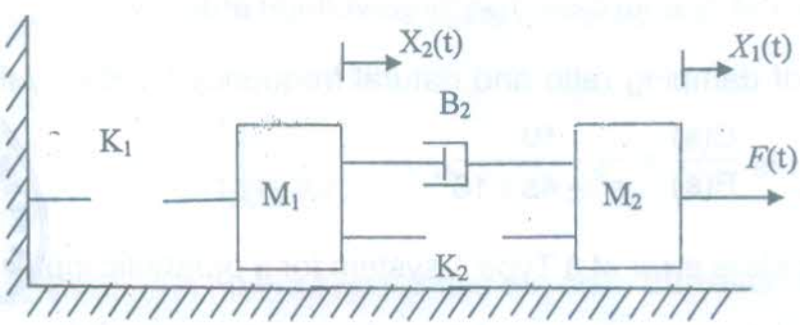

Fig. Q.–11 (a)

12. A feedback system is characterized by the closed loop transfer function,

$$\frac{Y(s)}{U(s)} = \frac{s^2 + 3s + 3}{s^3 + 6s^2 + 11s + 6}.$$

Construct the state model of the system in (a) companion form and in (b) Jordan canonical form. (5+5)

13. a) It is desired that a second order system should have a maximum overshoot of 20% and the settling time must not exceed 2 sec. Determine the values of damping ratio and the natural frequency. 5

b) A unity feedback system has its forward path transfer function,

$$G(s) = \frac{10}{s(0.5s+1)(0.2s+1)}.$$

Determine the steady state error or this system for unit step and unit ramp inputs. 5

Module – 2

14. a) State and explain any four rules that are used in construction of root locus diagram. 4

b) The open loop transfer function of a unity feedback system is,

$$G(s) = \frac{K}{(s+2)(s+4)(s^2+6s+25)}.$$

Discuss the stability of the closed loop system with the help of Routh criterion as a function of K. 6

15. The open loop transfer function of a unity feedback system is given by

$$G(s) = \frac{10}{s(1+s)(1+2s)(1+3s)}.$$

Sketch the polar plot of this system. Also obtain gain margin and phase margin. 10

16. The open loop transfer function of a unity feedback system is given by

$$G(s) = \frac{5(1+2s)}{s(1+4s)(1+0.25s)}.$$

Sketch the Bode plot of this system and therefrom obtain the gain margin and phase margin of the system. 10

Module – 3

17. Design a lead compensator for a unity feedback system with open loop transfer function $G(s) = \frac{K}{s(s+1)(s+5)}$ to satisfy the specifications :

    i) $K_v \geq 50$ and

    ii) Phase margin $\geq 20°$. **10**

18. Consider the discrete time unity feedback control system (with sampling period of T = 1 sec) whose open loop transfer function is given by

$$G(z) = \frac{K(0.3679z + 0.2642)}{(z - 0.3679)(z - 1)}.$$

Applying Jury's test determine the range of gain K for stability. **10**

19. A discrete time state equation of a system is given as,

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -0.24 & -1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

Solve using z-transform method and obtain the state transition matrix $\psi(k)$. **10**
