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12MAR22

Second Semester M.Tech. Degree Examination, June/July 2013
Modern Control Engineering

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Obtain the transfer function of armature controlled d.c. motor. **(10 Marks)**

b. Determine the transfer function $E_o(s)/E_i(s)$ for the electrical circuit shown in Fig.Q.1(b). **(10 Marks)**

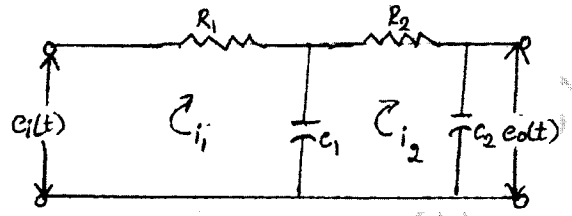

Fig.Q.1(b)

2 Draw the root-locus of a feed back system whose open-loop transfer is given by $GH = \frac{K}{s^4 + 5s^3 + 8s^2 + 6s}$ **(20 Marks)**

3 Sketch the bode plot for a unity feedback system characterized by the open-loop transfer function

$$G(S) = \frac{K(1+0.2s)(1+0.025s)}{s^3(1+0.001s)(1+0.005s)}.$$ **(20 Marks)**

4 a. Sketch the polar plot for a system with

$$G(S)H(S) = \frac{10}{s(s+1)(s+2)}$$

Calculate its gain margin in dB. Hence comment on its stability. **(12 Marks)**

b. Explain M and N circles. How they are useful in determining the stability of the system. **(08 Marks)**

5 Construct the complete Nyquist plot for a unity feed back control system whose open loop transfer function is $G(S)H(S) = \frac{K}{s(s^2 + 2s + 2)}$. Find maximum value of K for which the system is stable. **(20 Marks)**

6 a. The system equation for rocket flight is defined by the equation $\ddot{x} = F\cos\theta$, $\ddot{y} = F\sin\theta - g$, where x and y are horizontal and vertical axes, F is the thrust force per unit mass and θ is the thrust direction and g is gravitational force. Represent the dynamics of the system in state space form. **(10 Marks)**

b. Find the controllability and observability of the system using Kalman test.

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -6 & 2 & -4 \\ -18 & 3 & -8 \\ -6 & 1 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 3 \\ 1 \end{bmatrix} u(t) \qquad y = \begin{bmatrix} 1 & -1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}.$$ **(10 Marks)**

7 a. For the signal flow graph shown in Fig.Q.7(a):

i) Find C/R using Mason's gain formula.

ii) If $G_1 = 10$, $G_2 = 5$, $G_3 = 8$, $H_1 = 1$, $H_2 = 0.25$, $H_3 = 0.2$ and $R = 10.1$. Find the input to the block G_2. **(10 Marks)**

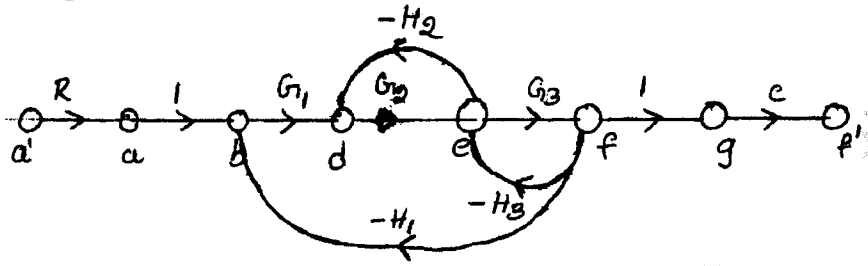

Fig.Q.7(a)

b. The Z transform for a digital control system is

$$C(Z) = Z\frac{z-0.7}{(z^2+0.6z+0.25)(z+0.5)}$$

Determine the inverse Z transform. **(10 Marks)**

8 a. Obtain the discrete time state-space representation for the differential equation $\ddot{c}+3\dot{c}+2c=f(t)$. Evaluate the resulting discrete time representation for a sampling period T = 0.2s. **(10 Marks)**

b. The transfer function for a plant is (S + 2)/[S(S + 1)]. Determine the characteristics of a digital controller such that response of the system to a unit step function will be $c(t) = 5\,(1 - e^{-2t})$. The sampling period is T = 1.0s. **(10 Marks)**

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