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EE43

Fourth Semester B.E. Degree Examination, Dec. 07 / Jan. 08
Control Systems

Time: 3 hrs. Max. Marks:100

Note : ***1. Answer any FIVE full questions.***
2. Missing data, if any, may be suitably assumed.

1 a. Explain with examples open loop and closed loop control systems. List the merits and demerits of open loop and closed loop control systems. **(10 Marks)**

b. For the mechanical system shown in fig.1(b)
i) Draw the mechanical network ii) Write the differential equations describing the system iii) Draw the F-V analogous electrical circuit after writing the corresponding electrical equations. **(10 Marks)**

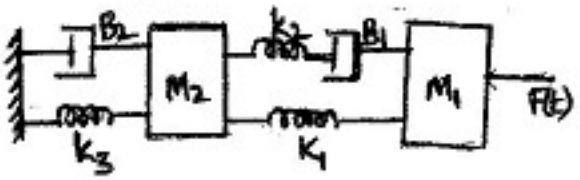

Fig.1(b)

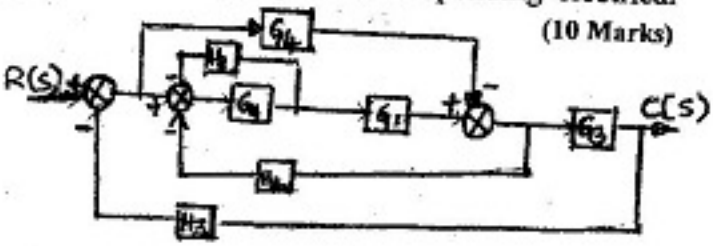

Fig.2(a)

2 a. For the system shown in fig.2(a), determine $C(s)/R(s)$ by block diagram reduction technique. **(10 Marks)**

b. For the signal flow graph shown in the fig.2(b), obtain transfer function Y_7/Y_1 and Y_7/Y_2. **(10 Marks)**

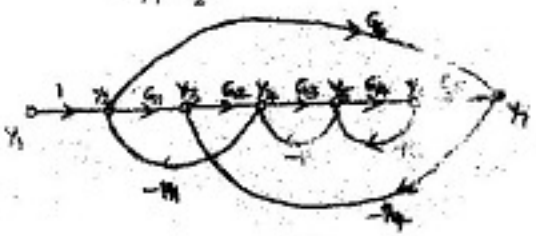

Fig.2(b)

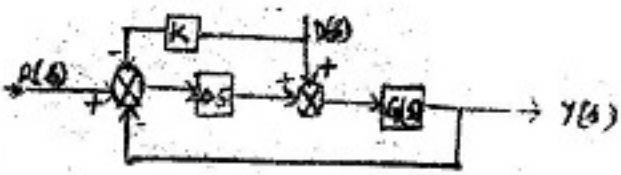

Fig.3(a)

3 a. The relation of the response Y(s) to the excitation R(s) in the presence of the undesired disturbance D(s) is represented by the fig.3(a). Determine K such that, with $R(s) = 0$, the output $Y(s) = 0$ for any disturbance D(s). **(06 Marks)**

b. It is desired that a control system with unity feed back, and forward path transfer function $G(s) = \dfrac{(s+\alpha)}{s^3 + (1+\alpha)s^2 + (\alpha-1)s + 1 - \alpha}$ be stable and the steady state error for a unit step input be less than or equal to 0.05. Determine the range of α that meets both requirements. **(06 Marks)**

c. Define the term transfer function. The unit step response of single loop, UFBCS is given by $C(t) = 1 - 1.25e^{-2t} + 0.25e^{-10t}$. Determine its closed loop and open loop transfer function. **(08 Marks)**

4 a. What are static error coefficients? Derive expressions for the same. **(06 Marks)**

b. Explain the following time domain specifications of a second order system:
i) Maximum overshoot ii) Peak time iii) Delay time iv) Rise time v) Settling time. **(06 Marks)**

c. For a servomechanism system with $G(s) = \dfrac{K_1}{s^2}$ and $H(s) = 1 + K_2 s$, determine the value of K_1 and K_2 so that the peak overshoot to a unit step response is 0.25 and peak time is 2 seconds. **(08 Marks)**

5 a. Show that the root loci for UFBCS, $G(s)=\frac{K(s+2)(s+3)}{s(s+1)}$ is a circle. **(06 Marks)**

b. Draw the root locus diagram for the loop transfer function $G(s)H(s)=\frac{K}{s(s^2+8s+17)}$. From the root locus evaluate the value of 'K' for a system damping ratio of 0.5. **(14 Marks)**

6 a. The polynomial $F(s)=s^4+2s^3+3s^2+s+1$ has all its roots in left hand side of a 's' plane. Use R-H criterion to determine the number of roots of F(s) lying between s = -0.5 and s = -1. **(10 Marks)**

b. State Routh-Hurwitz stability criterion. The system shown in fig.6(b) oscillates at a frequency of 2 radians/sec. Using R-H criterion determine the values of 'K' and 'a'. **(10 Marks)**

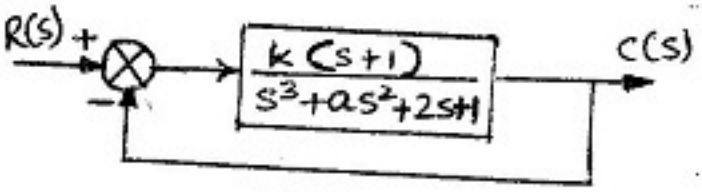

Fig.6(b)

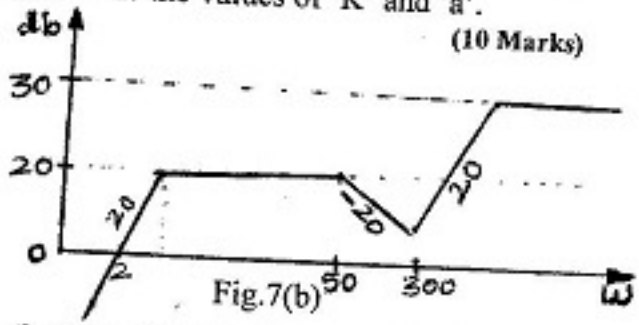

Fig.7(b)

a. The open loop transfer function of a unity feed back control system is given by $G(s)=\frac{K}{s(1+0.02s)(1+0.05s)}$. Draw the asymptotic Bode plots and hence find the value of 'K' for which the gain margin is 10 dB. What is the corresponding phase margin? **(12 Marks)**

b. Estimate the transfer function from the Bode plot shown in fig.7(b). Digits on line indicate slope in dB/dec. **(08 Marks)**

a. For a feedback system with $G(s)=\frac{120}{s(s+1)(s+5)}$, $H(s)=\frac{s}{6}$, determine peak resonance and resonance frequency. Derive the expressions used. **(10 Marks)**

b. Fig.8(b)(i) and Fig.8(b)(ii) represent Nyquist plots drawn for $\omega = 0$ to $\omega = \infty$ for two different G(s)H(s). Neither of these have poles on RH plane. For each case i) Complete the plot for 'ω' values on negative imaginary axis and $\omega = 0_+$ to $\omega = 0_-$. ii) Indicate the type of G(s)H(s) iii) Is the system stable? If not determine the number of zeros 1 + G(s)H(s) on RH of 's' plane. **(10 Marks)**

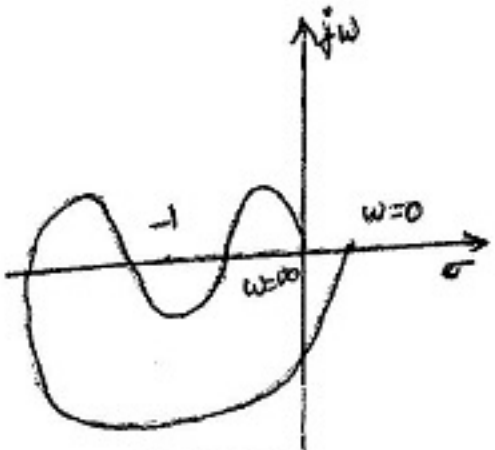

Fig.8(b)(i)

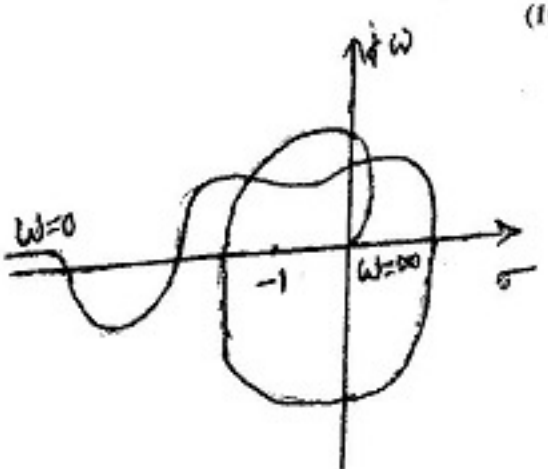

Fig.8(b)(ii)

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