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EE43

Fourth Semester B.E. Degree Examination, June / July 08
Control Systems

Time: 3 hrs. Max. Marks:100

Note : *Answer any FIVE full questions.*

1 a. Explain the effect of feedback on the following system performance characteristics: i) Sensitivity ii) External disturbance. **(10 Marks)**

b. Determine the transfer function of the electrical network shown in fig.Q1(b). Assume zero initial conditions. **(10 Marks)**

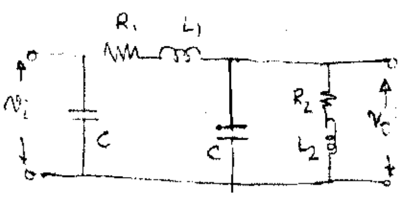

Fig.1(b)

2 a. What are the analogous systems? What are the advantages of studying non – electrical systems interms of their electric analogs? **(05 Marks)**

b. Draw the f – V analogous mechanical systems for the electrical circuit of fig.Q2(b). **(10 Marks)**

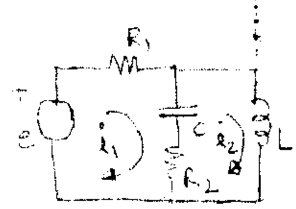

Fig.2(b)

c. Draw a block diagram for the circuit shown in fig. Q2(c), where V_s and i_L are the input and output variables respectively. **(05 Marks)**

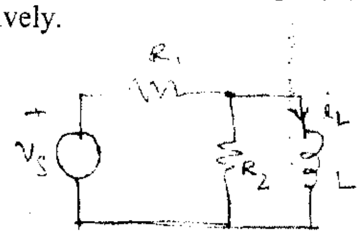

Fig.2(c)

3 a. For the unity feedback control system shown in fig.Q3(a), starting from the fundamentals derive an expression for the error signal e(t). Assume that the system is under damped ($0 < \xi < 1$) and the input is a unit step signal. **(10 Marks)**

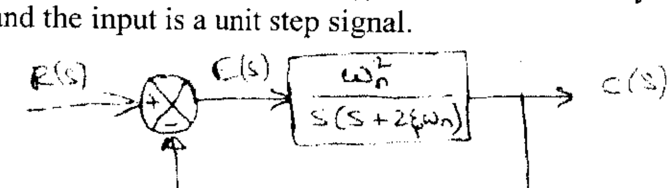

Fig.3(a)

b. A feedback control system is described by the forward path and feedback path transfer functions, $G(s) = \frac{16}{s^2 + 4s + 16}$ and H(s) = Ks respectively. It has a damping ratio of 0.8. Determine the overshoot of the system and the value of K for a unit step input. **(06 Marks)**

c. Explain why many control systems are designed with higher gain (and hence lower damping). **(04 Marks)**

4 a. A unity feedback control system has the forward path transfer function $G(s)=\dfrac{K(2s+1)}{s(4s+1)(s+1)^2}$.

The input r(t) = 1+5t is applied to the system. It is desired that the steady state value of the error should be equal to or less than 0.1 for the given input function. Determine the minimum value of K to satisfy the requirement. **(08 Marks)**

b. Define asymptotic stability. Prove that for BIBO stability, the roots of the characteristic equation must all lie in the left – half of s-plane. **(12 Marks)**

5 a. The open loop transfer function of a unity feedback system is given by $G(s)=\dfrac{K}{s(s+3)(s^2+s+1)}$. Determine the value of K that will cause sustained oscillations in the closed loop system. Also find the frequency of sustained oscillations. **(08 Marks)**

b. The closed-loop transfer function of the system shown in fig.Q5(b) is given by

$$M(s)=\frac{Y(s)}{R(s)}=\frac{b_m s^m + b_{m-1} s^{m-1} + \ldots + b_1 s + b_0}{s^n + a_{n-1} s^{n-1} + \ldots + a_1 s + a_0}$$ where n > m. Assuming H(o) = KH

(a constant), derive a general expression for the steady state error in terms of the closed – loop transfer function. There from obtain error equation for a step input R(s) = R/s. **(12 Marks)**

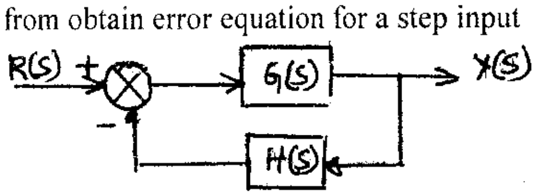

Fig.5(b)

6 a. Obtain the equation for root locus for a unity feedback control system whose forward path transfer function $G(s)=K\dfrac{(s+b)}{s(s+a)}$. Show that the root locus is a circle centred at (-b, o) and of radius $\sqrt{b^2-ab}$. **(08 Marks)**

b. A unity feed back control system has $G(s)=\dfrac{K}{s(s+2)(s+5)}$. Sketch the root locus and show on it i) break away point ii) line for $\xi=0.5$ and value of K for this damping ratio iii) the frequency at which the root locus crosses the imaginary axis and the corresponding value of K. **(12 Marks)**

7 a. A feedback control system is described by $G(s)=\dfrac{10}{s(1+0.2s)(1+0.01s)}$, H(s) = 1. Construct an asymptotic log magnitude plot and an exact phase plot. There from determine gain margin and phase margin, and comment on the stability of the closed loop system. **(12 Marks)**

b. For a prototype second – order system, whose closed loop transfer function is given by $M(s)=\dfrac{\omega_n^2}{s^2+2\xi\omega_n s+\omega_n^2}$, derive expressions for the resonant peak (M_r) and the frequency ω_r at which it occurs. **(08 Marks)**

8 a. The open loop transfer function of a feed back control system is $G(s)H(s)=\dfrac{K}{s(s+1)(s+2)}$.

Draw the polar plot and determine the restriction on K for stability. **(12 Marks)**

b. Explain the following : i) Order and type of system ii) Absolute stability and relative stability. **(08 Marks)**

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