USN | | | | | | | | | | 2002 SCHEME **EE43**

Fourth Semester B.E. Degree Examination, Dec 08 / Jan 09

Control Systems

Time: 3 hrs. Max. Marks:100

Note : *1. Answer any FIVE full questions.*
2. Graph papers and semilog graph papers will be supplied.

1 a. Define transfer function of a control system. **(04 Marks)**

b. For the mechanical system shown in fig.1(b), find the transfer function $\frac{X_1(s)}{F(s)}$. **(10 Marks)**

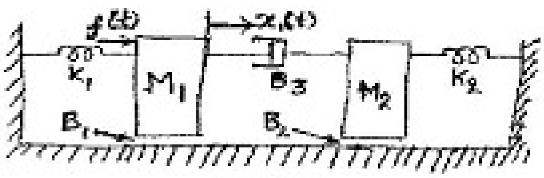

Fig.1(b)

c. Draw f – v and f – i analogous circuits for fig.1(b). **(06 Marks)**

2 a. State Mason's gain formula. **(04 Marks)**

b. For the circuit shown in fig.2(b) e_i and e_o are input and output voltages, i_1 and i_2 are loop currents. e_1 is node voltage. Draw a signal flow graph incorporating these variables. **(10 Marks)**

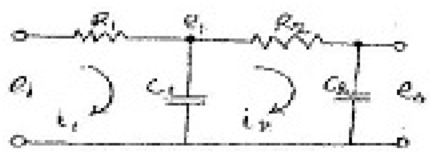

Fig.2(b)

c. Obtain transfer function $\frac{E_o(s)}{E_i(s)}$ for the circuit shown in fig.2(b). **(06 Marks)**

3 a. Derive expressions for peak response time t_p and maximum overshoot M_p of an under damped second order control system subjected to unit step input. **(06 Marks)**

b. Maximum overshoot M_p and peak time t_p of an underdamped second order control system subjected to unit step input are respectively 0.163 and 0.363 secs. Find the transfer function of the control system. **(07 Marks)**

c. The transfer function of a unity feedback control system is $G(s) = \frac{K_1}{s(s+2+K_2)}$. Find the values of K_1 and K_2 so that damping ratio $\zeta = 0.6$ and the steady state error for ramp input is 0.2 radian. **(07 Marks)**

4 a. What is the effect of feedback on i) the overall gain ii) stability and iii) external disturbance. **(08 Marks)**

b. A second order control system is subjected to a unit step input. Sketch the outpur response curves when damping ratio is i) less than 1, ii) equal to 1 and iii) greater than 1. **(04 Marks)**

c. Draw the block diagram of an armature controlled d.c. motor. Obtain transfer function $\frac{\theta(s)}{E_a(s)}$, where $\theta(s)$ is output shaft displacement of motor in radians and $E_a(s)$ is input armature voltage in volts. **(08 Marks)**

5 a. With zero initial conditions, the system is said to be bounded – input bounded – output (BIBO) stable, or simply stable, if its output c(t) is bounded to a bounded input r(t). Prove the statement. **(06 Marks)**

b. Forward path transfer function of a unity feedback control system is $G(s) = \dfrac{K}{s(s+10)(s+20)}$. Determine the range of K for stability by applying Routh – Hurwitz criterion. Determine the value of K that will cause sustained constant – amplitude oscillations in the system. Determine the frequency of oscillation. **(07 Marks)**

c. The block diagram of a motor control system with tachometer feedback is shown in fig.5(c). Find the range of the tachometer constant K_t so that the system is asymptotically stable. **(07 Marks)**

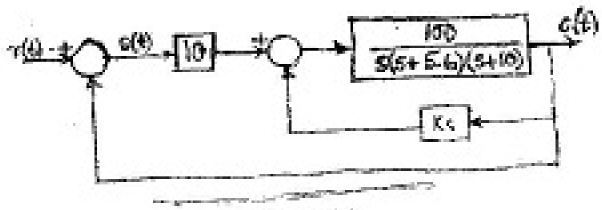

Fig.5(c)

6 a. Define the following : i) Relative Stability ii) Absolute Stability iii) Marginal Stability iv) Conditional Stability of a system. **(08 Marks)**

b. The open loop T.F of a unity feed back control system is $G(s) = \dfrac{K}{s(s+2)(s+4)}$. Construct the root locus and therefrom, find the value of K for a damping ratio of 0.5. **(12 Marks)**

7 a. The open loop transfer function of a unity feed back control system is given by $G(s) = \dfrac{K}{s(1+0.5s)(1+0.2s)}$.

i) Sketch the Bode magnitude and phase plots for k = 10. Find phase margin and gain margin.

ii) Determine the value of k, so that phase margin of the system is 30^0. **(14 Marks)**

b. Find the transfer function of the system whose Bode magnitude plot is given in fig.7(b). **(06 Marks)**

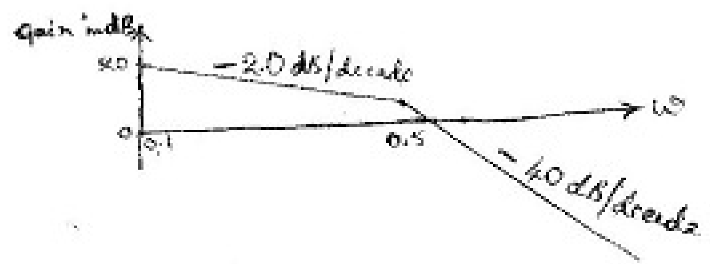

Fig.7(b)

8 a. Find the resonant peak, resonant frequency and bandwidth when closed loop transfer function is $\dfrac{C(s)}{R(s)} = \dfrac{5}{s^2+2s+5}$. **(08 Marks)**

b. Discuss the stability of a feedback control system with loop transfer function $G(s)H(s) = \dfrac{250}{s(s+5)(s+10)}$, using the Nyquist stability criterion. **(12 Marks)**

*****