ETC 7th Semester Examination 2011
Control Systems ETC 702

1 · 12 · 11

Answer any 5 questions

Time: 3 hrs FM: 70

1a) Draw the detailed block diagram of the following circuit (Fig.1) and obtain the response instantaneously after switching.

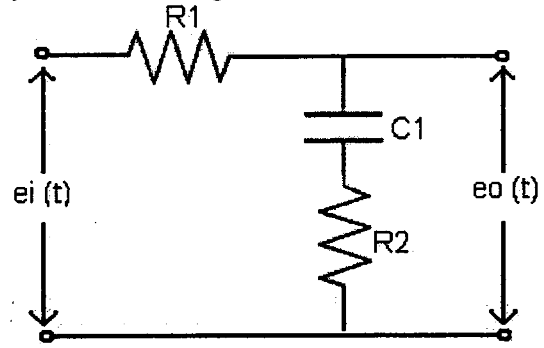

Fig.1

b) Obtain the signal flow graph representation for a system whose block diagram is given in Fig.2 and use Mason's gain formula to obtain C/R.

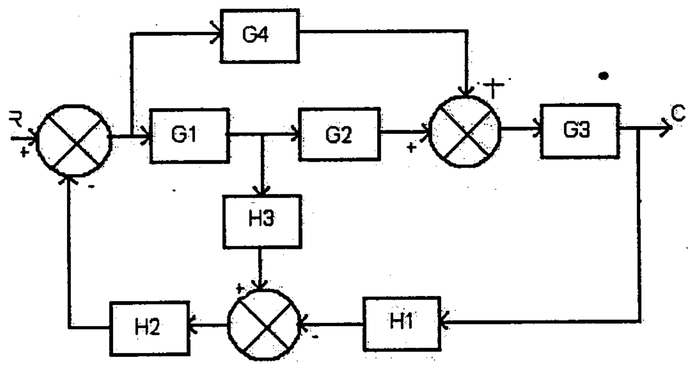

Fig.2

c) What is meant by 'order' and 'type' of a system?

(5+6+3)

2a) Measurement conducted n a servomechanism show the system response to be

$$c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$$

when subjected to a unit step input.

i) Obtain the expression for the closed loop transfer function
ii) Determine the undamped natural frequency and peak overshoot of the system.

b) A unity feedback heat treatment system has open loop transfer function $G(s) = 10000/\{(1+s)(1+0.5s)(1+0.02s)\}$. The set point is 500°C. What is the steady state temperature?

c) For a unit feedback control system with the closed loop transfer function $C(s)/R(s) = (Ks+b)/(s^2+as+b)$

Show that the steady state error in the unit ramp input response is given by $e_{ss} = (a-k)/b$

(4+6+4)

3a) The overall transfer function of a unity feedback system is given by $10/(s^2+6s+10)$. Find the values of static error constants. Also determine the steady state error for the input $r(t) = 1+t+t^2$.

b) The system shown in Fig.3 has the specifications: velocity error constant =10 and damping factor =0.5. Find the values of k_I and k_f to meet the given specifications of the system.

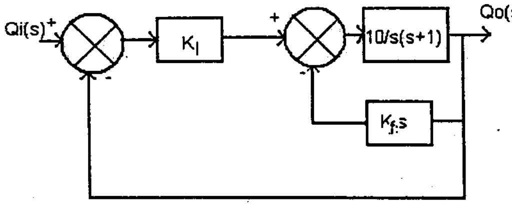

Fig.3

(7+7)

4a) Mention two significant advantage of Bode plot based analysis?

b) Sketch the gain (in dB) vs frequency of

$$G(s) = 512(s+3)/(s\,(s^2+16s+256))$$

c) The characteristic equation of feedback control system is $s^4+20s^3+15s^2+2s+K=0$

i) Determine the range of K for the system to be stable.

ii) Can the system be marginally stable? If so, find the value of K and the frequency of sustained oscillation.

(3+6+5)

5a) Establish the two basic rules for the construction of root locus.

b) Define breakaway point of a root locus plot and derive the expression for the same.

c) Sketch the root loci for $G(s) = K(s+1)/(s^2+4s+13)$, $H(s)=1$

(3+5+6)

6a) State Nyquist stability criteria. The open loop transfer function of a feedback control system is $G(s)H(s)= k(1+2s)/\{s(1+s)(1+s+s^2)\}$. Sketch complete Nyquist plot and find the range of k for stability.

b) Consider a lag lead network defined by

$$G_c(s) = K\{(s+1/T_1)(S+1/T_2)\}/\{(s+\beta/T_1)(s+1/\beta T_2)\}$$

Show that at frequency ω_1 where $\omega_1=1/(T_1T_2)^{1/2}$, the phase angle of $G_c(\omega_1)$ becomes zero.

(8+6)

7a) What is the impact on the time domain and frequency domain response of a system whose gain margin is slightly less than the phase margin. Explain with necessary equations.

b) What are the advantages of state variable analysis over the transfer function method?

c) In a first order electrical system, draw a detailed block diagram to incorporate a proportional and derivative controller and compare the transient and steady state performance with and without the controller.

(6+3+5)

8a) For the system shown in Fig.4, obtain the state equations.

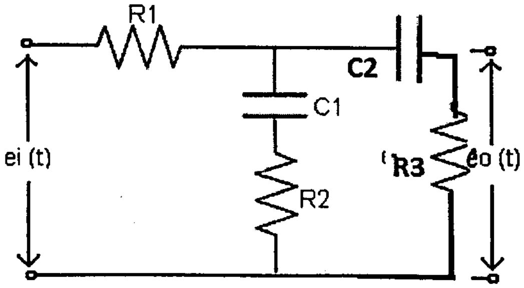

Fig.4

b) An open loop transfer function is given by $G(s)=K/\{s(s+1)\}$. It is specified that $K_v=12/s$ and phase margin is 40^0. Design a lead compensator to meet the specifications.

(5+9)

Please provide Semilog and MM graph papers.