B. Tech

CPEE 5302

Fifth Semester Examination – 2008

CONTROL SYSTEM ENGINEERING

Full Marks – 70

Time – 3 Hours

*Answer Question No. 1 which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

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1. Give brief answers : 2×10

   (i) What is the transfer function of a system whose response c(t) to an input r(t) is given by the differential equation :

$$\frac{d^2c}{dt^2} + 3\frac{dc}{dt} + 5c = 5r$$

(ii) What is overall transfer function of the system whose signal flow graph is shown in Fig. 1 ?

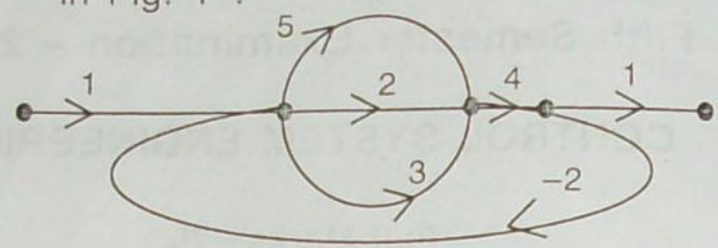

Fig. 1

(iii) What are the effects of negative feedback control on sensitivity to noise and parameter variation of a system ?

(iv) Explain the effects of adding a zero to a second order system ?

(v) What are the damping factor and natural frequency, ω_n of the system shown in Fig. 2 ?

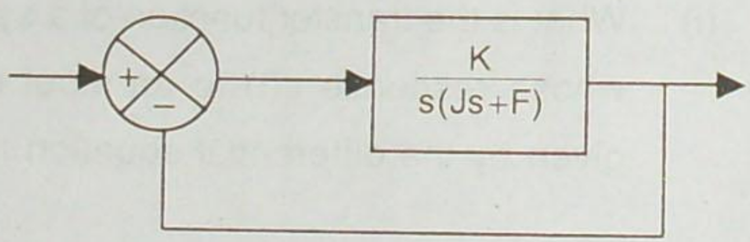

Fig. 2

(vi) Explain gain margin and phase margin.

(vii) What is the peak-overshoot for unit step response of the system described by closed loop transfer function,

$$G(s) = \frac{49}{s^2 + 16s + 49}$$

(viii) Draw the log-magnitude versus phase plot of a second order under damped system.

(ix) What are the effects of integral control action ?

(x) What are the effects of derivative control action ?

2. (a) Explain the principle of operation and characteristics of a two phase servo motor. 4

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(b) Obtain the transfer function, $\frac{V_0(s)}{V_1(s)}$ of the cascaded R-C circuit shown in Fig. 3. 6

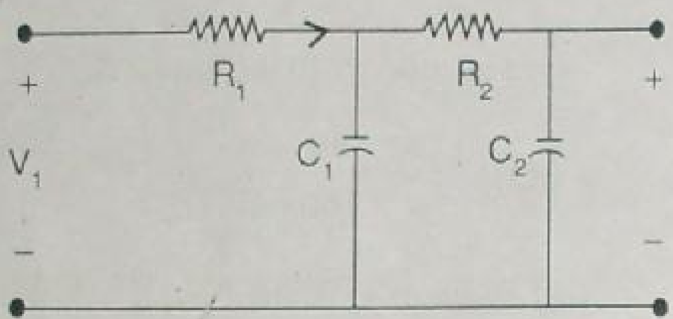

Fig. 3

3. (a) Draw the signal flow graph, for the circuit shown in Fig. 4, taking voltage and current of inductor and capacitor as variables. Using Mason's gain formula, obtain the overall transfer function of the svstem. 6

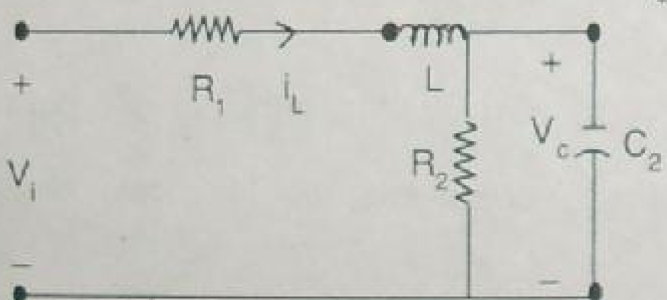

Fig. 4

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(b) Obtain the expression for unit step-response of a second order under-damped system. 4

4. (a) Define lime response specifications. Obtain their expressions for unit step response of a under damped second order system. 5

(b) Block diagram model of a control system is shown in Fig. 5. Determine the value of K such that the damping ratio is 0.5. Also obtain the values of rise time and maximum overshoot in its unit step response. 5

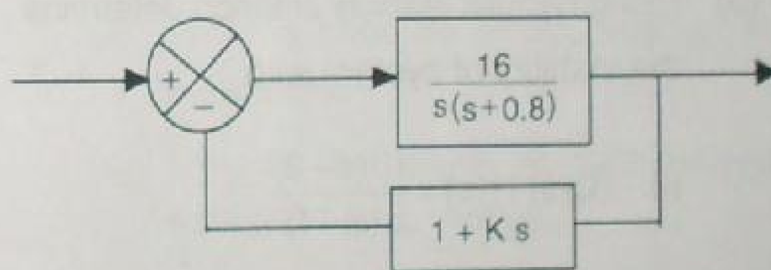

Fig. 5

5. (a) Using Routh-Hurwit criterion, investigate the stability of the system, whose characteristic equation is : 3

$$s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$$

(b) Sketch the root locus plot of a unity feedback system with forward path gain,

$$G(s) \frac{K}{s(s+2)(s+4)}$$

Find the range of K for which the system is under damped. 4

(c) Explain Nyquist criterion to determine stability of control systems. 3

6. (a) Using Nyquist stability criterion determine the stability of system with 4+3

(i) $G(s)\,H(s) = \dfrac{10(s+3)}{s(s-1)}$

(ii) $G(s)\,H(s) = \dfrac{(s+2)}{(s+1)(s-1)}$

(b) Sketch the polar plots for : 3

(i) $G(s)\,H(s) = \dfrac{1}{1+sT}$

(ii) $G(s)\,H(s) = \dfrac{1}{s(1+sT)}$

7. (a) Sketch the Bode plot for :

$G(s)\,H(s) = \dfrac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$ different values of ξ. Obtain resonant frequency and resonant peak. 5

(b) Describe the construction, working and applications of an Amplidyne. 5

8. (a) Explain the constant M-circles, the constant N-circles, and the Nichol's chart. 3

(b) Write a note on applications of P-I-D controllers. 3

(c) Discuss the Zeigler-Nichol's method of tuning P-I-D controllers. 4

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