

Code: DE15
Time: 3 Hours

Subject: CONTROL ENGINEERING
Max. Marks: 100

JUNE 2011

NOTE: There are 9 Questions in all.

- Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.
- The answer sheet for the Q.1 will be collected by the invigilator after 45 Minutes of the commencement of the examination.
- Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.
- Any required data not explicitly given, may be suitably assumed and stated.

Q.1 Choose the correct or the best alternative in the following: (2 × 10)

a. Which of the following statement is not true for root locus technique?

- (A) It is used to obtain closed-loop pole configuration from open-loop poles and zeros.
- (B) It is most useful for single-input single-output systems
- (C) It provides the pattern of movement of closed-loop poles when open-loop gain varies
- (D) None of these

b. The transfer function of the network as shown in Fig. 1.

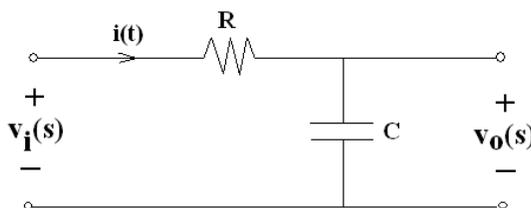


Fig. 1

- | | |
|---|---|
| <p>(A) $\frac{RC}{s + \frac{1}{RC}}$</p> <p>(C) $\frac{\frac{1}{RC}}{s + \frac{1}{RC}}$</p> | <p>(B) $\frac{1}{s + RC}$</p> <p>(D) $\frac{1}{s + \frac{1}{RC}}$</p> |
|---|---|

c. Laplace transform of damped cosine wave $e^{-at} \cos \omega t$ is

- | | |
|--|---|
| <p>(A) $\frac{\omega}{(s + a)^2 + \omega^2}$</p> <p>(C) $\frac{s}{(s + a)^2 + \omega^2}$</p> | <p>(B) $\frac{s + a}{(s + a)^2 + \omega^2}$</p> <p>(D) $\frac{1}{(s + a)^2 + \omega^2}$</p> |
|--|---|

- d. In force-voltage analogy, mass is analogous to
- (A) Voltage (B) Inductance
(C) Resistance (D) Capacitance
- e. The damped natural frequency of an under damped second –order system is given by
- (A) $\omega_d = \omega_n$ (B) $\omega_d = \xi\omega_n$
(C) $\omega_n = \omega_d\sqrt{1-\xi^2}$ (D) $\omega_d = \omega_n\sqrt{1-\xi^2}$
- f. Gain cross-over frequency is defined as
- (A) $|G(j\omega)H(j\omega)| = 1$ (B) $|G(j\omega)H(j\omega)| = 0$
(C) $|G(j\omega)H(j\omega)| = \infty$ (D) $|G(j\omega)H(j\omega)| = \frac{1}{\sqrt{2}}$
- g. The value of K for which the system $s^3 + 3s^2 + 3s + 1 + K = 0$ becomes stable is
- (A) $K > 8$ (B) $K = 8$
(C) $K = 7$ (D) None of these
- h. The transfer impedance is defined as
- (A) The ratio of transform voltage to transform current at the same part
(B) The ratio of transform voltage at one part to the current transform at the other part
(C) Both (A) and (B)
(D) None of these
- i. The steady state error of a stable type 0 unity feedback system for a unit step function is: where K_p is the position error constant.
- (A) 0 (B) $\frac{1}{1 + K_p}$
(C) ∞ (D) $\frac{1}{K_p}$
- j. The number of roots of $s^3 + 5s^2 + 7s + 3 = 0$, in the left half of the s-plane is:
- (A) zero (B) one
(C) two (D) three

**Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.**

- Q. 2** a. Write the differential equations describing the dynamics of the system as shown in Fig. 2. Find the ratio $\frac{X_2(s)}{F(s)}$ (8)

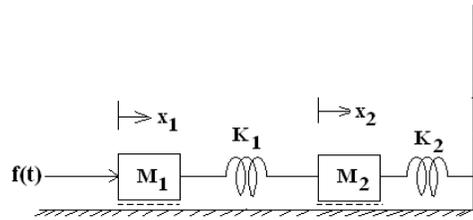


Fig. 2

b. Find the transfer function of lag network as shown in Fig. 3 (8)

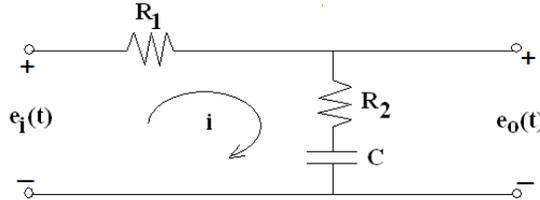


Fig. 3

Q. 3 a. Reduce the block diagram shown in Fig.4 to the simplest form and obtain its closed loop transfer function. (8)

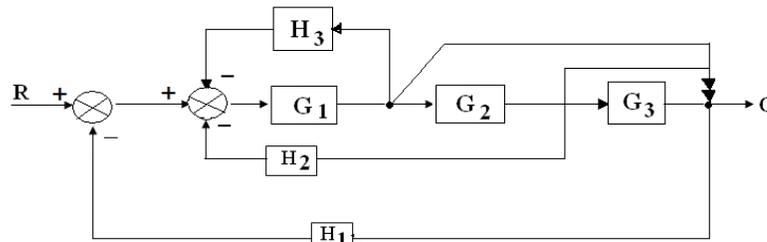


Fig. 4

b. Explain the characteristics of LVDT and derive the expression for its transfer function. (8)

Q. 4 a. Discuss the effect of feedback on: (i) Overall gain (ii) Stability (iii) Sensitivity (8)

b. Explain Derivative feedback control. (8)

Q. 5 a. For a single loop feedback control system

$$G(s) = \frac{1}{s^2(s+12)} \text{ and } H(s) = \frac{5(s+1)}{(s+5)}. \text{ Evaluate the steady state errors for}$$

three basic types of inputs, unit step, unit ramp and unit parabola. (6)

b. Consider the closed-loop control system as shown in Fig. 5. Sketch the root loci diagram of the system for $0 \leq K < \infty$. Show the following on the sketch: (i) asymptotes of root loci as $s \rightarrow \infty$ (ii) intersection of the asymptotes. (10)

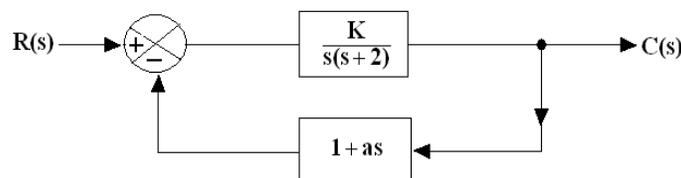


Fig. 5

- Q. 6** a. Draw the Bode plot for the transfer function $G(s) = \frac{50}{s(1 + 0.25s)(1 + 0.1s)}$.
 From the graph determine:
 (i) Gain crossover frequency (ii) Phase crossover frequency
 (iii) GM and PM (iv) Stability of the system (10)

b. Discuss the following: (i) Nichol's chart (ii) Phase margin and gain margin. (6)

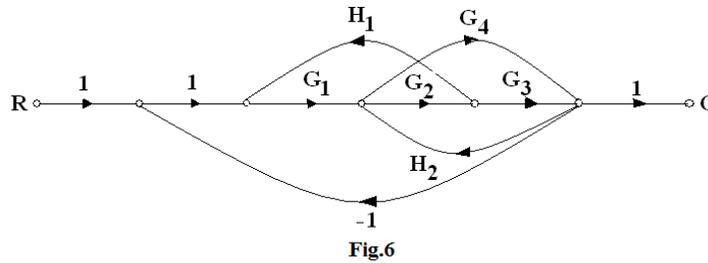
- Q.7** a. A unity feedback system has open loop transfer function
 $G(s) = \frac{1}{2(1 + 2s)(1 + s)}$. Sketch Nyquist plot for the system and therefore
 obtain the gain margin and the phase margin (8)

b. What is a phase lead network? Calculate the transfer function and draw the Bode plot. (8)

- Q.8** a. The characteristic equation of a feedback system is $s^4 + 20ks^3 + 5s^2 + (10+k)s + 15 = 0$.
 Determine k for stable system. (8)

b. Write short notes on Passive electric networks. (8)

- Q.9** a. Obtain C/R ratio of a system whose signal flow graph is represented in Fig.6. (8)



- b. Write notes on: (8)
 (i) Op-amp as proportional & integral.
 (ii) Op-amp as proportional, integral & derivative.