[06 – 3216]

III/IV B.E. DEGREE EXAMINATION.

Second Semester

Electrical and Electronics Engineering

CONTROL SYSTEMS

(Common with ECE and Dual Degree Program in ECE, EEE)

(Effective from the admitted batch of 2006–2007)

Time : Three hours Maximum : 70 marks

Question No. 1 is compulsory.

Answer any FOUR from the remaining.

All questions carry equal marks.

1. (a) Explain the significance of Mason's gain formula.

   (b) Explain

      (i) marginal stability

      (ii) asymptotic stability.

(c) Explain the time response of the 1st order system for a unit impulse input.

(d) Define the time domain specifications

(i) delay time

(ii) rise time

(iii) peak time

(iv) settling time.

(e) Define the terms

(i) static position error coefficient

(ii) static velocity error coefficient

(iii) static acceleration error coefficient.

(f) What are the rules to construct the Root Locus Diagram?

(g) What is the significance of bode plot?

2. (a) Obtain the transfer functions $x_1(s)/u(s)$ and $x_2(s)/u(s)$ of the mechanical system shown in the figure below.

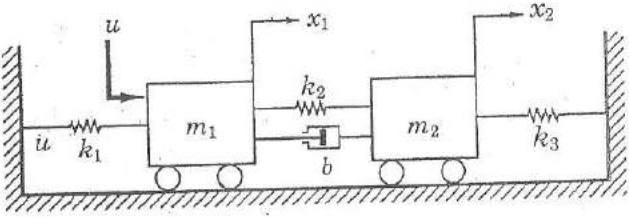

Figure 1

(b) Define the terms (i) mass (ii) linear spring (iii) frictions, for translational motion subject to mathematical modeling of mechanical systems.

3. (a) Write the various properties of a transfer function.

(b) The following differential equations represent linear time-invariant systems, where $r(t)$ denotes the input and $c(t)$ denotes the output. Find the transfer function of each of the system.

(i) $\frac{d^3c(t)}{dt^3}+3\frac{d^2c(t)}{dt^2}+4\frac{dc(t)}{dt}+c(t)=2\frac{dr(t)}{dt}+r(t)$

(ii) $\frac{d^2c(t)}{dt^2}+10\frac{dc(t)}{dt}+2c(t)=r(t-2)$.

4. (a) Define various terms related to signal flow graphs.

(b) Find the gain of the signal flow graph shown below, where a, b, c, d, e, g and l are respective gains of the branches.

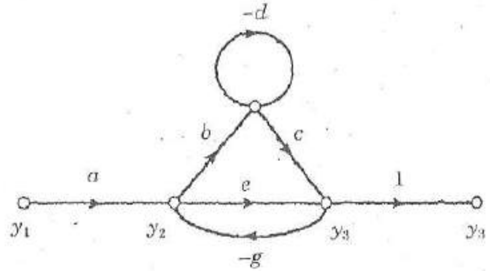

Figure 2

5. (a) For the transient-response characteristics of a control system to a unit-step input. Define

(i) Delay time

(ii) Rise time

(iii) Peak time

(iv) Maximum overshoot

(v) Settling time.

(b) Determine the position, velocity, and acceleration error constants for the control system whose open loop transfer function is as given below with unity feedback.

$$G(s)=\frac{50}{(1+0.1s)(1+2s)}.$$

6. The characteristic equations for certain feedback control systems are as given below. In each case determine the values of K that correspond to a stable system.

(a) $s^4+22s^3+10s^2+2s+K=0$

(b) $s^4+20Ks^3+5s^2+(10+K)s+15=0$

(c) $s^3+(K+0.5)s^2+4Ks+50=0$.

7. (a) Is a closed-loop system with the following open-loop transfer function and with $K=2$ stable?

$$G(s)H(s)=\frac{K}{s(s+1)(2s+1)}.$$

Find the critical value of the gain K for stability.

(b) Define gain margin and phase margin with necessary expressions.

8. (a) Obtain the phase and gain margins of the system shown in figure 3, for the two cases where $K = 10$ and $K = 100$.

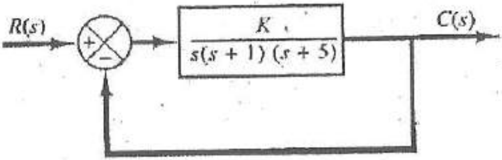

Figure 3

(b) Define gain crossover frequency and phase crossover frequencies with necessary expressions.