Uva Wellassa University, Sri Lanka
End Semester Examination –March/April 2013
SCT 462-2 Control Theory

Uva Wellassa University

Time: Two (02) Hours

Total **04** Questions
Answer **all** questions

1.

I. Give three examples of **open loop** systems.

(03 marks)

II. Draw a block diagram of a **feedback control system** and name the components.

(05 marks)

III. What is the voltage gain of the following arrangement?

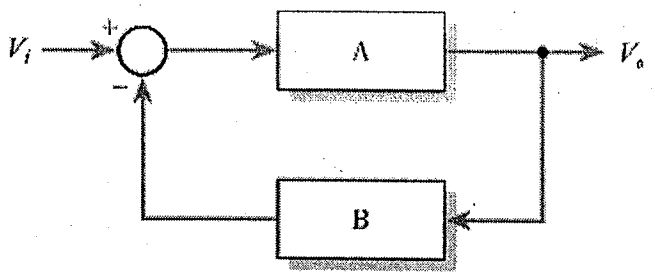

Fig. Q1-1

(05 marks)

IV. Obtain mathematical model of the mechanical system shown in Fig. Q1-2, where m = 1 kg, b = 3 N-sec/m, and k = 2 N/m. Assume zero initial conditions.

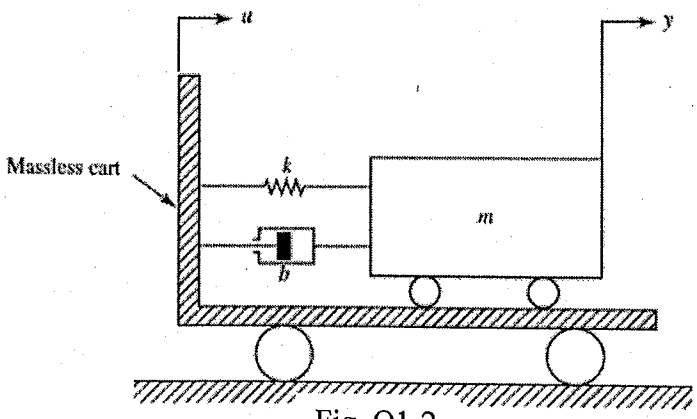

Fig. Q1-2

a. Obtain the mathematical equation for the motion of the mass. (Assume no external forcing function.)
b. Obtain the Laplace transform of the system.
c. Obtain time domain response for the above system and plot.

(12 marks)

2.

I. Consider the unit-step response of a unity-feedback control system whose open-loop transfer function is

$$G(s) = \frac{2}{(5S+10)}$$

Obtain the unit-impulse response and unit ramp response.

(10 marks)

II. Fig. Q2–1 shows a system with two inputs and two outputs.

a. Derive $C_1(s)/R_1(s)$, $C_1(s)/R_2(s)$, $C_2(s)/R_1(s)$, and $C_2(s)/R_2(s)$. (In deriving outputs for $R_1(s)$, assume that $R_2(s)$ is zero, and vice versa.)

b. Use the above results to draw a simplified block diagram for $C_1(s)/R_1(s)$, $C_1(s)/R_2(s)$.

(15 marks)

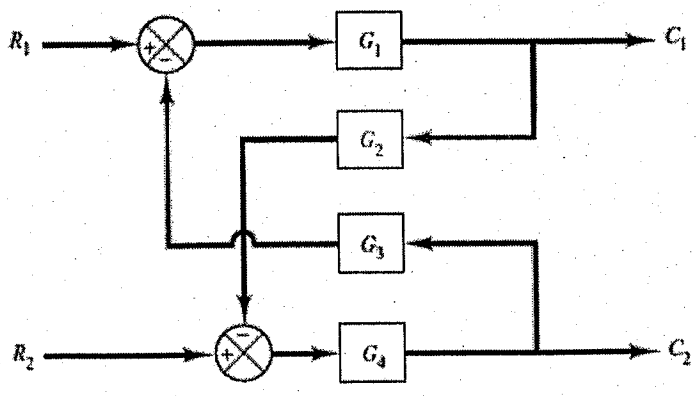

Fig. Q2-1

3.

I. How a second order system is classified depending on the value of damping? Draw a suitable graph to show the transient behavior of a second order system.

(05 marks)

II. Consider the system shown in Fig.Q3-1. Determine the following.

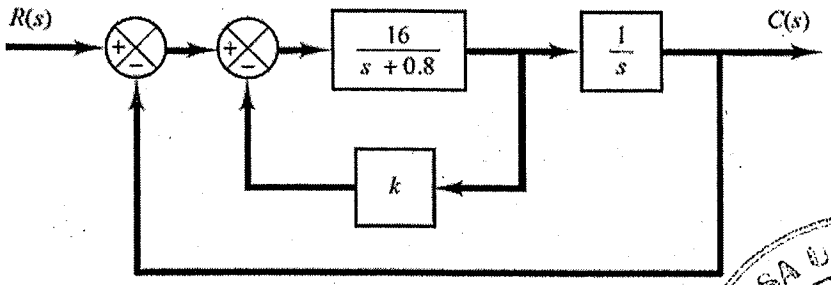

Fig. Q3-1

a. Value of k such that the damping ratio ξ is 0.5.
b. Rise time t_r
c. Peak time t_p
d. Maximum overshoot M_p
e. Settling time t_s
for a unit-step response.

(10 marks)

III. The closed loop transfer function of second order system is

$$\frac{C(s)}{R(s)} = \frac{10}{(s^2 + 6s + 10)}$$

Determine the damping ratio and the natural frequency of oscillations.

(10 marks)

4.

I. Consider the system shown in Q4-1. For the sinusoidal input x (t) = X sin(ωt) obtain the steady state output y_{ss} in standard notation.

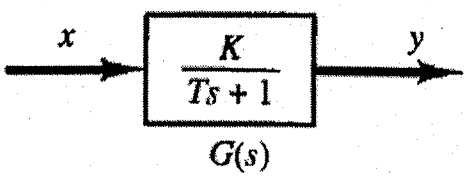

Fig. Q4-1

(04 marks)

2 1

II. Consider the following characteristic equation: Using the Routh stability criterion, determine the range of K for stability.

$$s^4 + 2s^3 + (4 + K)s^2 + 9s + 25 = 0$$

(06 marks)

III. Consider the system shown in Fig. Q4-2. Determine the following.

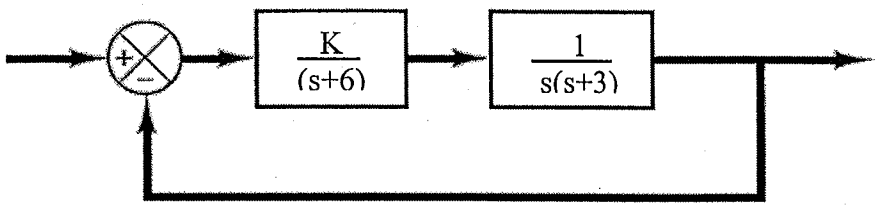

Fig. Q4-2

a) Root loci on the real axis
b) The asymptotes of the root loci.
c) The breakaway point.
d) The points where root loci crosses imaginary axis.
e) Draw the root loci, based on the information you obtained for above questions.
f) Value of K for marginal stability.

(15 marks)