Uva Wellassa University, Sri Lanka
End Semester Examination – January 2010
ENG 408-2 Control Theory

Time: Two (02) hours

Total 04 Questions
Answer All Questions

01)

I. Explain Closed-Loop Control and Open-Loop Control in control engineering. What are the advantages and disadvantages if each of the above system.

(30 marks)

II. Consider the mechanical system shown in Figure 1, where m = 1 kg, b = 3 N-sec/m, and k = 2 N/m. Assume that at t = 0 the mass m is pulled downward such that x (0) = 0.1 m and $\dot{x}(0)$ = 0.05 m/sec.

a. Obtain the mathematical equation for the motion of the mass. (Assume no external forcing function.)
b. Obtain the Laplace transform of the system subjected to the initial condition.
c. Using partial fraction method, obtain time domain response for the above system and plot it.

(70 marks)

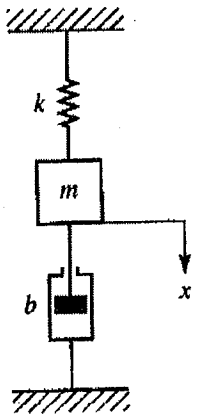

Figure. 1

02)

I. What is Root-Locus analysis? Explain it using Angle and Magnitude Criteria.

(30 marks)

II. Consider the system shown in Figure 2. (Assume that the value of K is nonnegative). You are required to answer following questions **clearly explaining** each step of the answer.

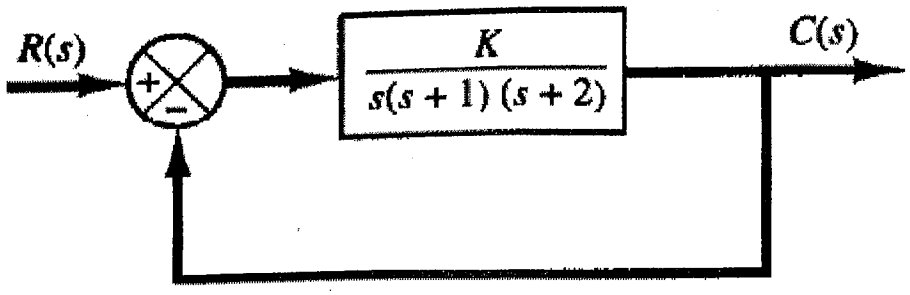

Figure. 2

a) Determine root loci on the real axis
b) Determine the asymptotes of the root loci.
c) Determine the breakaway point.
d) Determines the points where root loci crosses imaginary axis.
e) Draw the root loci, based on the information you obtained for above questions.
f) Determine a pair of dominant complex-conjugate closed-loop poles such that the damping ratio is 0.5.

(70 marks)

03)

I. What is frequency response analysis? Explain in brief.

(10 marks)

II. Prove that stable ,linear, time invariant system subjected to a sinusoidal input at steady state have a sinusoidal output of the same frequency as the input but amplitude and the phase of the output will differ from those of the input.

(20 marks)

III. You are required to draw the Bode-Plot for the transfer function given below

$$G(s) = \frac{10\ (S+3)}{s(s+2)\ (s^2+S+2)}$$

a) Determine gain factors, integrating factors, first order factors and quadratic factors for the above system.
b) Identify corner frequencies for each of the above factors.
c) Plot magnitude and phase plot for each of the above factors in the given logarithmic sheet. (Cleary name each factors in the graph).
d) Complete the Bode- Plot for the above system

(20 marks)

04)

I. Explain how unit step response of a second order system varies when the roots of the characteristic equation change in the S plane as explained below.

a) Real part is positive and imaginary part is zero
b) Real part is negative and imaginary part is zero
c) Real part is zero imaginary part is none zero
d) Real part is positive and imaginary part is none zero
e) Real part is negative and imaginary part is none zero

(40 marks)

II. Referring to the system shown in Figure 4 determine the transfer function in standard form and find values of K and k such that the system has a damping ratio ε of 0.7 and an undamped natural frequency ω_n 4 rad/sec.

(60marks)

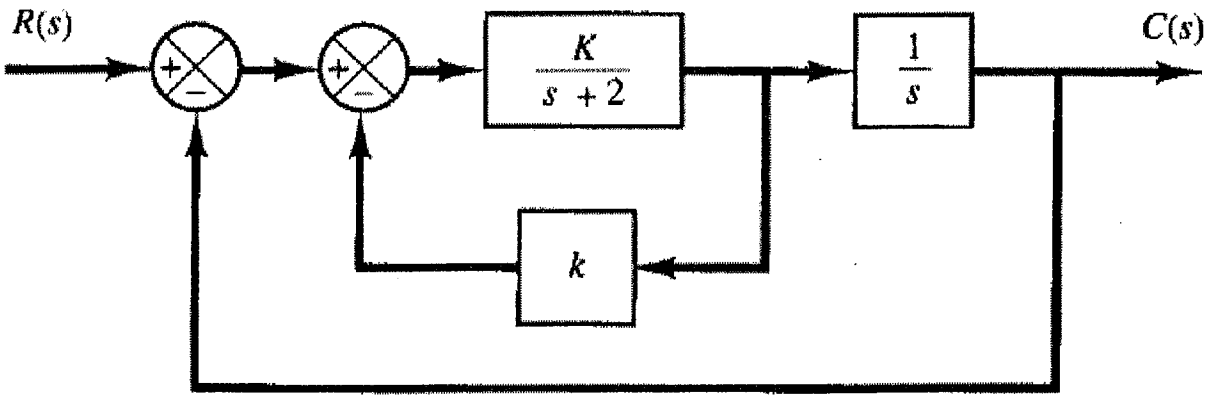

Figure 4

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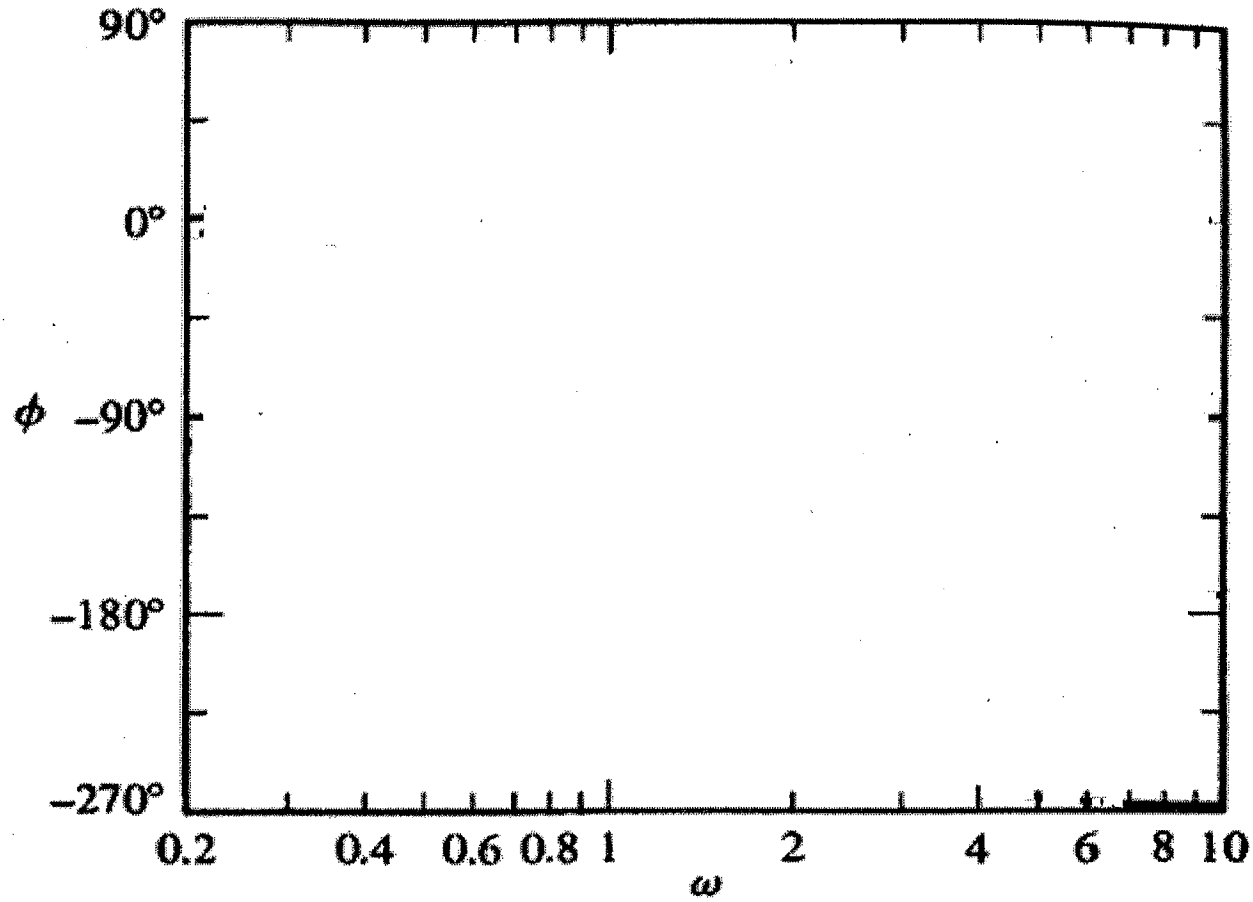
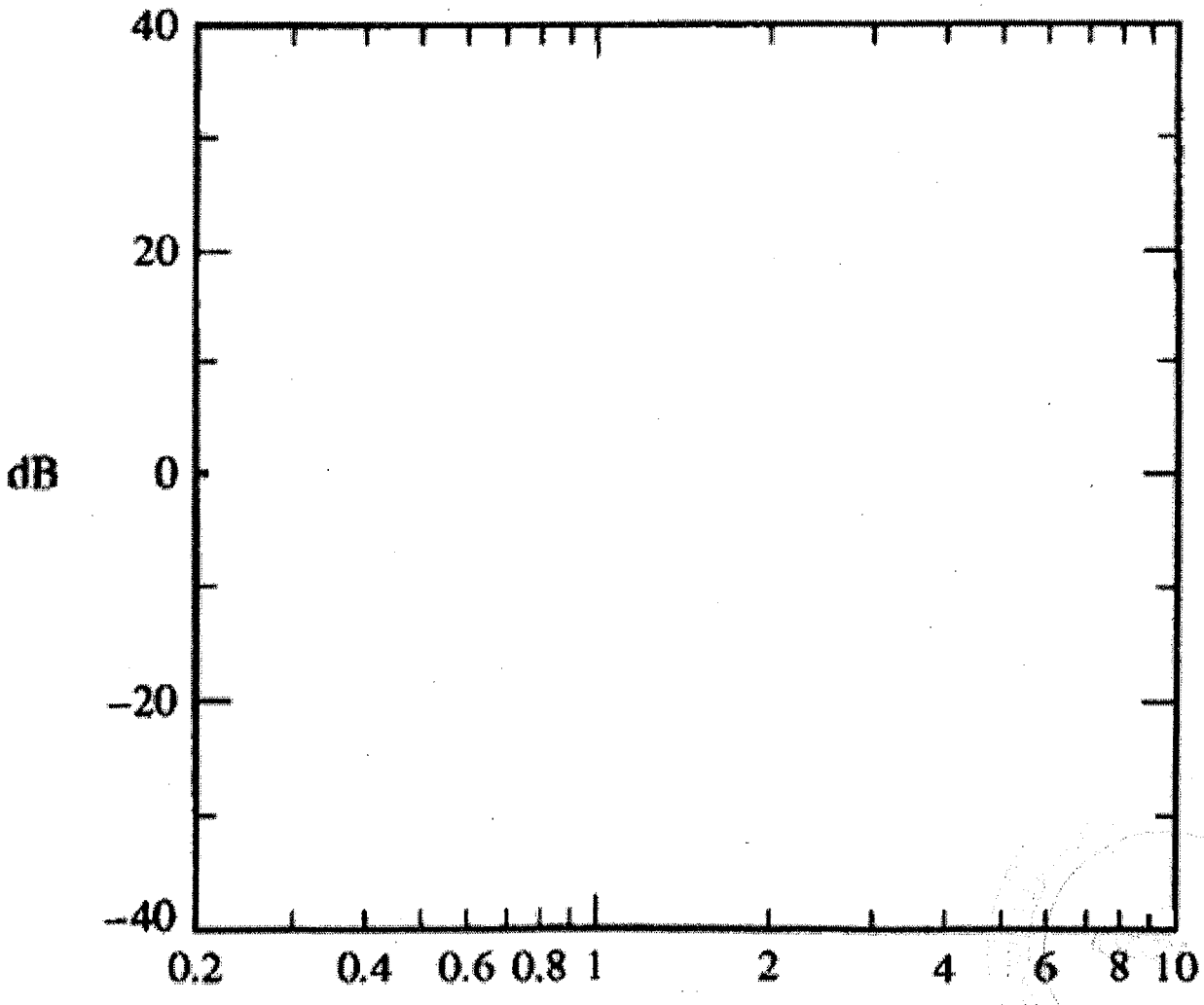
Question 3





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