KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th year 2nd Term Examination, 2013

ME 4085

(Servomechanism & Control Engineering)

Time: 3 Hours. Total Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.
iv) Necessary Charts/Tables may be supplied on request.

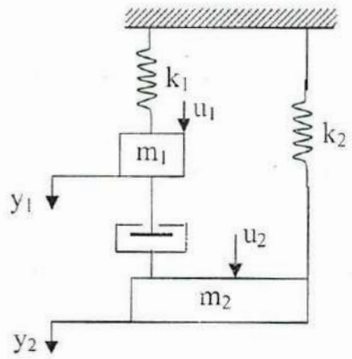
SECTION - A

1(a) Define system, command input, reference selector, reference input, and actuating signal. 10

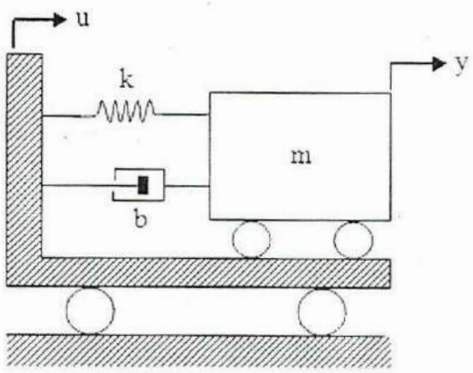
1(b) Define open-loop and closed-loop control systems. What are the advantages and disadvantages of closed-loop control systems over open-loop control systems? 12

1(c) What is servo mechanism? Derive the system equations of dc and ac servomotors. Which one is superior in performance and why? 13

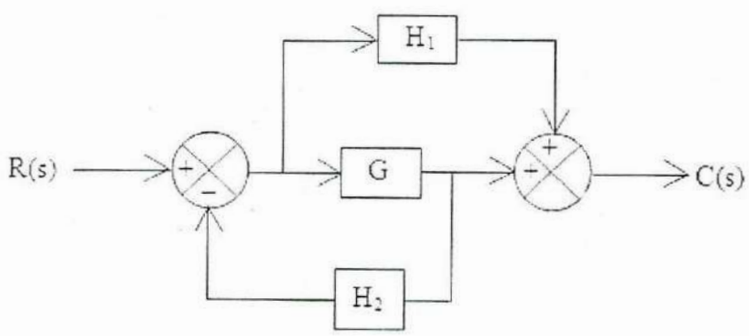
2(a) Obtain the state-space representation of the mechanical system shown in figure below, where, u_1 and u_2 are the inputs and y_1 and y_2 are the outputs. 12



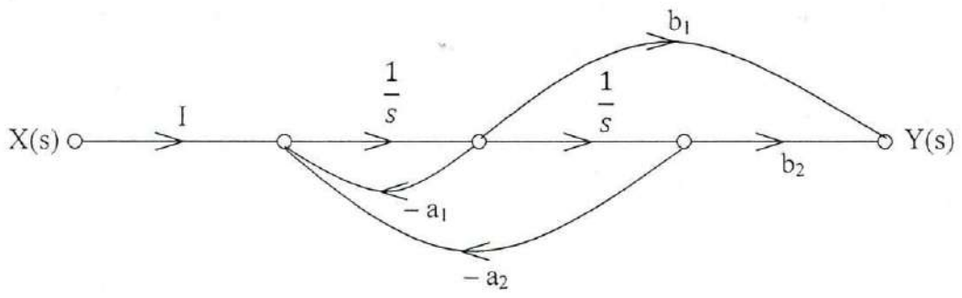
2(b) Obtain the transfer function of the following spring-mass dashpot system mounted on a cart. 12



2(c) Simplify the block diagram shown in figure below. Obtain the transfer function relating C(s) and R(s). 11

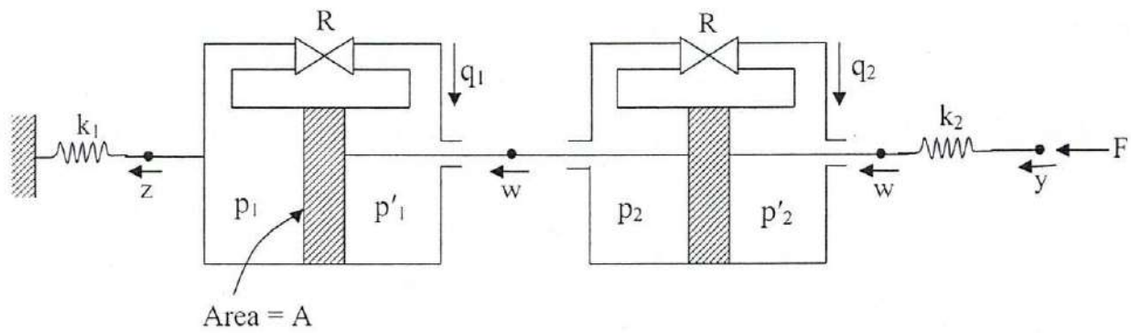


3(a) Obtain the transfer function $\frac{Y(s)}{X(s)}$ of the system shown in figure below. 12



3(b) Give a brief comparison between pneumatic systems and hydraulic systems. 12

3(c) Derive the transfer function $\frac{Z(s)}{Y(s)}$ of the hydraulic system shown in figure below. Assume that the two dashpots in the system are identical ones. 11



4(a) Deduce the expression for step, ramp and parabolic error coefficients for Type 1 system. 10

4(b) Consider the characteristic equation of a system, $S^4 + 2S^3 + (4 + K)\,S^2 + 9S + 25 = 0$; determine the range of K for stability. 12

4(c) Draw a signal flow graph for the following state and output equations: 13

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}-2 & 1 & 0\\ 0 & -3 & 1\\ -3 & -4 & -5\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u$$

$$y = [0 \quad 1 \quad 0]\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$

SECTION – B

5(a) What are break-in and break away points in a root locus? What is their significance? 10

5(b) Sketch the bode diagram, representation of the frequency response for the following transfer function. 25

$G(s)H(s) = \frac{30(s+8)}{s(s+2)}$

6(a) Define gain and phase margins. What are the minimum and non-minimum phase transfer functions? 10

6(b) A unity feedback control system has the following transfer function 25

$G(s) = \frac{K(S+3)}{S(S^2+4S+10)}$

Sketch the root locus for the system for positive gain. Comment on the system for positive gain.

7(a) Discuss briefly the action of P, PI and PID controller. 10

7(b) Briefly discuss about Fuzzy logic controller and programmable logic controller with proper diagram. 10

7(c) Discuss the interconnected power system and its development in Bangladesh. 08

7(d) Write down the state space representation of the following system 07

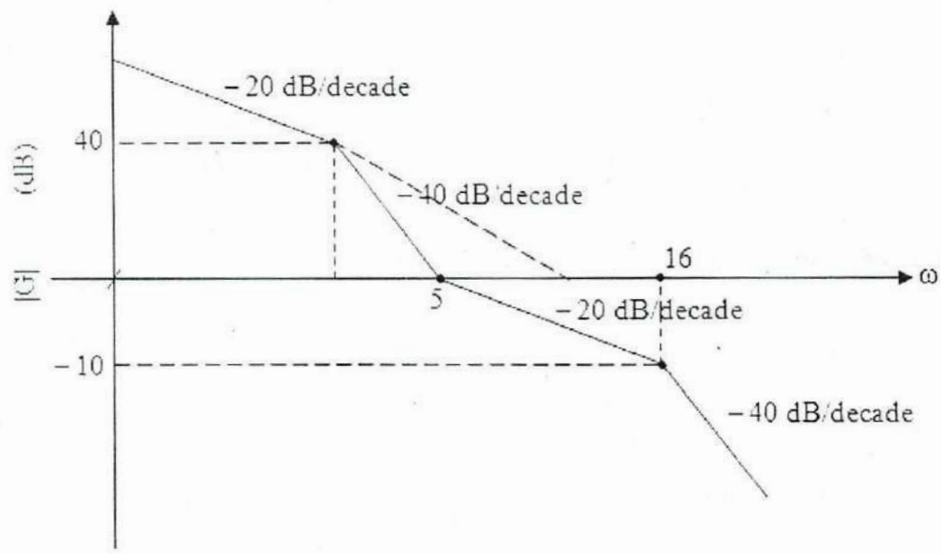
$$\frac{d^3y}{dt^3} + 5\frac{d^2y}{dt^2} + \frac{dy}{dt} + 7y = u(t)$$

8(a) Define controllability and observability. State whether the following system is controllable and observable. 12

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-3 & 1\\ -2 & 3/2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ 0\end{bmatrix}u$$

$$y = [0.8 \quad 1]\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

8(b) Evaluate the transfer function that corresponds to the following log magnitude curve. 12



8(c) How can you convert an unstable system to a stable system? 07

8(d) Explain Nichols chart. 04

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