COLLEGE OF ENGINEERING & TECHNOLOGY

Department : **Electrical & Control Engineering**
Lecturer : **Staff**
Course : **Modern Control**
Course Code : **EE 419** **Marks** : **40**
Date : **25/5/2015** **Time** : **2 hour**

Final Exam

Answer all questions:

1) Consider the antenna position system shown in Figure 1. (10 marks)

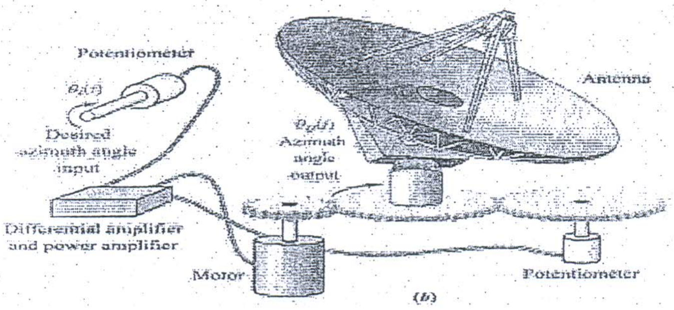

Figure (1)

This is represented with the block diagram shown in Figure 2

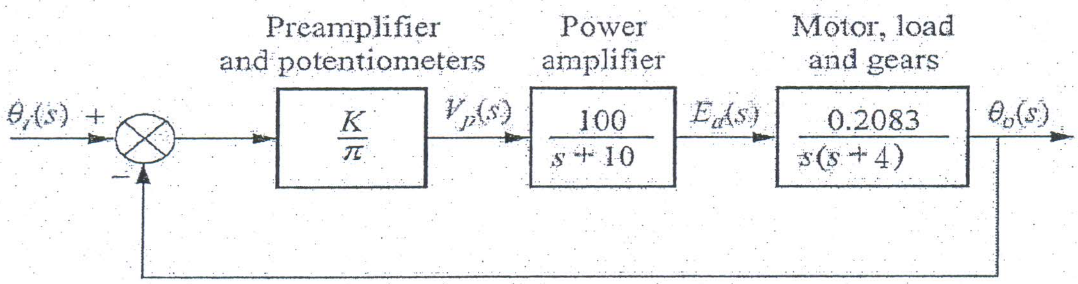

Figure (2)

Design a lag-lead compensator with damping ration 0.5 to meet the following specifications:

i- The settling time must approximately be 8.0 seconds
ii- velocity error constant of 2 sec^{-1}

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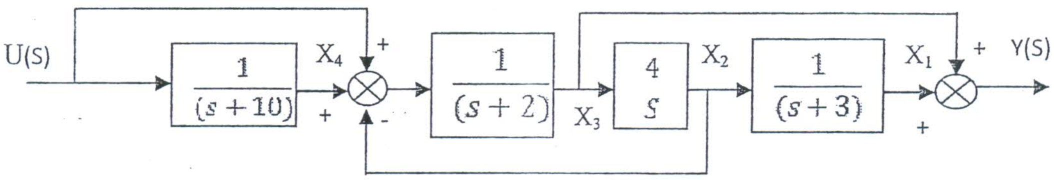
2) The steering dynamics of a ship are represented by the transfer function (10 marks)

$$\frac{V(s)}{\delta_r} = G(s) = \frac{K[10S+1]}{s(6s+1)(60s+1)}$$

Where V is the ship's lateral velocity in meters per second, and δ_r is the rudder angle in radians.

a) Indicate the crossover frequency, PM and GM
b) Is the ship steering stable with K= 20?
c) Design a compensator that meets the following Specifications:
   i. Velocity constant $K_v=2$
   ii. $PM \geq 50^o$

3) a) obtain the state space equation for the following system (6 marks)



b) Obtain a state-space representation of the following system (4 marks)

$$\frac{Y(s)}{U(s)} = \frac{s^2+4s+16}{s^3+14s^2+56s+160}$$

in Controllable Canonical form and Observable Canonical Form.

4) For the system given below in its state-space representation: (10 marks)

$$\underline{\dot{x}}(t) = \begin{bmatrix} 0 & 1 \\ -4 & -5 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

Determine: i) The system transfer function.
ii) Check the system controllability and observability.
iii) The output $y(t)$ if the input $u(t)$ is a unit step function and the system initial state vector is:

$$\underline{x}(0) = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

iv) Design a State feedback for the following systems for a response of 2% settling time and 10% overshoots for unit step input.

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