COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Electrical & Control Engineering

Lecturer : Prof. Dr. Ahmed F. Amer

Course : Modern Control Systems

Course Code: EE 419

Date : 22 / 1 / 2015

Marks: 40

Time : 2

Final Exam

Answer Four Questions Only:

1) The open-loop transfer function of a system is given by:

$$G(s) = \frac{k}{s(s+1)(s+4)}$$

It is required that the system is to be compensated in order to meet the following specifications:

- Damping ratio = 0.5
- Static error constant $\geq 5 \text{ sec}^{-1}$
- Undamped natural frequency = 2 rad/sec

Find the compensator transfer function using root-locus technique.

1) Design – using Bode diagrams - a series compensation network for the negative unity feedback system having :

$$G_p(s) = \frac{k}{s(s+1)}$$

Subject to:

System phase margin, $\phi_{pm} \geq 45^{o}$

System steady-state error $e_{ss}\big|_{unit\ ramp} \leq 0.05\ radians$

3) Derive state space model for the system described by the following transfer function:

$$\frac{y(s)}{u(s)} = \frac{2s+5}{s^3+7s^2+14s+8}$$

Using: i) Controller canonical form.

ii) Observer canonical form.

Members of course Examination Committee:	Signature:	Date:
Lecturer: Prof. Ahmed Amer	Ahmed F. Amer	17/1/2015
Course Coordinator: Dr. Ahmed El Shenawi	[signature]	17/1/2015
Head of Department: Prof. Hany Asher	Hany	18/1/2015

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

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

$$y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Determine: i) The system transfer function.

ii) The output $y(t)$ if the input $u(t)$ is a unit step function and the system initial state vector is:

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

5) Consider the system given by the state space model,

$$\underline{\dot{x}}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -15 & -23 & -9 \end{bmatrix} \underline{x}(t) + \begin{bmatrix} 0 \\ 0 \\ 4 \end{bmatrix} u(t)$$

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

i) Check the system state controllability and system state observability.

ii) Design a state feedback control for the system to place the closed loop poles at $-2 \pm j3$, and -8.

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Lecturer: Prof Ahmed Amer	Ahmed Z. Amer	17/1/2015
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Head of Department: Prof. Hamdy Ashour	Hamdy	18/1/2015