COLLEGE OF ENGINEERING & TECHNOLOGY

Department : Electrical & Control Engineering
Lecturer : Prof. Medhat Elsngaby and Prof. Ahmed F. Amer
Course : Modern Control
Course Code : EE 419 **Marks : 40**
Date : 10 / 1 / 2016 **Time : 2 hour**

Final Exam

Answer all the following questions

Question 1: B-2

A unity feedback control system has the following open-loop transfer function:

$$G(s) = \frac{1}{s(s+2)}$$

Design a lead compensator to achieve the following specifications:

- The damping ratio $\varsigma \geq 0.45$
- The velocity error constant $\geq 20 \sec^{-1}$
- The undamped natural frequency $\omega_n = 9\ rad/\sec$ (10 marks)

Question 2: B-3

A negative unity feedback control system has the following open loop transfer function:

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

Design a lag compensator using Bode plots to achieve the following specifications:

- The system phase margin $\phi_{pm} \geq 45^o$.
- Velocity error constant $\geq 20 \sec^{-1}$ (10 marks)

Question 3: A-3

a) For the system presented by its transfer function G(s) where,

$$G(s) = \frac{s^2 + 2s + 3}{s^3 + 4s^2 + 5s + 1}$$

(i) Get its controllable canonical state-space form.
(ii) Get its observable canonical state-space form.

Members of course Examination Committee:	Signature:	Date:
Lecturer: Prof. Medhat Elsengaby & Prof. Ahmed F. Amer	[signature]	10/1/2016
Course Coordinator : Dr. Ahmed Elshenawy	[signature]	10/1/2016
Head of Department: Prof. Hamdy Ashour	[signature]	10/1/2016

MPC 6/1-1

b) For a system presented by the following state-space form; obtain its transfer function:

$$\dot{\underline{x}}(t) = \begin{bmatrix} 1 & 3 \\ 2 & 5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 6 \\ 7 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 8 & 9 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + 10u(t)$$

(10 marks)

Question 4: C-3

a) Check for the state controllability and state observability of the system given below by its state-space form:

$$\dot{\underline{x}}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \underline{x}(t) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 0 & 4 & 1 \end{bmatrix} \underline{x}(t)$$

b) For a system presented by the following state dynamic equation,

$$\dot{\underline{x}}(t) = \begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 10 \end{bmatrix} u(t)$$

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

Find a state feedback matrix $\underline{k}$ such that the resulting closed-loop matrix A_f has eigenvalues located at $-2 \pm j2$. (10 marks)

Members of course Examination Committee:	Signature:	Date:
Lecturer: Prof. Medhat Elsengaby & Prof. Ahmed F. Amer	M. El Sengaby	4/1/2016
Course Coordinator: Dr. Ahmed El-Shenawy	[signature]	4/1/2016
Head of Department: Prof. Hamdy Ashour	Hamdy	4/1/2016