



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 $\zeta \geq 0.45$
- The velocity error constant $\geq 20 \text{ sec}^{-1}$
- The undamped natural frequency $\omega_n = 9 \text{ rad/sec}$ (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 $\phi_{pm} \geq 45^\circ$.
- Velocity error constant $\geq 20 \text{ sec}^{-1}$ (10 marks)

Question 3:

A-3

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

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

- Get its controllable canonical state-space form.
- Get its observable canonical state-space form.

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

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

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

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

Question 4:

C-3

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

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

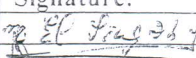
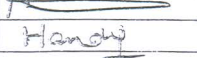

$$y(t) = \begin{bmatrix} 0 & 4 & 1 \end{bmatrix} \underline{x}(t)$$

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)

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