Alexandria University
Faculty of Engineering
Electrical Engineering Department
Mid-term Exam, March 2015

جامعة الإسكندرية
كلية الهندسة
قسم الهندسة الكهربية
امتحان نصف الفصل الدراسي الثاني (مارس ٢٠١٥)

Course Title and Code Number:
Control Systems and Components (EE391)
Third Year (Communications and Electronics)
Time Allowed: 45 Mins

Part II

اسم المقرر والرقم الكودي له:
نظم التحكم ومكوناتها (EE391)
السنة الدراسية الثالثة (اتصالات و الكترونيات)
الزمن: ٤٥ دقيقة

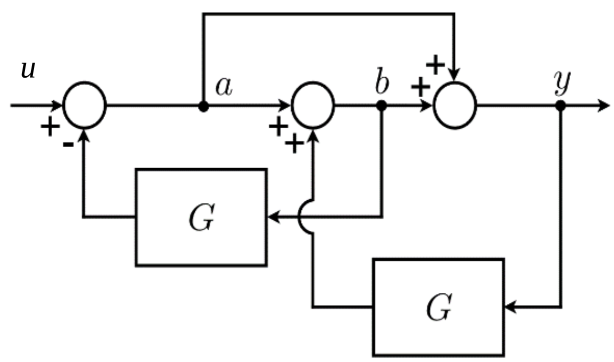
Name: **Seat number:**

Answer only two questions in the dedicated space: **(15 marks)**

Question 1: **(7 marks)**

For the block diagram shown in figure:

a) Find the transfer function $\frac{y}{u}$



b) Write a state space representation for $G = S$

c) Find the impulse response assuming zero initial conditions for $G = S$

Question 2: **(7 marks)**

A single-input single-output (SISO) system having *n* state variables is described in the state space as:

$$\dot{x}(t) = Ax(t) + bu(t)$$
$$y(t) = c^T x(t) + du(t)$$

a) Indicate the matrix size of *x(t), y(t), u(t), and A, b, c, d.*

b) For *n=3*, write an expression of the system's transfer function in terms of generic *A, b, c, d.*

c) For *n=3,* Draw the system block diagram showing individual system states.

Question 3: **(7 marks)**

A system is characterized by the following state equation:

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

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

a) Find the system transfer function $\frac{y(S)}{u(S)}$ and draw the system block diagram.

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b) Compute the state transition matrix.

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c) Obtain the solution to the state equation for a unit step input under zero initial conditions.

Laplace Transform Table

$f(t)$	$F(s)$
$f'(t)$	$s\,F(s) - f(0)$
$f''(t)$	$s^2 F(s) - s\,f(0) - f'(0)$
$\dfrac{d^n f(t)}{d t^n}$	$s^n F(s) - \sum_{i=0}^{n-1} s^{n-1-i} f^{(i)}(0)$
$f(t - t_0)\,u(t - t_0)$	$F(s)\,e^{-s t_0}$
$\int_0^t f(\tau)\,d\tau$	$\frac{1}{s} F(s)$
$f(t - \tau)$	$e^{-s\tau} F(s)$
$e^{-at} f(t)$	$F(s + a)$
$f(0) = \lim_{t \to 0} f(t) = \lim_{s \to \infty} s\,F(s)$	
$f(\infty) = \lim_{t \to \infty} f(t) = \lim_{s \to 0} s\,F(s)$	
$-t \cdot f(t)$	$\frac{d}{ds} F(s)$
$\boldsymbol{\delta(t)}$	$\mathbf{1}$
$\delta_{-1}(t)$ or 1	$\frac{1}{s}$
$\boldsymbol{e^{-at}}$	$\boldsymbol{\dfrac{1}{s+a}}$
t	$\frac{1}{s^2}$
$\sin(a t)$	$\frac{a}{s^2 + a^2}$
$\cos(a t)$	$\frac{s}{s^2 + a^2}$

The Laplace Transformation

$$F(s) = \int_0^{\infty} f(t)\,e^{-st}\,dt$$

$$f(t) = \frac{1}{2\pi i} \int_{\sigma - i\omega}^{\sigma + i\omega} F(s)\,e^{st}\,dt$$