UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	CONTROL SYSTEM THEORY
COURSE CODE	:	BEH30603
PROGRAMME	:	BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS
EXAMINATION DATE	:	DECEMBER 2015/JANUARY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS **OF FOUR (4)** PAGES ONLY

Q1 (a) Describe the conditions for a point to be on the root locus.

(3 marks)

(b) By using the general rules for sketching root locus, sketch the root locus for a control system with the following transfer functions:

$$G(s) = \frac{K}{(s-1)(s^2+4s+7)} \quad \text{and } H(s) = 1$$

(13 marks)

(c) Select the value of the gain K such that the dominant closed-loop poles will have a damping ratio of 0.5.

(4 marks)

Q2 (a) Explain how the Bode diagram can be used to determine the absolute stability of a closed-loop control system.

(4 marks)

(b) By using the asymptotic or straight line approximation method, draw the Bode diagram for a control system with the open loop transfer function is given by:

$$G(s)H(s) = \frac{10}{s(s+1)(s+10)}$$

(12 marks)

(c) Analyze the stability of this control system.

(4 marks)

Q3 (a) Explain the function of a compensator in control system.

(4 marks)

(b) **Figure Q3(b)** shows a phase lag compensator circuit. Formulate the transfer function of $E_o(s)/E_i(s)$ where $E_o(s)$ and $E_i(s)$ are the Laplace transformation of $e_o(t)$ and $e_i(t)$ respectively.

(6 marks)

(c) Design a phase lag compensator circuit for a control system in such a way that the steady state error can be reduced by 10 times for a unit step input and the open loop transfer function of the control system with unity feedback is given by:

$$G(s) = \frac{165}{(s+1)(s+2)(s+10)}$$

(10 marks)

Q4 A single input single output control system can be represented by the state equation and output equation respectively as $\underline{\dot{x}} = A\underline{x}(t) + B\underline{u}(t)$ and $y(t) = C\underline{x}(t)$, where the matrices A, B and C are given respectively by:

$$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$

(a) Determine the state transition matrix Φ(t) for this system.

(10 marks)

(b) Obtain the output y(t) when the system is subjected to a unit step input and the initial states are given by $\underline{x}(0) = [0 \ \ 0]^T$.

(10 marks)

Q5 The state equation of a single input single output control system can be represented by the equation $\underline{\dot{x}} = A\underline{x}(t) + B\underline{u}(t)$ where the matrices A and B are given respectively by:

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -6 & -5 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

(a) Calculate the eigenvalues for this system.

(5 marks)

(b) Analyze the controllability of this control system.

(5 marks)

(c) This control system is to be compensated by state variable feedback where the specified eigenvalues are s = –2 ± j4, and s = –10. Design the closed-loop control system by specifying the gains in the feedback paths.

(10 marks)

– END OF QUESTION –

FINAL EXAMINATION

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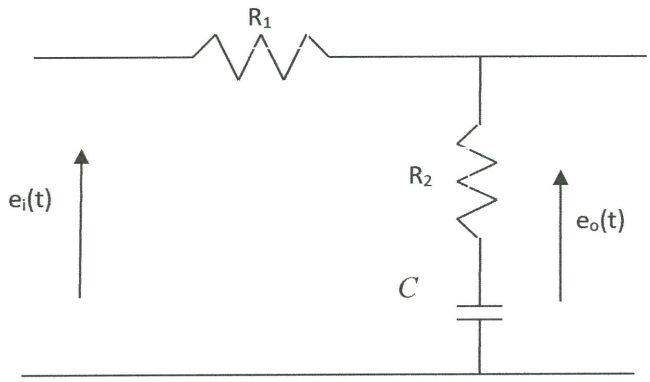

FIGURE Q3(b)

TABLE 1 : Laplace Transform Table

f(t)	*F(s)*
$u(t)$	$\frac{1}{s}$
$e^{-at}u(t)$	$\frac{1}{s+a}$
$e^{-at}\sin\omega t u(t)$	$\frac{\omega}{(s+a)^2+\omega^2}$
$e^{-at}\cos\omega t u(t)$	$\frac{s+a}{(s+a)^2+\omega^2}$