UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	ELECTRICAL CONTROL SYSTEM
COURSE CODE	:	BEF 33003
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JUNE / JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) List **four (4)** advantages of closed loop control system.

(6 marks)

(b) Describe the meaning of each control system component as listed below:

(i) Input.

(1 marks)

(ii) Output.

(1 marks)

(c) Amira is assigned by his lecturer to obtain a transfer function, $\frac{C(s)}{R(s)}$ for a steam distillation system as shown in **Figure Q1(c)**. The transfer function obtained by Amira is shown as:

$$\frac{C(s)}{R(s)} = \frac{G1G2G3^2}{G3 + G1H4[G3 + H3(G2G3)(H1 + G3H2 + 1)] + G1G2G3H5}$$

By using block diagram algebra approach, prove that the transfer function, $\frac{C(s)}{R(s)}$ obtained by Amira is right or wrong.

(17 marks)

Q2 (a) List **two (2)** physical laws of science and engineering used for developing a mathematical model in practice.

(5 marks)

(b) Describe the definition of translational mechanical system.

(3 marks)

(c) Determine the transfer function, $G(s) = \frac{X(s)}{F(s)}$ for the translational mechanical system as shown in **Figure Q2(c)**. Given the parameters of the system are as below:

$M_1=M_2=M_3=1$ Kg
$D_1=D_2=D_3=2$ N-s/m
$K_1=K_2=K_3=1$ N/m

(17 marks)

Q3 (a) Differentiate between over damped, critically damped and underdamped response.

(6 marks)

(b) Based on the block diagram of a positioning system as shown in **Figure Q3(b)**:

(i) Determine the transfer function of the system.

(3 marks)

(ii) Calculate the peak time (T_p), rise time (T_r), percentage of overshoot ($\%\mu_s$) and settling time (T_s) of the system.

(9 marks)

(c) A feedback control system is shown in **Figure Q3(c).** The system will be stabled if the K_c value is positive. Using Routh Hurwitz stability Criterion, investigate the range of K_c for stable system.

(7 marks)

Q4 The simplified block diagram for transformer tap changer tracking system is shown in **Figure Q4**.

(a) By using root locus sketching approach, investigate either each of these statement is correct or incorrect to represent the root locus characteristics for the system shown in **Figure Q4**: number of branches is 3, there is no angle of departure and angle of arrival, root locus exists on real axis between: 0 and -3, intersect of asymptotes is at -1.5, the system is stable when the value of K less than 0, and if the value of K is equal to -2.25225 the system is stable.

(17 marks)

(b) Sketch the root locus of the system.

(8 marks)

- END OF QUESTIONS –

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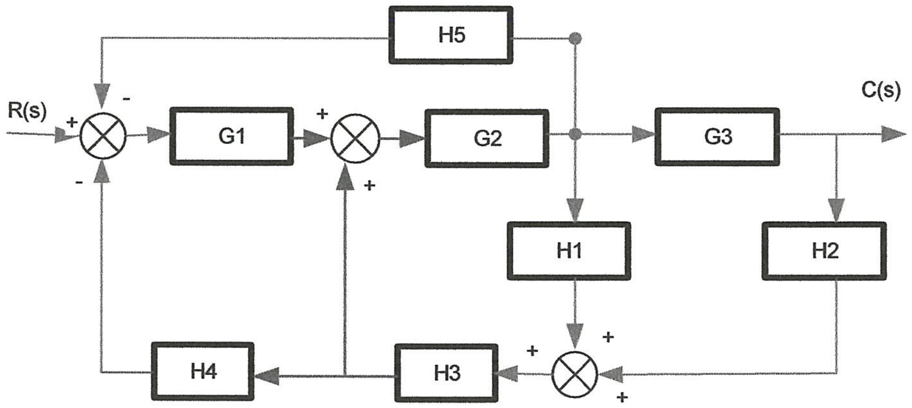

Figure Q1(c)

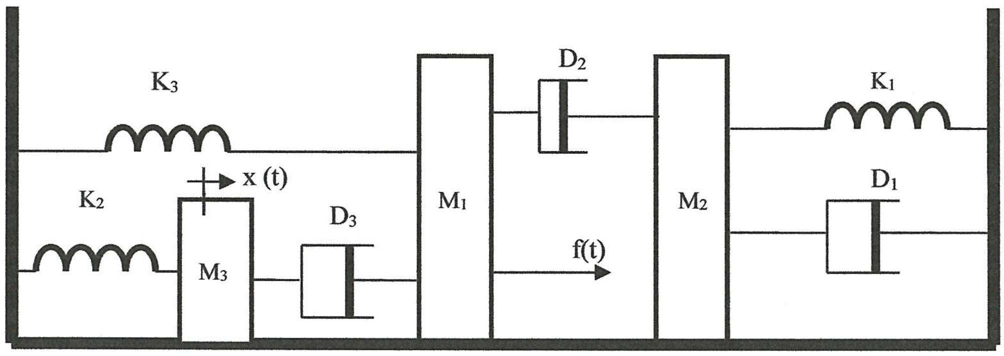

Figure Q2(c)

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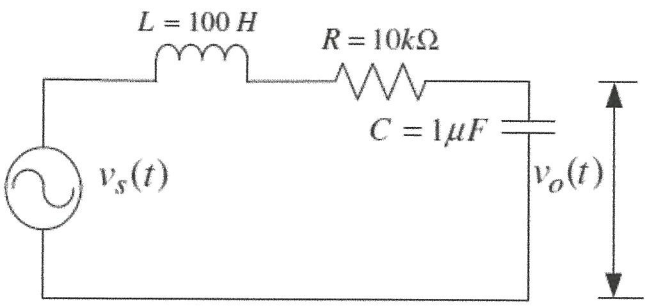

Figure Q3(b)

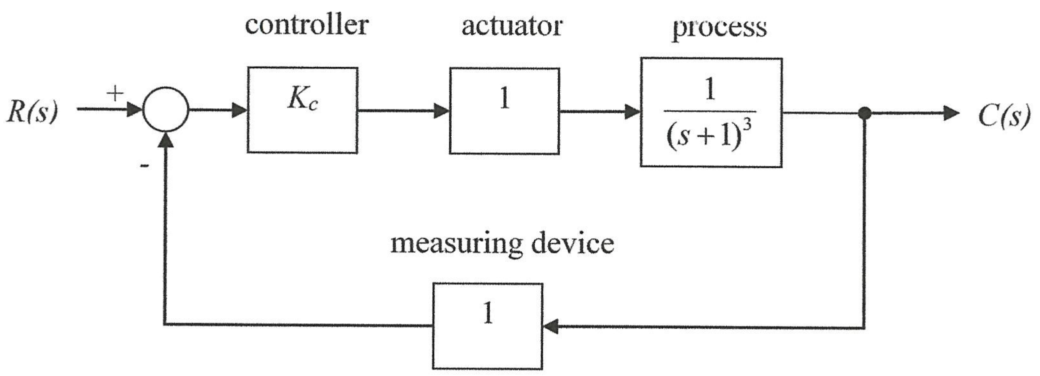

Figure Q3(c)

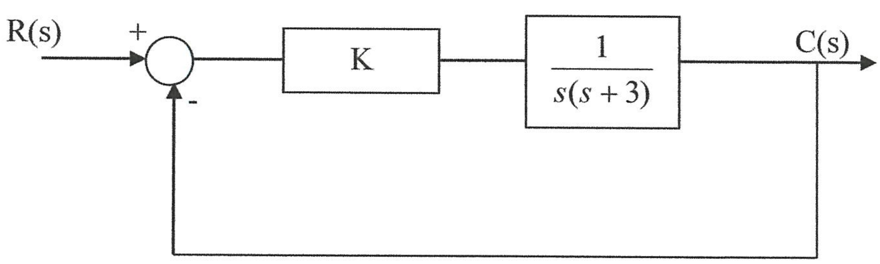

Figure Q4

TERBUKA

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FORMULAE

Table A
Laplace transform table

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

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Table B
Laplace transform theorems

Name	Theorem
Frequency shift	$\mathscr{L}\left[e^{-at}f(t)\right]=F(s+a)$
Time shift	$\mathscr{L}\left[f(t-T)\right]=e^{-sT}F(s)$
Differentiation	$\mathscr{L}\left[\frac{d^n f}{dt^n}\right]=s^nF(s)-\sum_{k=1}^{n}s^{n-k}f^{k-1}(0^-)$
Integration	$\mathscr{L}\left[\int_{0^-}^{t}f(\tau)d\tau\right]=\frac{F(s)}{s}$
Initial value	$\lim_{t\to 0}f(t)=\lim_{s\to\infty}sF(s)$
Final value	$\lim_{t\to\infty}f(t)=\lim_{s\to 0}sF(s)$

Table C
2nd Order prototype system equations

$\frac{C(s)}{R(s)}=\frac{\omega_n^{\ 2}}{s^2+2\zeta\omega_n s+\omega_n^{\ 2}}$	$T_r=\frac{\pi-\cos^{-1}\zeta}{\omega_n\sqrt{1-\zeta^2}}$
$\mu_p=e^{\frac{-\zeta\pi}{\sqrt{1-\zeta^2}}}$	$T_p=\frac{\pi}{\omega_n\sqrt{1-\zeta^2}}$
$T_s=\frac{4}{\zeta\omega_n}$ (2% criterion)	$T_s=\frac{3}{\zeta\omega_n}$ (5% criterion)