UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	CONTROL SYSTEM
COURSE CODE	:	DEK 3123
PROGRAMME	:	3 DEE/DET
EXAMINATION DATE	:	APRIL/MAY 2011
DURATION	:	2 ½ HOURS
INSTRUCTIONS	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

Q1 (a) Based on closed loop control system,

(i) Sketch the block diagram of the system.
(ii) Briefly explain all the elements involved in constructing the system.

(15 marks)

(b) List ten (10) control system classifications.

(10 marks)

Q2 (a) Find the time domain of the following transfer function.

$$F(s) = \frac{(s+10)}{s^2(s+1)(s+4)}$$

(18 marks)

(b) List three (3) types of time domain input function and sketch the graph respectively.

(7 marks)

Q3 (a) Find the transfer function for the block diagram shown in Figure Q3 (a).

(10 marks)

(b) List four (4) types of damping ratio with its value and sketch the response respectively.

(6 marks)

(c) For the following transfer function, find:

$$\frac{\theta_o(s)}{\theta_i(s)} = \frac{100}{s^2 + 25s + 100}$$

i) Find the natural frequency ω
ii) The damping ratio ζ
iii) The type of response

(9 marks)

Q4 (a) Give four (4) reasons why digital control system is most currently used in control system.

(4 marks)

(b) Calculate the output of decimal value of a 10-bits ADC when input voltage V_{in} is 2.5V and reference, V_{ref} is 5V.

(7 marks)

(c) Based on Figure Q4(c), explain the operation of the system.

(14 marks)

Q5 (a) Give 4 types of signal in digital control system and sketch the signal respectively.

(8 marks)

(b) Explain data acquisition system with the aid of complete block diagram.

(17 marks)

Q6 (a) List six (6) types of level measurement.

(6 marks)

(b) Briefly explains the working operation of Bourdon Tube with the aid of a gauge diagram.

(12 marks)

(c) i) Sketch the block diagram of the Final Control Element Operation.
ii) Briefly explain its operation.

(7 marks)

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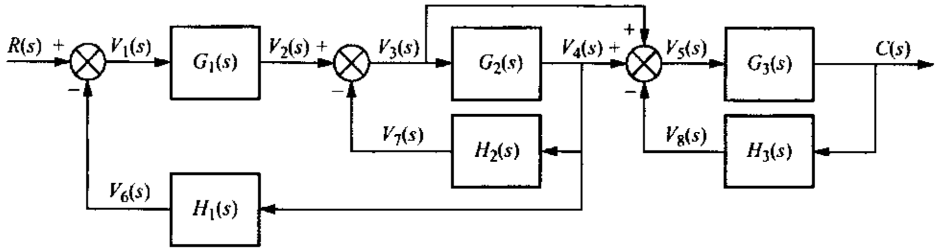

FIGURE Q3(a)

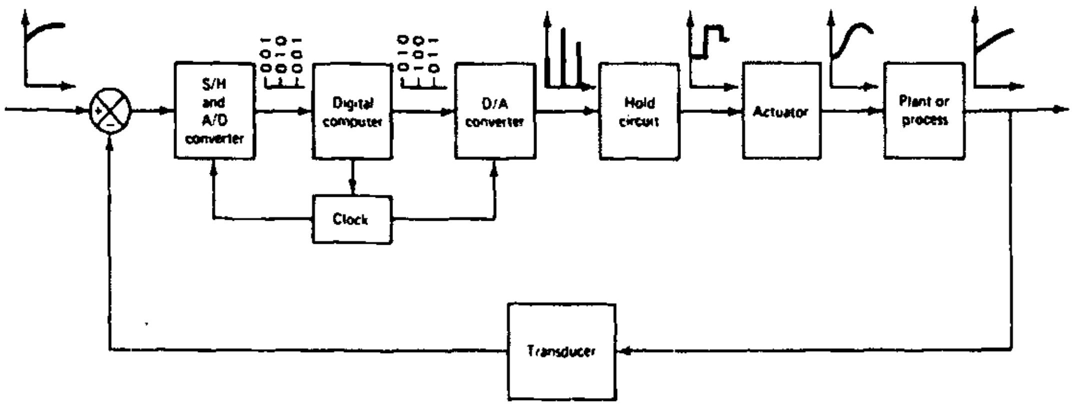

FIGURE Q4(c)

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Table1: Laplace Transform Table

Item no.	f(t)	F(s)
1.	$\delta(t)$	1
2.	$u(t)$	$\frac{1}{s}$
3.	$tu(t)$	$\frac{1}{s^2}$
4.	$t^n u(t)$	$\frac{n!}{s^{n+1}}$
5.	$e^{-at}u(t)$	$\frac{1}{s+a}$
6.	$\sin \omega t u(t)$	$\frac{\omega}{s^2+\omega^2}$
7.	$\cos \omega t u(t)$	$\frac{s}{s^2+\omega^2}$

Table 2: Transform Theorem

Item no.	Theorem		Name
1.	$\mathscr{L}[f(t)] = F(s)$	$= \int_{0-}^{\infty} f(t)e^{-st}dt$	Definition
2.	$\mathscr{L}[kf(t)]$	$= kF(s)$	Linearity theorem
3.	$\mathscr{L}[f_1(t)+f_2(t)]$	$= F_1(s) + F_2(s)$	Linearity theorem
4.	$\mathscr{L}[e^{-at}f(t)]$	$= F(s+a)$	Frequency shift theorem
5.	$\mathscr{L}[f(t-T)]$	$= e^{-sT}F(s)$	Time shift theorem
6.	$\mathscr{L}[f(at)]$	$= \frac{1}{a}F\left(\frac{s}{a}\right)$	Scaling theorem
7.	$\mathscr{L}\left[\frac{df}{dt}\right]$	$= sF(s) - f(0-)$	Differentiation theorem
8.	$\mathscr{L}\left[\frac{d^2f}{dt^2}\right]$	$= s^2F(s) - sf(0-) - \dot{f}(0-)$	Differentiation theorem
9.	$\mathscr{L}\left[\frac{d^nf}{dt^n}\right]$	$= s^nF(s) - \sum_{k=1}^{n} s^{n-k}f^{k-1}(0-)$	Differentiation theorem
10.	$\mathscr{L}\left[\int_{0-}^{t} f(\tau)d\tau\right]$	$= \frac{F(s)}{s}$	Integration theorem
11.	$f(\infty)$	$= \lim_{s\to 0} sF(s)$	Final value theorem[1]
12.	$f(0+)$	$= \lim_{s\to\infty} sF(s)$	Initial value theorem[2]

[1] For this theorem to yield correct finite results, all roots of the denominator of $F(s)$ must have negative real parts and no more than one can be at the origin.
[2] For this theorem to be valid, $f(t)$ must be continuous or have a step discontinuity at $t = 0$ (i.e., no impulses or their derivatives at $t = 0$).

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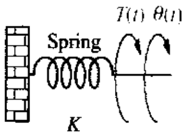
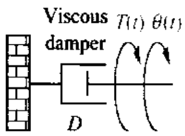
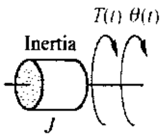
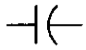
Table 3: Rotational Mechanical Table

Component	Torque-angular velocity	Torque-angular displacement	Impedance $Z_M(s) = T(s)/\theta(s)$
	$T(t) = K\int_0^t \omega(\tau)\,d\tau$	$T(t) = K\theta(t)$	K
	$T(t) = D\omega(t)$	$T(t) = D\frac{d\theta(t)}{dt}$	Ds
	$T(t) = J\frac{d\omega(t)}{dt}$	$T(t) = J\frac{d^2\theta(t)}{dt^2}$	Js^2

Note: The following set of symbols and units is used throughout this book: $T(t)$ = N-m (newton-meters), $\theta(t)$ = rad (radians), $\omega(t)$ = rad/s (radians/second), K = N-m/rad (newton-meters/radian), D = N-m-s/rad (newton-meters-seconds/radian), J = kg-m^2 (kilogram-meters^2 = newton-meters-seconds^2/radian).

Table 4: Electrical Component Table

Component	Voltage-current	Current-voltage	Voltage-charge	Impedance $Z(s) = V(s)/I(s)$	Admittance $Y(s) = I(s)/V(s)$
 Capacitor	$v(t) = \frac{1}{C}\int_0^t i(\tau)\,d\tau$	$i(t) = C\frac{dv(t)}{dt}$	$v(t) = \frac{1}{C}q(t)$	$\frac{1}{Cs}$	Cs
 Resistor	$v(t) = Ri(t)$	$i(t) = \frac{1}{R}v(t)$	$v(t) = R\frac{dq(t)}{dt}$	R	$\frac{1}{R} = G$
 Inductor	$v(t) = L\frac{di(t)}{dt}$	$i(t) = \frac{1}{L}\int_0^t v(\tau)\,d\tau$	$v(t) = L\frac{d^2q(t)}{dt^2}$	Ls	$\frac{1}{Ls}$

Note: The following set of symbols and units is used throughout this book: $v(t)$ = V (volts), $i(t)$ = A (amps), $q(t)$ = Q (coulombs), C = F (farads), R = Ω (ohms), G = ℧ (mhos), L = H (henries).