KOLEJ YAYASAN PELAJARAN JOHOR

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FINAL EXAMINATION

COURSE NAME	:	**CONTROL SYSTEMS**
COURSE CODE	:	**DKE 2163**
EXAMINATION	:	**OCTOBER 2019**
DURATION	:	**2 HOURS 30 MINUTES**

INSTRUCTION TO CANDIDATES /
ARAHAN KEPADA CALON

1. The examination paper consists of **FOUR (4)** questions. Answer **ALL** questions in the anwer booklet provided ./
*Kertas soalan ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan didalam Buku Jawapan yang dibekalkan.*

2. Candidates are not allowed to bring any material to examination room except with the permission from the invigilator. The formula was attached at the back question paper. /
Calon tidak dibenarkan membawa masuk sebarang peralatan ke dalam bilik peperiksaan kecuali dengan kebenaran pengawas peperiksaan.

3. Please check to make sure that this examination pasck consist of:/
Sila pastikan bahan-bahan berikut diperoleh untuk sesi peperiksaan ini:
   i. Question Paper
   / Kertas Soalan
   ii. Answer Booklet
   / Buku Jawapan
   iii. Graph Paper
   / Kertas Graf

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO /
JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIBERITAHU

This examination paper consists of 8 printed pages including front page
Kertas soalan ini mengandungi 8 halaman bercetak termasuk muka hadapan

This paper contains of **FOUR(4)** questions. Answer **ALL** questions in the Answer Booklet.

*Kertas soalan ini mengandungi **EMPAT(4)** soalan. Jawab **SEMUA** soalan di dalam buku jawapan yang disediakan.*

QUESTION 1 / SOALAN 1

(a) What is an open loop control system and state the characteristics in control system.

Apakah sistem kawalan gelung terbuka dan nyatakan kriterianya dalam sistem kawalan.

(5 Marks / *Markah*)

(b) Draw the block diagram for an open loop control system.

Lukiskan rajah blok untuk sistem kawalan gelung terbuka.

(3 Marks / *Markah*)

(c) Find the transfer function, $G(s) = \frac{V_L(s)}{V(s)}$ for the circuit shown in Figure Q1(c).

Dapatkan rangkap pindah , $G(s) = \frac{V_L(s)}{V(s)}$ bagi litar Rajah Q1(c) di bawah.

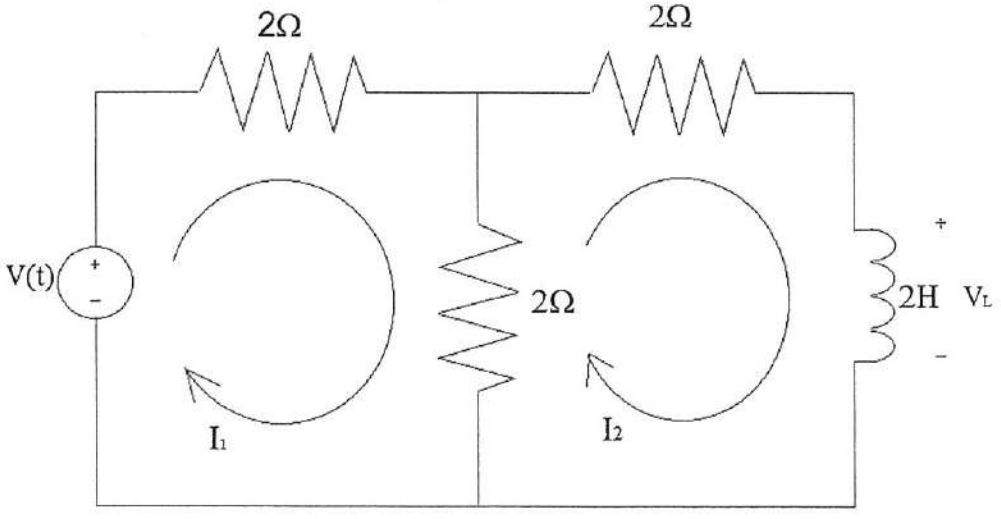

Figure Q1(c)/ *Rajah Q1(c)*

(10 Marks / *Markah*)

QUESTION 2 / SOALAN 2

Given the system in Figure Q2(a) below, find J and D to yield 20% percent overshoot and a settling time of 2 seconds for a step input of torque T(t).

Diberi sistem pada Rajah Q2(a) di bawah, cari J dan D untuk menghasilkan 20% peratus lajakan dan masa penginapan pada 2 saat untuk masukan unit daya kilas tork T(t).

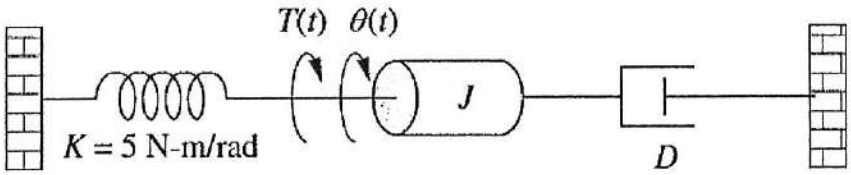

Figure Q2(a) / *Rajah Q2(a)*

(13 Marks / *Markah*)

QUESTION 3 / SOALAN 3

(a) Find the transfer function C(s)/R(s) in the figure Q3(a) by using a Mason's Rule formula.

Tentukan rangkap pindah C(s)/R(s) pada rajah Q3(a) dengan menggunakan Aturan Mason.

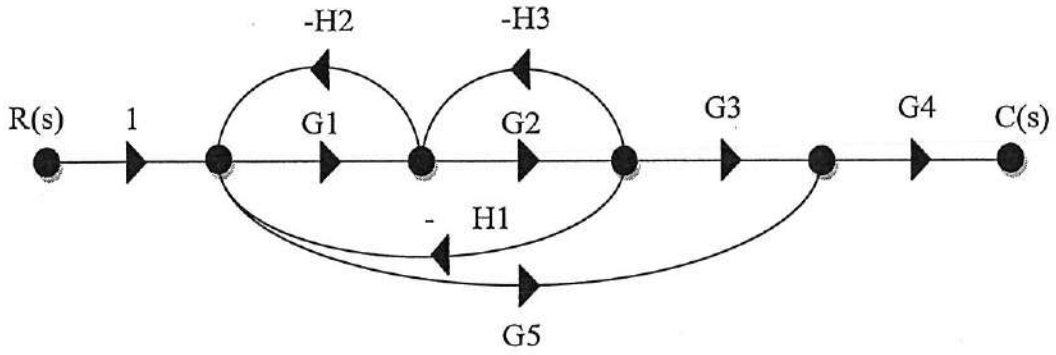

Figure Q3(a) / *Rajah* Q3(a)

(8 marks / markah)

(b) Use Routh-Hurwitz stability criterion to determine how many roots with positive real parts for the equation.

Gunakan kriteria kestabilan Routh-Hurwitz untuk menentukan jumlah punca untuk bahagian sebenar positif untuk persamaan ini.

$$S^5 + 10s^4 + 30s^3 + 80s^2 + 344s + 480 = 0$$

(10 Marks / *Markah*)

(c) Figure Q3(c) below shows the block diagram of the transfer function C(s)/R(s). Find the stability of the system by using Routh-Hurwitz criterion.

Rajah Q3(c) di bawah menunjukkan rajah blok untuk rangkap pindah C(s)/R(s). *Cari kestabilan sistem dengan menggunakan kriteria Routh-Hurwitz.*

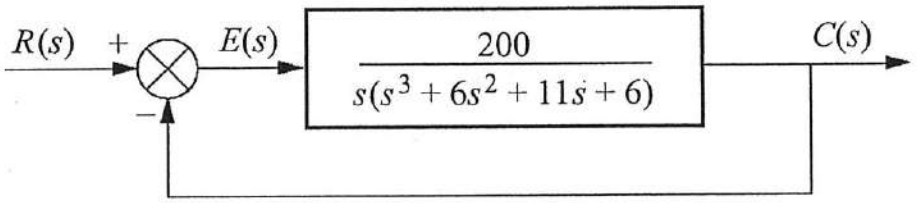

Figure Q3(c) / *Rajah* Q3(c)

(8 marks / markah)

QUESTION 4 / SOALAN 4

(a) For the unity feedback control system shown in Figure Q4(a), where K and T are constants. The maximum overshoot (%O.S) for unit step is 10%. Peak time, t_p for the system is 0.75s.

Untuk sistem kawalan suapbalik unit ditunjukkan dalam Rajah Q4(a) di mana K dan T adalah pemalar. Lajakan maksimum bagi sambutan unit langkah ialah 10%. Masa puncak, t_p untuk sistem ialah 0.75s.

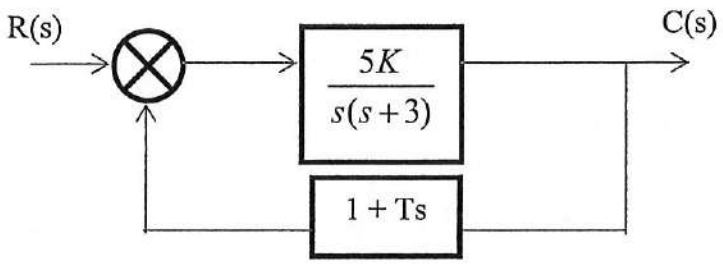

Figure Q4(a) / Rajah Q4(a)

i) Define the transfer function system ,C(s)/R(s) in terms of K and T.

ii) Express the damping ratio, ξ and natural frequency, ω_n in terms of K and T.

iii) Specify damping ratio, ξ and natural frequency, ω_n.

iv) Find the value of K and T.

i) Ungkapkan rangkap pindah sistem, C(s)/R(s) dalam sebutan K dan T.

ii) Ungkapkan nisbah redaman, ξ dan frekuensi tabii, ω_n dalam sebutan K dan T.

iii) Tentukan nisbah redaman, ξ dan frekuensi tabii, ω_n.

iv) Cari nilai K dan T.

(18Marks / *Markah*)

(b) An open loop system with unity feedback has an open loop transfer function G(s) given by :

Satu sistem gelung buka suap balik uniti mempunyai rangkap pindah gelung buka G(s) seperti berikut:

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

If K = 50, sketch the Bode magnitude and phase plot using straight line approximation.

Sekiranya K=50, lakarkan plot Bode magnitud dan fasa menggunakan penghampiran garis lurus.

i) Calculate the gain margin and phase margin.
Kirakan jidar gandaan dan jidar fasa.

ii) State the stability of the unity feedback system.
Nyatakan kestabilan sistem suap balik unit.

[For the magnitude plot, use a scale of 1 unit = 20dB with maximum value 20dB and minimum value -80dB, for the phase plot, use of a scale of 1 unit= 45 o with maximum value = -45° and minimum value = -225°]
[Untuk plot magnitud, gunakan skala 1 unit = 20dB dengan magnitud maksimum 20dB dan magnitud minimum -80dB, untuk fasa, gunakan skala 1 unit = 45 dengan magnitud fasa maksimum -45° dan magnitud fasa minimum = -225°]

(25 Marks / *Markah*)

[100 Marks / *Markah*]

END OF QUESTION PAPER / KERTAS SOALAN TAMAT

Laplace Transform Table

(Jadual Penjelmaan Laplace)

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.	$\cos \omega t u(t)$	$\frac{s}{s^2 + \omega^2}$

Laplace Transform Theorems Table

(*Jadual Theorem Penjelmaan Laplace*)

Item no.	Theorem	Name
1.	$\mathcal{L}[f(t)] = F(s) = \int_{0-}^{\infty} f(t)e^{-st}dt$	Definition
2.	$\mathcal{L}[kf(t)] = kF(s)$	Linearity theorem
3.	$\mathcal{L}[f_1(t) + f_2(t)] = F_1(s) + F_2(s)$	Linearity theorem
4.	$\mathcal{L}[e^{-at}f(t)] = F(s+a)$	Frequency shift theorem
5.	$\mathcal{L}[f(t-T)] = e^{-sT}F(s)$	Time shift theorem
6.	$\mathcal{L}[f(at)] = \frac{1}{a}F\left(\frac{s}{a}\right)$	Scaling theorem
7.	$\mathcal{L}\left[\frac{df}{dt}\right] = sF(s) - f(0-)$	Differentiation theorem
8.	$\mathcal{L}\left[\frac{d^2f}{dt^2}\right] = s^2F(s) - sf(0-) - f'(0-)$	Differentiation theorem
9.	$\mathcal{L}\left[\frac{d^nf}{dt^n}\right] = s^nF(s) - \sum_{k=1}^{n} s^{n-k}f^{k-1}(0-)$	Differentiation theorem
10.	$\mathcal{L}\left[\int_{0-}^{t} f(\tau)d\tau\right] = \frac{F(s)}{s}$	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]