SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI JUN 2018

DJM5092: CONTROL SYSTEM

TARIKH : 03 NOVEMBER 2018
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEBELAS (11)** halaman bercetak.
Struktur (4 soalan)
Dokumen sokongan yang disertakan : Jadual dan Graf

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTION:

This section consists of **FOUR (4)** structured questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan struktur. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1
C1

(a) Define control system and state **THREE (3)** applications of control system.

*Berikan definisi sistem kawalan dan nyatakan **TIGA (3)** aplikasi sistem kawalan.*

[5 marks]

[*5 markah*]

CLO1
C3

(b) By referring to Figure Q1(b) :

Dengan merujuk kepada Rajah S1(b):

i. State the type of control system in Figure Q1(b).

Nyatakan jenis sistem kawalan pada Rajah S1(b).

[2 marks]

[*2 markah*]

ii. Interpret the transfer function for this control system.

Terjemahkan rangkap pindah untuk sistem kawalan ini.

[8 marks]

[*8 markah*]

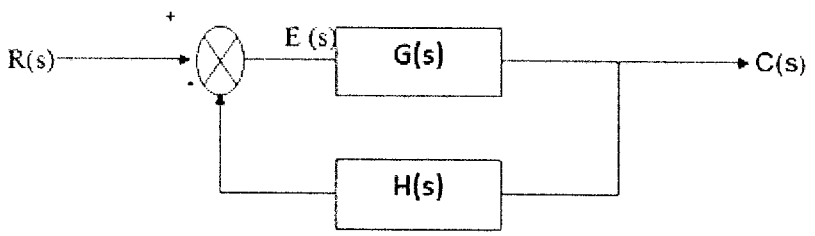

Figure Q1(b) / *Rajah S1(b)*

CLO1
C2

(c) In an industrial process control, several types of controllers are being used based on its application. Determine **FOUR (4)** types of controller that are usually used in industrial process control.

*Dalam kawalan proses industri, beberapa jenis pengawal digunakan berdasarkan kepada aplikasinya. Kenal pasti **EMPAT (4)** jenis pengawal yang biasa digunakan dalam kawalan proses industri.*

[4 marks]
[*4 markah*]

CLO1
C3

(d) PID controller is the most advanced controller being used in industry.
Pengawal PID merupakan pengawal yang paling maju digunakan dalam industri.

i. List **TWO (2)** advantages and disadvantages of using PID controller.
*Senaraikan **DUA (2)** kelebihan dan keburukan pengawal PID.*

[4 marks]
[*4 markah*]

ii. List **TWO (2)** applications of PID controller.
*Senaraikan **DUA (2)** aplikasi pengawal PID.*

[2 marks]
[*2 markah*]

QUESTION 2

SOALAN 2

CLO1
C2

(a) A liquid flows in a pipe where the temperature is taken 4 meter away from the temperature detector which is attached to the pipe. Given the diameter of the pipe is 0.6 meter and the liquid flow rate is 3 m^3/s.

Cecair mengalir melalui paip di mana suhu diambil 4 meter daripada pengesan suhu yang dipasang pada paip. Diberi diameter paip adalah 0.6 meter dan kadar alir cecair adalah 3 m^3/s.

i. Describe the meaning of velocity lagging.
Jelaskan maksud susul halaju.

[1 mark]
[*1 markah*]

ii. Calculate the velocity lagging of the liquid traced from the temperature detector.
Kirakan susul halaju cecair yang dikesan dari pengesan suhu.

[6 marks]
[*6 markah*]

CLO1
C3

(b) In a system, the value of transfer lagging is 0.5 s. The temperature increasing rate is 2 °K/s while the temperature cooling rate is 1 °K/s. Given the set point is 353°K. Calculate:

Dalam sebuah sistem, nilai susul pemindahannya ialah 0.5 saat. Kadar suhu meningkat 2 °K/s sementara kadar pendinginan suhu 1 °K/s. Diberi suhu titik set ialah 353°K. Kira:

i. Overshoot.
Nilai terlajak atas.

[2 marks]
[*2 markah*]

ii. Undershoot.
Nilai terlajak bawah.

[2 marks]
[*2 markah*]

iii. Offset.
Nilai ralat.

[3 marks]
[*3 markah*]

iv. Average temperature.
Nilai suhu purata.

[3 marks]
[*3 markah*]

CLO1
C4

(c) Differentiate between the characteristics of Proportional Controller and Integral Controller.
Bezakan ciri-ciri Pengawal Berkadar Terus dengan Pengawal Kamiran.

[8 marks]
[*8 markah*]

QUESTION 3

SOALAN 3

CLO1
C2

(a) Given

Diberi

$$f(t) = 3\ddot{x}+5\dot{x}+7x$$

$$x(0) = 2 \quad \dot{x}(0)= 4$$

i. Identify the basic formula of Laplace Transform.

Kenalpasti formula asas bagi Jelmaan Laplace.

[1 mark]

[*1 markah*]

ii. Calculate the Laplace Transform F(s) for the above function.

Kirakan Jelmaan Laplace F(s) untuk fungsi di atas.

[6 marks]

[6 *markah*]

CLO1
C3

(b) Signal flow graph is one of the methods to find transfer function.

Graf aliran syarat merupakan salah satu cara untuk mendapatkan rangkap pindah.

i. Interpret the meaning of signal flow graph.

Tafsirkan definisi graf aliran syarat.

[3 marks]

[*3 markah*]

ii. List **TWO (2)** advantages of using signal flow graph to represent a system.

*Senaraikan **DUA (2)** kelebihan menggunakan graf aliran syarat untuk mewakili sistem.*

[2 marks]

[*2 markah*]

iii. List the difference between source node and sink node of signal flow graph.
Senaraikan perbezaan antara nod punca dan nod terima dalam graf aliran syarat.

[2 marks]
[*2 markah*]

iv. List **THREE (3)** closed-loop of the signal flow graph given in Figure Q3(b).
*Senaraikan **TIGA (3)** gelung tertutup bagi graf aliran syarat dalam Rajah S3(b).*

[3 marks]
[*3 markah*]

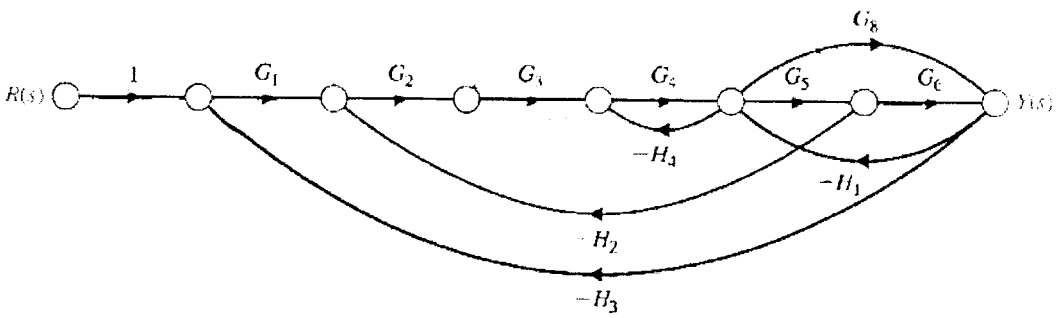

Figure Q3 (b) / *Rajah S3 (b)*

CLO1
C4

(c) Figure Q3(c) shows a block diagram that has been converted to a signal flow graph. Solve the transfer function using Mason's Rule.
Rajah S3(c) menunjukkan gambarajah blok yang telah ditukar kepada graf aliran syarat. Selesaikan rangkap pindah menggunakan Hukum Mason.

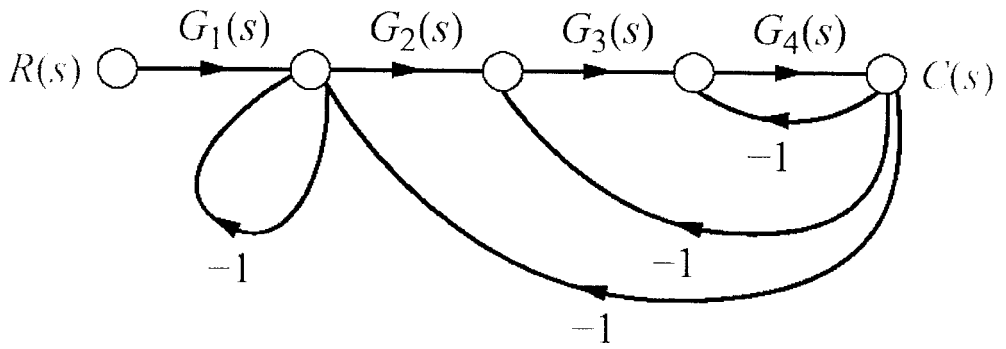

Figure Q3 (c) / *Rajah S3 (c)*

[8 marks]
[*8 markah*]

QUESTION 4

SOALAN 4

CLO1 C2

(a) Every system needs to be tested to find the stability of the system.
Setiap sistem perlulah diuji untuk mengetahui kestabilan pada sistem tersebut

i. Identify **TWO (2)** types of stability test method.
*Kenalpasti **DUA (2)** jenis kaedah ujian kestabilan.*

[2 marks]
[*2 markah*]

ii. Describe **TWO (2)** Routh-Hurwitz stability criteria.
*Huraikan **DUA (2)** kriteria kestabilan Routh-Hurwitz.*

[3 marks]
[*3 markah*]

CLO1 C3

(b) Given
Diberi

$$s^4 + 22s^3 + 164s^2 + 458s + 315 = 0$$

By using Routh-Hurwitz criteria, calculate the stability of this closed loop system.
Dengan menggunakan kriteria Routh-Hurwitz, kirakan kestabilan sistem kawalan gelung tertutup ini.

[9 marks]
[*9 markah*]

CLO1
C4

(c) Bode Diagram is a graph of the frequency response of a system. It is a combination of a magnitude plot and a phase shift. Draw the Bode Diagram by referring to the data in Table Q4(c).

Rajah Bode merupakan rajah frekuensi sesuatu sistem. Ianya merupakan kombinasi plot magnitud dan alihan fasa. Lukiskan Rajah Bode berdasarkan kepada Jadual S4(c).

Frequency (rad/s)	0.2	0.4	0.8	1.0	2.0	4.0	6.0	8.0	10.0
Magnitude (dB)	40	34	29	26	12	2	-7	-13	-20
Phase angle (degree)	-105	-120	-140	-150	-178	-210	-224	-238	-240

Table Q4(c) / *Jadual S4(c)*

[6 marks]
[*6 markah*]

CLO1
C4

(d) By referring to your Bode Diagram in question Q4(c), determine:-
Berpandukan Rajah Bode anda pada soalan 4(c), kenalpasti:-

i. Gain margin.
Margin gandaan.

ii. Phase margin.
Margin fasa.

iii. Conclusion of the system stability.
Kesimpulan kestabilan sistem.

[5 marks]
[*5 markah*]

SOALAN TAMAT

Table 1: Table of Laplace Transforms

Number	$f(t)$	$F(s)$
1	$\delta(t)$	1
2	$u_s(t)$	$\frac{1}{s}$
3	t	$\frac{1}{s^2}$
4	t^n	$\frac{n!}{s^{n+1}}$
5	e^{-at}	$\frac{1}{(s+a)}$
6	te^{-at}	$\frac{1}{(s+a)^2}$
7	$\frac{1}{(n-1)!}t^{n-1}e^{-at}$	$\frac{1}{(s+a)^n}$
8	$1-e^{-at}$	$\frac{a}{s(s+a)}$
9	$e^{-at}-e^{-bt}$	$\frac{b-a}{(s+a)(s+b)}$
10	$be^{-bt}-ae^{-at}$	$\frac{(b-a)s}{(s+a)(s+b)}$
11	$\sin at$	$\frac{a}{s^2+a^2}$
12	$\cos at$	$\frac{s}{s^2+a^2}$
13	$e^{-at}\cos bt$	$\frac{s+a}{(s+a)^2+b^2}$
14	$e^{-at}\sin bt$	$\frac{b}{(s+a)^2+b^2}$
15	$1-e^{-at}(\cos bt+\frac{a}{b}\sin bt)$	$\frac{a^2+b^2}{s[(s+a)^2+b^2]}$

Table 1: Properties of Laplace Transforms

Number	Time Function	Laplace Transform	Property
1	$af_1(t) + bf_2(t)$	$aF_1(s) + bF_2(s)$	Superposition
2	$f(t-T)u_s(t-T)$	$F(s)e^{-sT}$; $T \geq 0$	Time delay
3	$f(at)$	$\frac{1}{a}F(\frac{s}{a})$; $a > 0$	Time scaling
4	$e^{-at}f(t)$	$F(s+a)$	Shift in frequency
5	$\frac{df(t)}{dt}$	$sF(s) - f(0^-)$	First-order differentiation
6	$\frac{d^2f(t)}{dt^2}$	$s^2F(s) - sf(0^-) - f^{(1)}(0^-)$	Second-order differentiation
7	$f^n(t)$	$s^nF(s) - s^{n-1}f(0) - s^{n-2}f^{(1)}(0) - \ldots - f^{(n-1)}(0)$	n^{th}-order differentiation
8	$\int_{0^-}^{t} f(\zeta)d\zeta$	$\frac{1}{s}F(s)$	Integration
9	$f(0^+)$	$\lim_{s\to\infty} sF(s)$	Post-initial value theorem
10	$\lim_{t\to\infty} f(t)$	$\lim_{s\to 0} sF(s)$	Final value theorem
11	$tf(t)$	$-\frac{dF(s)}{ds}$	Multiplication by time