SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI DISEMBER 2016

DEJ3133: BASIC CONTROL SYSTEM

TARIKH : 09 APRIL 2017
MASA : 2.30 PM – 4.30 PM (2 JAM)

Kertas ini mengandungi **SEBELAS (11)** halaman bercetak.
Bahagian A: Objektif (10 soalan)
Bahagian B: Sturktur (4 soalan)
Bahagian C: Esei (2 soalan)
Dokumen sokongan yang disertakan :
Formula Laplace, Rajah Pengecilan Blok

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A: 10 MARKS
BAHAGIAN A: 10 MARKAH

INSTRUCTION:
This section consists of **TEN (10)** objective questions. Mark your answers in the OMR form provided.

ARAHAN:
*Bahagian ini mengandungi **SEPULUH (10)** soalan objektif. Tandakan jawapan anda di dalam borang OMR yang disediakan.*

CLO1
C1

1. A good control system has all the following features **EXCEPT**
*Satu sistem kawalan yang baik mempunyai ciri-ciri berikut **KECUALI***

A good stability
kestabilan yang baik

B slow response
tindakbalas yang perlahan

C good accuracy
ketepatan yang baik

D less expensive
lebih murah

CLO1
C2

2. A car is running at a constant speed of 50km/h. Identify the feedback element for the driver.
Sebuah kereta sedang berjalan pada kelajuan malar 50km/j. Tentukan unsur suapbalik bagi pemandu.

A Clutch
Klac

B Speedometer
Meter kelajuan

C Eyes
Mata

D Steering wheel
Roda stereng

CLO1
C2

3. The following are examples of closed loop control system in real life application **EXCEPT**
*Berikut adalah contoh bagi sistem gelung tertutup dalam aplikasi kehidupan sebenar **KECUALI***

A home heating system
sistem pemanas rumah

B ship stabilization
kapal penstabil

C D.C. motor speed control
kawalan kelajuan motor D.C.

D stepper motor positioning system
sistem kedudukan motor pelangkah

CLO2
C3

4. Calculate the poles of the transfer function below
Kirakan kutub bagi rangkap pindah di bawah

$$T(s) = \frac{(s+4)}{s(s-6)}$$

A s = 0, s = 4

B s = -4, s = 6

C s = 0, s = 6

D s = -4, s = 0

CLO1
C2

5. Laplace Transform formula can be expressed as _____
Formula Transformasi Laplace diekspresikan sebagai _____

A $F(s) = \int_{\infty}^{0} f(t).e^{-st}\,dt$

B $F(s) = \int_{0}^{\infty} f(t).e^{-st}\,dt$

C $F(s) = \int_{0}^{\infty} f(t).e^{st}\,dt$

D $F(s) = \int_{\infty}^{0} f(t).e^{st}\,dt$

CLO1
C1

6. Based on the statement below, identify the **CORRECT** respond type of the control system.
*Berdasarkan kenyataan di bawah, kenal pasti jenis respon yang **BETUL** bagi sistem kawalan tersebut.*

- Systems which have damping ratio lying between zero and unity.
- *Sistem yang mempunyai nisbah redaman di antara sifar dan satu.*

A Underdamped system
Sistem redaman kurang

B Criticaly damped system
Sistem redaman genting

C Overdamped system
Sistem redaman lebih

D Unity system
Sistem uniti

CLO1
C2

7. A system produces the following equation
Satu sistem menghasilkan persamaan berikut

$$G(s) = \frac{100}{s^2 + 8s + 100}$$

Calculate the damping ratio (ξ) for the system.
Kirakan nisbah redaman (ξ) untuk sistem tersebut.

A 0.2
B 0.4
C 0.8
D 8

CLO1
C1

8. In a proportional temperature controller, if the temperature under the heater increases, the offset will
Dalam satu pengawal suhu berkadaran, jika suhu di bawah pemanas meningkat, offset akan

A Increase
meningkat

B Reduce
menurun

C remain unaffected
tetap tidak terjejas

D none of the above
tiada satu di atas

CLO1
C2

9. A system with a controller reduces the steady state error to a step input. This can be achieved by
Satu sistem dengan satu pengawal mengurangkan ralat keadaan mantap bagi satu input langkah. Ia boleh dicapai dengan

A rate feedback
kadar suapbalik

B increasing the controller gain
meningkatkan gandaan pengawal

C adding internal action to the controller
menambah tindakan dalaman pada pengawal

D position feedback
tempat suapbalik

CLO2
C3

10. The range of measured variable for a certain control system is 4mV to 20mV and a setpoint of 10mV. Calculate the error in percentage of span when the measured variable is 8mV.
Julat pembolehubah yang telah diukur untuk satu sistem kawalan tertentu ialah 4mV kepada 20mV dan setpointnya ialah 10mV. Hitung ralat dalam peratus span apabila pembolehubah yang telah diukur ialah 8mV.

A 12.5%
B 4%
C 80%
D 25%

SECTION B : 60 MARKS
BAHAGIAN B : 60 MARKAH

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

ARAHAN:
*Bahagian ini mengandungi **EMPAT (4)** soalan berstruktur. Jawab **SEMUA** soalan.*

CLO1
C1

QUESTION 1
SOALAN 1

a. List **THREE (3)** applications that use open loop control system.
*Senaraikan **TIGA (3)** aplikasi yang menggunakan sistem kawalan gelung terbuka.*

[3 marks]
[*3 markah*]

CLO1
C2

b. Compare **FIVE (5)** differences between opened loop control system and closed loop control system.
*Bandingkan **LIMA (5)** perbezaan antara sistem gelung terbuka dan sistem gelung\ tertutup*

[5 marks]
[5 *markah*]

CLO2
C3

Figure B1(c) / *Rajah B1(c)*

c. Figure B1(c) shows a woman riding a motorcycle. Draw a block diagram and explain the operations involved in that condition.
Rajah B1(c) menunjukkan seorang wanita menunggang motorsikal. Lukiskan gambarajah blok dan terangkan operasi yang terlibat dalam keadaan tersebut.

[7 marks]
[*7 markah*]

CLO1
C1

QUESTION 2

SOALAN 2

a. List **THREE (3)** advantages of Block Diagram Reduction.
*Senaraikan **TIGA (3)** kebaikan Pengecilan Gambarajah Blok.*

[3 marks]
[*3 markah*]

CLO1
C2

b. Referring to the system shown in Figure B2(b), calculate its transfer function where $V_o(t)$ is output and $V_i(t)$ is input to the system.
Merujuk kepada sistem pada Rajah B2(b), kirakan rangkap pindahnya dimana $V_o(t)$ adalah keluaran and $V_i(t)$ adalah masukan bagi sistem ini.

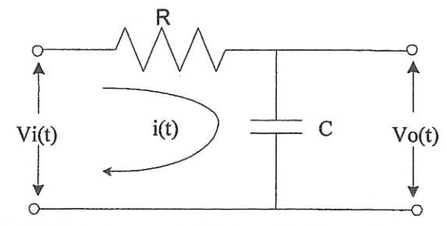


Figure B2(b) / *Rajah B2(b)*

[5 marks]
[5 *markah*]

CLO2
C3

c. Calculate the inverse Laplace Transform of the following function.
Kirakan Jelmaan Laplace songsang bagi fungsi berikut.

$$F(s)=\frac{15}{s(s+6)(s+8)}$$

[7 marks]
[*7 markah*]

CLO1
C1

QUESTION 3

SOALAN 3

a. State **THREE (3)** types of standard test input with a suitable diagram.
*Nyatakan **TIGA (3)** jenis input ujian piawai berserta rajah yang sesuai.*

[3 marks]
[*3 markah*]

CLO1
C2

b. Determine the type of damping in the following system:
Tentukan jenis redaman bagi sistem berikut:

$$\frac{C(s)}{R(s)}=\frac{8}{s^2+3s+8}$$

[5 marks]
[*5 markah*]

CLO2
C3

c. Solve the response c(t) of the following transfer function for a unit ramp input.
Kirakan sambutan c(t) bagi rangkap pindah berikut dengan masukan unit tanjakan.

$$\frac{C(s)}{R(s)}=\frac{3}{s^2+4s+3}$$

[7 marks]
[*7 markah*]

CLO1
C1

QUESTION 4

SOALAN 4

a. State **THREE (3)** properties of controller.
*Nyatakan **TIGA (3)** sifat-sifat pengawal.*

[3 marks]
[*3 markah*]

CLO1
C2

b. Figure B4(b)(i) and Figure B4(b)(ii), shows how derivative mode changes the controller output for the various rates of change of the error. Complete Figure B4(b)(ii).
Rajah B4(b)(i) dan Rajah B4(b)(ii), menunjukkan bagaimana mod terbitan mengubah keluaran pengawal untuk pelbagai kadar perubahan ralat. Lengkapkan Rajah B4(b)(ii).

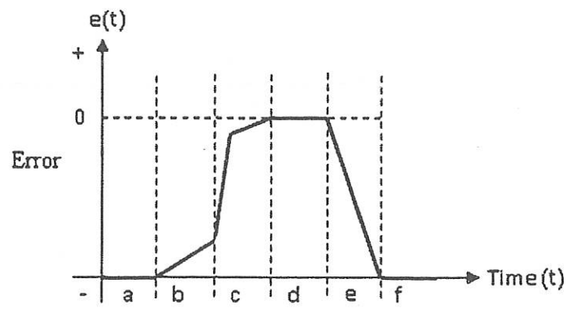


Figure B4(b)(i) / *Rajah* B4(b)(i)

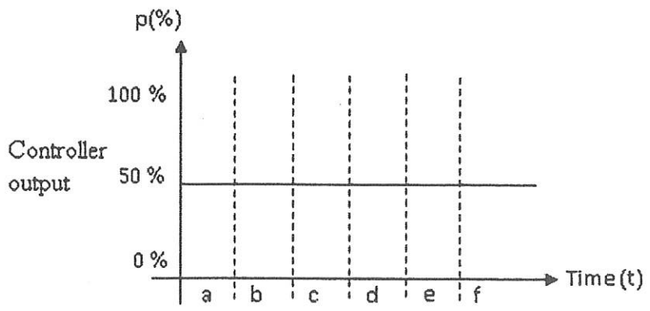


Figure B4(b)(ii) / *Rajah* B4(b)(ii)

[5 marks]
[5 *markah*]

CLO2
C3

c. A Proportional + Integral (PI) controller is used to control certain process. The setting of the controller are kp = 3% and ki = 6% per minute. While p(0) = 4%, the error signal is found to be 9t + 3 where t is the time. Calculate the controller output in % after 2 minutes.
Satu pengawal perkadaran + kamiran (PI) digunakan untuk mengawal proses tertentu. Tetapan kp = 3% dan ki = 6% per minit. Manakala p(0) = 4%, isyarat ralat ialah 9t + 3 dimana t ialah masa. Kirakan keluaran pengawal dalam % selepas 2 minit.

[7 marks]
[7 *markah*]

SECTION C: 30 MARKS
BAHAGIAN C: 30 MARKAH

INSTRUCTION:
This section consists of **TWO (2)** essay questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **DUA (2)** soalan esei. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO2
C3

Solve the transfer function of the system shown in Figure C1 by using Mason Gain Rule.
Selesaikan rangkap pindah bagi sistem yang ditunjukkan di Rajah C1 dengan menggunakan Hukum Gandaan Mason.

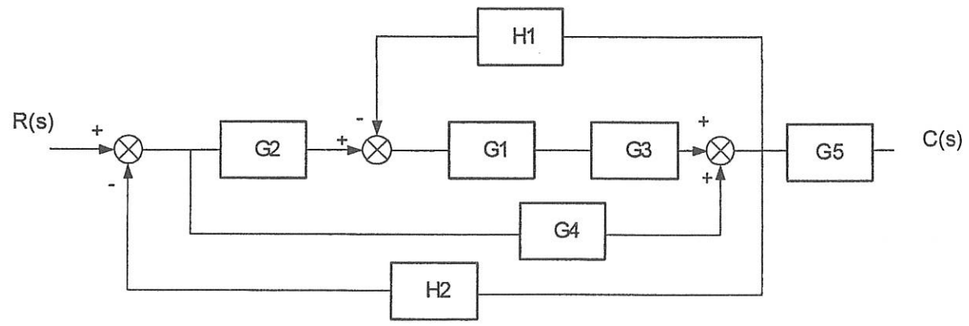


Figure C1 / *Rajah C1*

[15 marks]
[15 *markah*]

QUESTION 2
SOALAN 2

CLO2
C3

Based on the closed loop system given,
Berdasarkan sistem gelung tertutup yang diberikan,

$$\frac{C(s)}{R(s)} = \frac{\omega n^2}{S^2 + 2\varepsilon\omega n s + \omega n^2}$$

Calculate the values of damping ratio, ξ and damped natural frequency, ω_n so that the system responds to a step input with approximately 5% overshoot and with a settling time of 2 seconds.
Kirakan nilai nisbah redaman dan frekuensi tabii redaman bagi sambutan sistem untuk unit langkah dengan nilai terlajak kira-kira 5% dan masa pengenapan 2 saat

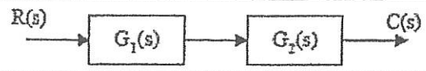
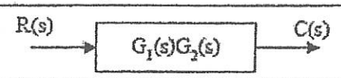
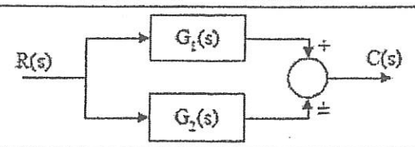
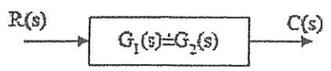
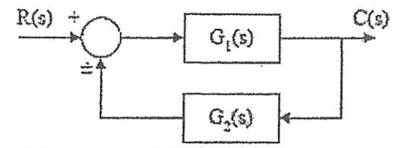
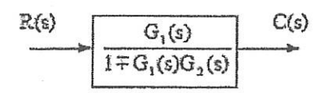
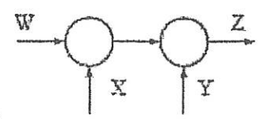
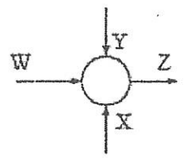
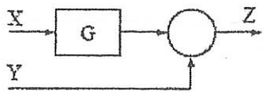
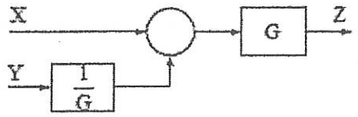
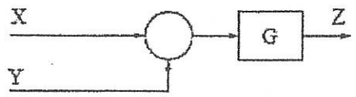
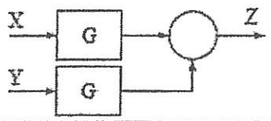
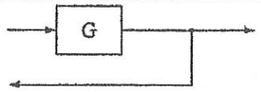
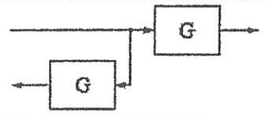
[15 marks]
[*15 markah*]

SOALAN TAMAT

LAPLACE FORMULA

$f(t) = \mathcal{L}^{-1}\{F(s)\}(t)$	$F(s) = \mathcal{L}\{f(t)\}(s) = \int_0^\infty e^{-st} f(t)dt$
1	$\frac{1}{s}, \quad s > 0$
t^n, n an integer	$\frac{n!}{s^{n+1}}, \quad s > 0$
e^{at}	$\frac{1}{s-a}, \quad s > a$
$\sin bt$	$\frac{b}{s^2+b^2}, \quad s > 0$
$\cos bt$	$\frac{s}{s^2+b^2}, \quad s > 0$
$e^{at} f(t)$	$F(s-a)$
$e^{at} t^n$, n an integer	$\frac{n!}{(s-a)^{n+1}}, \quad s > a$
$e^{at} \sin bt$	$\frac{b}{(s-a)^2+b^2}, \quad s > a$
$e^{at} \cos bt$	$\frac{(s-a)}{(s-a)^2+b^2}, \quad s > a$
$t \sin bt$	$\frac{2bs}{(s^2+b^2)^2}, \quad s > 0$
$t \cos bt$	$\frac{s^2-b^2}{(s^2+b^2)^2}, \quad s > 0$
$y' = \dot{y} = \frac{dy}{dt}$	$sY(s) - y(0)$
$y'' = \ddot{y} = \frac{d^2y}{dt^2}$	$s^2Y(s) - sy(0) - \dot{y}(0)$

BLOCK DIAGRAM REDUCTION RULES

Case	Original Structure	Equivalent Structure
1		
2		
3		
4		
5		
6		
7		
8