SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI JUN 2016

DEJ3133: BASIC CONTROL SYSTEM

TARIKH : 24 OKTOBER 2016 (ISNIN)
MASA : 8.30 AM – 10.30 AM(2 JAM)

Kertas ini mengandungi **TIGA BELAS (13)** halaman bercetak.
Bahagian A: Objektif (10 soalan)
Bahagian B: Struktur (4 soalan)
Bahagian C: Esei (2 soalan)
Dokumen sokongan yang disertakan : Jadual Laplace dan Pengecilan Rajah Blok

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JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

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. State the portion of a system to be controlled or regulated.
Nyatakan bahagian sistem yang akan dikawal atau diatur.

A. Disturbance
Gangguan

C. Controller
Pengawal

B. Comparator
Pembanding

D. Process
Proses

CLO1
C2

2. A car is running at a constant speed of 50km/h. Identify the measurement element of the running car.
Sebuah kereta sedang bergerak pada kelajuan malar 50km/h. Kenalpasti unsur elemen pengukuran bagi kereta yang sedang bergerak tersebut.

A. Clutch
Klac

C. Eyes
Mata

B. Speedmotor
Meter kelajuan

D. Steering wheel.
Roda Stereng

CLO1 C2

3. Based on the statement below, identify the related type of control sistem.
Berdasarkan kenyataan di bawah, kenalpasti jenis sistem kawalan berkaitan.

- Output quantity has no effect on the input quantity
  Kuantiti keluaran tidak memberi kesan ke atas kuantiti masukan.
- The output can be varied by varying the input. But due to external disturbance the system output may change.
  Keluaran boleh diubah oleh pelbagai masukan. Tetapi disebabkan gangguan luaran sistem keluaran boleh berubah.

A. Open loop control system / *Sistem kawalan terbuka*
B. Closed loop control system/ *Sistem kawalan tertutup*
C. Multivariable control system/ *Sistem kawalan pelbagai pembolehubah*
D. Combitional control system/ *Sistem kawalan gabungan*

CLO2 C3

4. Three blocks with gains of 4, 6 and 8 are connected in parallel. The total gain of the arrangement is
Tiga blok dengan gandaan 4,6 dan 8 disambung secara selari.Kira jumlah gandaan bagi susunan tersebut adalah

A. 18
B. 32
C. 196
D. 52

CLO1 C2

5. The transfer function of a system is used to determine
Rangkap pindah satu system digunakan untuk menentukan

A. The output for a given input
Keluaran bagi sesuatu masukan
B. The type of the system
Jenis sesuatu kawalan
C. The input for a given output
Masukan bagi sesuatu keluaran
D. The steady state gain
Gandaan keadaan mantap

CLO1 C1

6. Based on the statement below, identify the related response or this type of control system.
Berdasarkan kenyataan di bawah, kenalpasti jenis respon sistem kawalan yang berkaitan

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

A. underdamped system / *sistem redaman kurang*
B. critically 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, determine the damping ratio (ξ) for the system.
Satu sistem menghasilkan persamaan berikut, tentukan nisbah redaman (ξ) untuk sistem berikut.

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

A. 0.2
B. 0.4
C. 0.8
D. 8

CLO1
C1

8.

- It reduces the steady state error.
  Ia mengurangkan ralat keadaan mantap.
- It increases the damping factor.
  Ia menaikkan faktor redaman.
- Natural frequency remains the same.
  Frekuensi tabii tetap sama.
- The settling time decreases.
  Masa pengenapan berkurang.

Which one of the following controllers has the above characteristics?
Manakah di antara pengawal mempunyai ciri-ciri di atas?

A. Proportional controller (P) / *Berkadaran (P)*
B. Proportional Integral (PI) / *Kamilan Berkadaran (PI)*
C. Proportional Derivative (PD) / *Perbezaan Berkadaran (PD)*
D. Proportional Integral Derivative (PID)/ *Kamilan Perbezaan Berkadaran (PID).*

CLO1
C2

9. Mathematically, the proportional control mode is expressed as:
Secara matematik,pengawal mod jenis berkadaran dinyatakan sebagai:

$$P(t) = K_p e^{(t)} + P_0$$

Define K_p / *Berikan maksud* K_p.

A. Proportional gain constant/ *Pemalar gandaan berkadaran*
B. Proportional control mode / *Mod kawalan berkadaran*
C. Proportional error detector / *Pengesan ralat berkadaran*
D. Proportional band output / *Keluaran ruang berkadaran*

CLO2
C3

10. Based on Figure A10, choose the controller that explains the block diagram.
Berdasarkan kepada Rajah A10, pilih pengawal yang menjelaskan gambarajah blok tersebut.

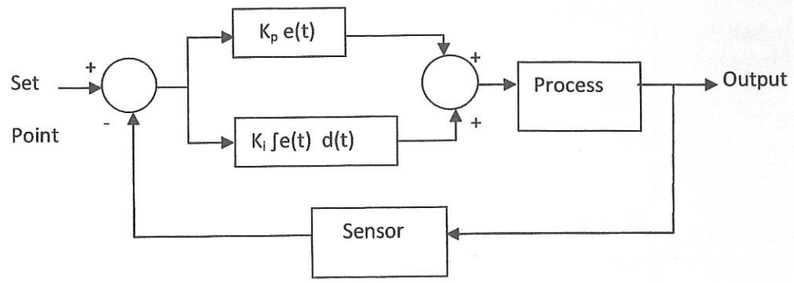


Figure A10/ *Rajah A10*

A. Proportional (P) / *Berkadaran (P)*
B. Integral (I) / *Kamiran (I)*
C. Proportional + Derivative (PD) / *Berkadaran + Perbezaan (PD)*
D. Proportional + Integral (PI) / *Berkadaran + Kamiran (PI)*

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.*

QUESTION 1

SOALAN 1

CLO1
C1

(a) Define the following terminologies :- Controller and Control system

Definisikan terminology berikut :- Pengawal dan Sistem kawalan

[3 marks]
[3 *markah*]

CLO1
C2

(b) Differentiate between open loop and closed loop control systems.

Bezakan di antara sistem kawalan gelung terbuka dan sistem kawalan gelung tertutup.

[5 marks]
[*5 markah*]

CLO1
C3

(c) Figure B1 (c) is a turnable speed control. By referring to the figure :

Rajah B1(c) adalah rajah kawalan kelajuan turnable. Dengan merujuk kepada rajah tersebut:

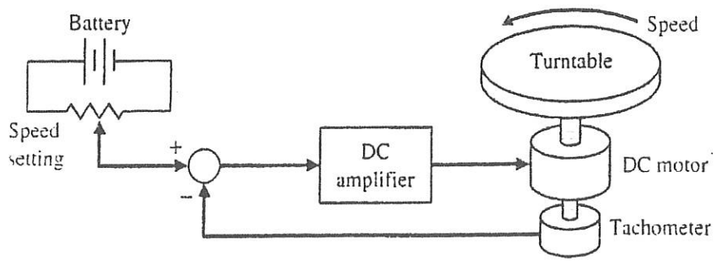


Figure B1(c) / *Rajah B1(c)*

Determine whether this system is open loop or closed loop and draw the block diagram of the system.

Tentukan sama ada sistem ini gelung terbuka atau gelung tertutup dan lukiskan gambarajah blok bagi sistem tersebut.

[7 marks]
[7 *markah*]

CLO1
C1

QUESTION 2

SOALAN 2

(a) Based on the Figure B2(a), calculate the transfer function of the system using Block Diagram Reduction Method.

Berdasarkan Rajah B2(a), kira rangkap pindah bagi sistem tersebut menggunakan Kaedah Pengecilan Gambarajah Blok.

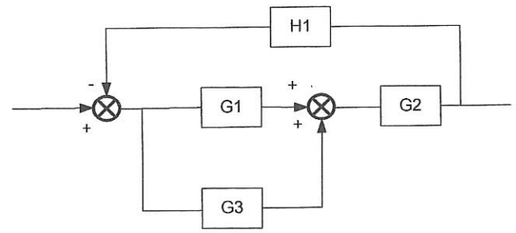


Figure B2(a)/ *Rajah B2(a)*

[3 marks]
[*3 markah*]

CLO1
C2

(b) Calculate the transfer function of the electrical network shown in Figure B2(b).

Kirakan rangkap pindah bagi rangkaian elektrik ditunjukkan pada Rajah B2(b).

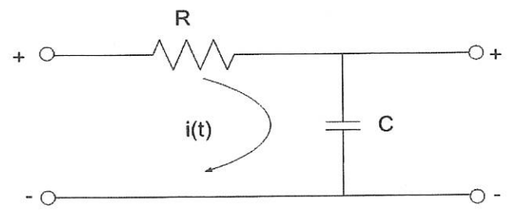


Figure B2(b)/ *Rajah B2(b)*

[5 marks]
[*5 markah*]

CLO2 C3

(c) Calculate the inverse Laplace Transform of the following function:-
Kirakan songsangan Jelmaan Laplace bagi fungsi berikut:-

$$F(s)=\frac{(s+2)}{s(s+3)(s+4)}$$

[7 marks]
[*7 markah*]

QUESTION 3
SOALAN 3

CLO1 C1

(a) List **THREE (3)** Standard test inputs.
*Senaraikan **TIGA (3)** Piawaian masukan ujian*

[3 marks]
[*3 markah*]

CLO1 C2

(b) By using a suitable diagram, briefly explain the meaning of Peak Time (Tp).
Dengan menggunakan gambarajah yang sesuai, terangkan secara ringkas maksud Masa Puncak (Tp).

[5 marks]
[*5 markah*]

CLO2 C3

(c) By referring to Figure C3(c), calculate all values of poles and zeros for the system and then sketch the system poles and zeros on the s-plane.
Dengan merujuk Gambarajahh C3 (c), kira semua nilai bagi kutub dan sifar untuk sistem tersebut dan kemudian lakarkan kutub dan sifar untuk sistem tersebut di atas satah-s.

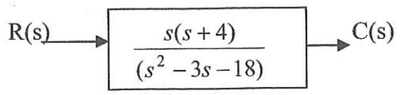


Figure C3(c)/ *Gambarajah C3(c)*

[7 marks]
[*7 markah*]

QUESTION 4
SOALAN 4

CLO1 C1

(a) The range of measured variable for certain control system is 4mV to 14mV and set point of the system is 8mV. Calculate the error in percentage when the measured variable is 7.5mV.
Julat bagi pembolehubah yang diukur untuk sesuatu sistem kawalan ialah 4mV hingga 14mV dan titik set untuk sistem tersebut 8mV. Kirakan ralat di dalam peratus apabila pembolehubah yang diukur ialah 7.5mV.

[3 marks]
[*3 markah*]

CLO1 C2

(b) By referring to the Figure Q4(b), calculate the output value of PD controller when $K_p = 3$ and $K_D = 0.5$ with $p(0) = 20\%$.
Berdasarkan kepada Rajah Q4(b), kirakan nilai keluaran bagi pengawal jenis PD apabila $K_p = 3$ dan $K_D = 0.5$ dengan $p(0) = 20\%$.

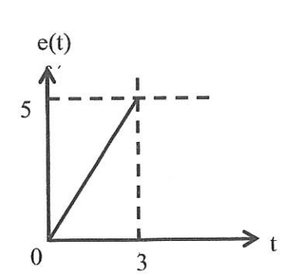


Figure Q4(b) / *Rajah Q4(b)*

[5 marks]
[*5 markah*]

CLO2
C3

(c) A Proportional + Integral (PI) controller is used to control certain processes. The settings of the controller are Kp = 4% and Ki = 6% per min. While p(0) = 5%, the error signal is found to be 7t + 2 where t is the time. Identify the controller output in % after 2 minutes.

Satu pengawal perkadaran + kamiran (PI) digunakan untuk mengawal proses tertentu. Tetapan Kp = 4% dan Ki = 6% setiap min. Manakala p(0) = 5%, isyarat ralat ialah 7t + 2 dimana t ialah masa. Tentukan nilai % 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.*

CLO2
C3

QUESTION 1
SOALAN 1

By using Mason's Gain Formula, generalize the overall transfer function for signal flow graph in Figure C1.

Dengan menggunakan Formula Gandaan Mason's, ringkaskan rangkap pindah keseluruhan bagi graf aliran isyarat dalam Rajah C1.

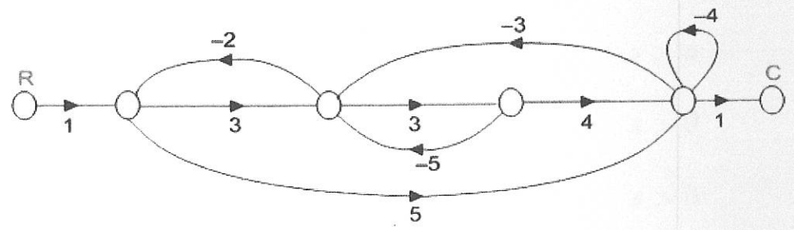


Figure C1 / *Rajah C1*

[15 marks]
[*15 markah*]

QUESTION 2

SOALAN 2

CLO2
C3

The transfer function of a control system is given by

Fungsi rangkap pindah bagi sebuah sistem kawalan diberi sebagai

$$F(s)=\frac{120(s+2)}{(s+3)(s+4)}$$

Calculate the steady state error for unit step, unit ramp and parabolic unit.

Kirakan ralat keadaan mantap bagi masukan unit langkah, masukan unit tanjakan dan masukan unit parabola.

[15 marks]

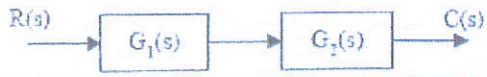
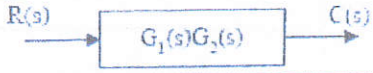
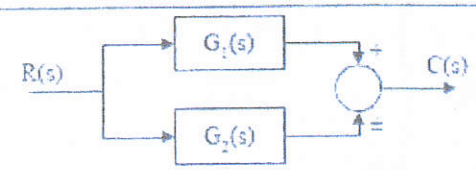
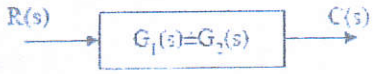
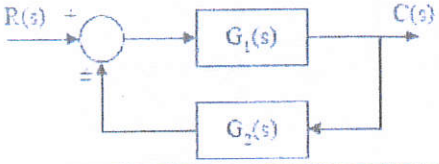
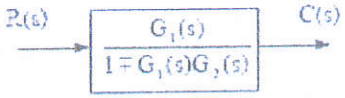
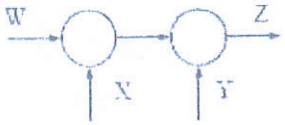
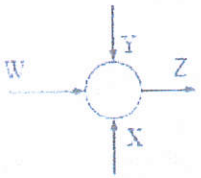
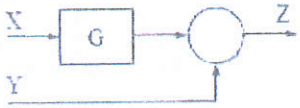
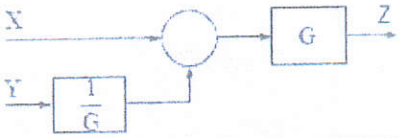
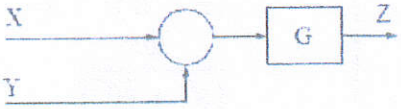
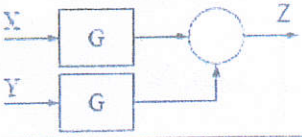
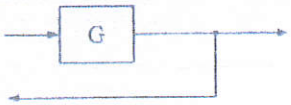
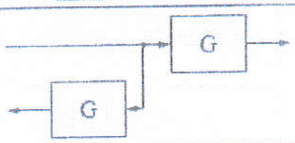
[*15 markah*]

SOALAN TAMAT

STANDARD LAPLACE TRANSFORM PAIRS

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

BLOCK DIAGRAM REDUCTION RULES

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