

SULIT



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

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI JUN 2018

DEJ3133: BASIC CONTROL SYSTEM

TARIKH : 31 OKTOBER 2018

MASA : 2.30 PETANG - 4.30 PETANG (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 : Laplace Table, Block Diagram
Reduction Table

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. Identify the purpose of a control system?

Tentukan tujuan sistem kawalan?

- A. Power Amplification & Remote Control.
Kuasa Pembesaran & Kawalan Remote.
- B. Convenience of input.
Kemudahan masukkan.
- C. Compensation of Disturbance.
Gangguan pampasan.
- D. All of the above.
Semua di atas.

CLO1
C2

2. A combination or an arrangement of different physical components which acts together to achieve certain objective. This statement describe about a _____.

Gabungan atau susunan komponen fizikal berbeza yang bertindak bersama untuk mencapai objektif tertentu. Kenyataan ini menerangkan tentang sebuah _____.

- A. system.
sistem.
- B. control system.
sistem kawalan.
- C. physical system.
sistem fizikal.
- D. controller.
pengawal.

CLO1
C2

3. Which of these answers **DOES NOT** represent the basic elements associated with block diagram?

*Di antara jawapan-jawapan ini manakah yang **TIDAK** mewakili elemen-elemen asas berkaitan dengan gambarajah blok?*

- A. Blocks.
Blok-blok.
- B. Error detector.
Pengesan ralat.
- C. Summing point.
Titik perjumlahan.
- D. Transfer function of elements shown inside the blocks.
Rangkap pindah elemen di dalam blok.

CLO2
C3

4. Calculate the values of poles for the transfer function given below:

Kirakan nilai kutub bagi rangkap pindah yang diberikan dibawah:

$$T(s) = \frac{(3+s)}{s(7-s)}$$

- A. $s = 0, s = 3$
- B. $s = -3, s = 7$
- C. $s = 0, s = 7$
- D. $s = -3, s = 0$

CLO1
C2

5. The following are the cases of root of the denominator in Inverse Laplace Transform **EXCEPT**

*Berikut adalah kes-kes bagi punca penyebut dalam Transformasi Laplace Songsang **KECUALI***

- A. Real and repeated.
Nyata dan berulang
- B. Linear and transient.
Lurus dan fana.
- C. Complex conjugate.
Konjugat Kompleks.
- D. Real and distinct.
Nyata dan berbeza.

CLO1
C1

6. Which one of the following is **NOT** a time domain specification?

*Yang mana satu daripada berikut **BUKAN** spesifikasi domain masa?*

- A. Peak time.
Masa puncak.
- B. Relay time.
Masa ganti.
- C. Rise time.
Masa menaik.
- D. Settling time.
Masa penenangan.

CLO1
C2

7. Based on the statement below, classify the related respond type of control system.

Berdasarkan kenyataan di bawah, kelaskan jenis tindakbalas sistem kawalan yang berkaitan.

- 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. Critically damped system.
Sistem redaman genting.
- C. Overdamped system.
Sistem redaman lebih.
- D. Unity system.
Sistem uniti.

CLO1
C1

8. All controller below are composite control modes **EXCEPT**

*Semua pengawal di bawah merupakan mod pengawal komposit **KECUALI***

- A. Proportional + Integral (PI)
Perkadaran + kamiran (PI)
- B. Proportional + Derivative (PD)
Perkadaran + pembezaan (PD)
- C. Integral + Derivative (ID)
Kamiran + pembezaan (ID)
- D. Proportional + Integral + Derivative (PID)
Perkadaran + kamiran + pembezaan (PID)

CLO1
C2

9. Mathematically, the PD control mode can be expressed as

Secara matematikanya, pengawal mod jenis PD boleh dinyatakan sebagai

$$p(t) = K_p e(t) + K_p K_d \frac{de(t)}{dt} + P_o$$

Identify K_p .

Tentukan K_p

- A. Proportional error
Ralat berkadar
- B. Derivative gain constant
Pemalar gandaan perbedaan
- C. Proportional gain constant
Pemalar gandaan berkadar
- D. Proportional output
Keluaran ruang berkadar

CLO2
C3

10. 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 of span when the measured variable is 7.5mV.

Julat pembolehubah yang telah diukur untuk satu sistem kawalan tertentu ialah 4mV kepada 14mV dan titik set ialah 8mV. Hitung ralat dalam peratus span apabila pembolehubah yang telah diukur ialah 7.5mV

- A. 0.05%
- B. 0.2%
- C. 5%
- D. 2%

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) State **THREE (3)** basic component of a control system.

Nyatakan TIGA (3) komponen asas sistem kawalan.

[3 marks]

[3 markah]

CLO1
C2

- b) Draw a block diagram of the open loop system and explain how the system works.

Lukis gambarajah blok sistem gelung terbuka dan terangkan bagaimana sistem berfungsi.

[5 marks]

[5 markah]

CLO1
C3

- c) By referring to Figure B1(c), control system use a human operator as a part of a closed-loop control system. Sketch the block diagram of the valve control system.

Dengan merujuk kepada Rajah B1 (c), sistem kawalan menggunakan pengendali manusia sebagai sebahagian daripada sistem kawalan gelung tertutup. Lakarkan gambarajah blok sistem kawalan injap.

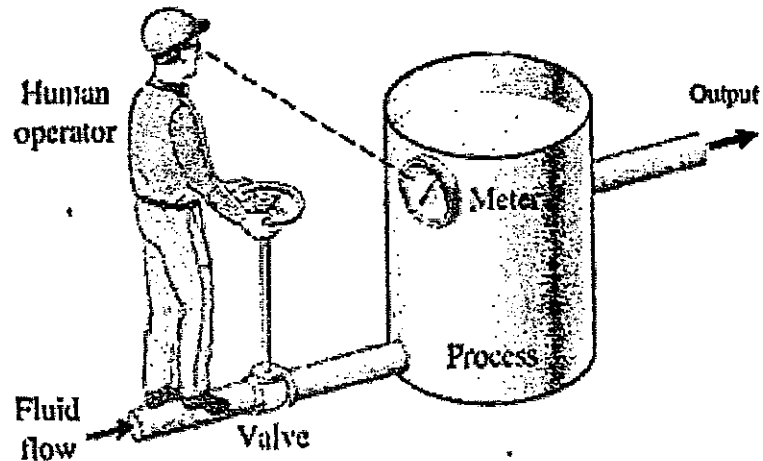


Figure B1(c) / Rajah B1(c)

[7 marks]
[7 markah]

QUESTION 2
SOALAN 2

CLO1
C1

- a) In principle, no matter how complicated the block diagram of closed loop system, it can be reduced to the standard single loop. State the basic approach to simplify a block diagram.

Pada dasarnya, tidak kira betapa rumit gambarajah blok sistem gelung tertutup, ia boleh dikurangkan kepada gelung tunggal standard. Nyatakan pendekatan asas untuk memudahkan gambarajah blok.

[3 marks]
 [3 markah]

CLO1
C2

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

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

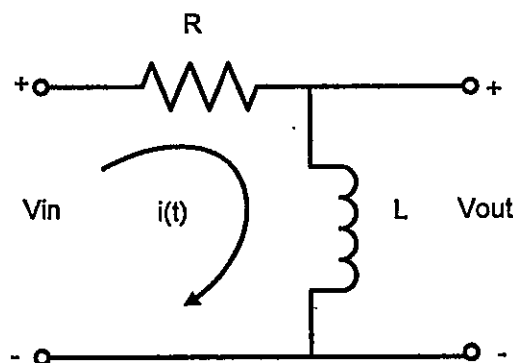


Figure B2(b) / Rajah B2(b)

[5 marks]
 [5 markah]

CLO2
C3

- c) Calculate the Inverse Laplace Transform of the following function:
Kirakan Jelmaan Laplace Songsang bagi fungsi berikut:

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

[7 marks]
 [7 markah]

QUESTION 3
SOALAN 3CLO1
C1

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

[3 marks]
[3 markah]

CLO1
C2

- b) Explain the maximum overshoot of transient response and sketch a suitable graph with complete labelling.

Jelaskan lanjakan maksimum sambutan fana dan lakarkan graf yang sesuai beserta pelabelan lengkap.

[5 marks]
[5 markah]

CLO2
C3

- c) The open loop transfer function of a unity feedback system is given as:
Rangkap pindah gelung terbuka bagi sistem suapbalik uniti adalah:

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

Calculate the value **K** so that the system will have a damping ratio, ζ of 0.5.
Kirakan nilai K supaya nisbah redaman, ζ ialah 0.5.

[7 marks]
[7 markah]

QUESTION 4
SOALAN 4CLO1
C1

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

[3 marks]
[3 markah]

CLO1
C2

- b) A major disadvantage of the Proportional control mode is an offset error. Explain briefly with the help of diagram about offset error.

Kelemahan utama mod kawalan berkadaran ialah ralat keseimbangan. Terangkan secara ringkas dengan bantuan gambarajah yang sesuai tentang ralat keseimbangan.

[5 marks]
[5 markah]

CLO2
C3

- c) A Proportional + Integral (PI) controller is used to control certain processes. The setting of the controller are $k_p = 4\%$ and $k_i = 5\%$ per min. While $p(0) = 3\%$, the error signal is found to be $(10t + 4)$ where t is the time. Calculate the controller output in % after 0.5 minutes.

Satu pengawal perkadaran + kamiran (PI) digunakan untuk mengawal proses tertentu. Tetapan bagi pengawal ialah $k_p = 4\%$ dan $k_i = 5\%$ setiap min. Manakala apabila $p(0) = 3\%$, isyarat ralat ialah $(10t + 4)$ dimana t ialah masa. Kirakan keluaran pengawal dalam % selepas 0.5 minit.

[7 marks]
[7 markah]

SECTION C : 30 MARKS
BAHAGIAN C : 30 MARKAH

INSTRUCTION:

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

ARAHAN:

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

QUESTION 1
SOALAN 1

CLO2
C3

Generalize the transfer function of the system shown in Figure C1 by using Mason Gain Formula.

Selesaikan rangkap pindah bagi sistem yang ditunjukkan di Rajah C1 dengan menggunakan Formula Gandaan Mason.

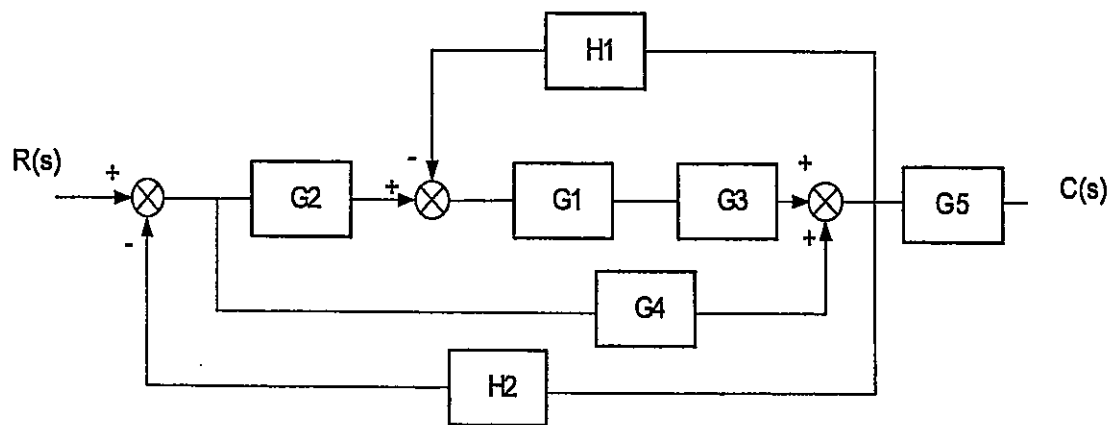


Figure C1 / Rajah C1

[15 marks]
[15 markah]

QUESTION 2
SOALAN 2CLO2
C3

By referring to Figure C2, determine the value of K so that the damping ratio, ζ is 0.4. With the value of K obtained, calculate the value of Time Rise (T_r), Peak Time (T_p) and the Percentage of Maximum Overshoot ($\%M_p$) of the system.

Dengan merujuk kepada Rajah C2, tentukan nilai K supaya nisbah redaman, ζ ialah 0.4. Dengan nilai K yang diperolehi, kirakan Masa Menaik (T_r), Masa Puncak (T_p) dan Peratus Lampau Lajak Maksima ($\%M_p$) bagi sistem tersebut.

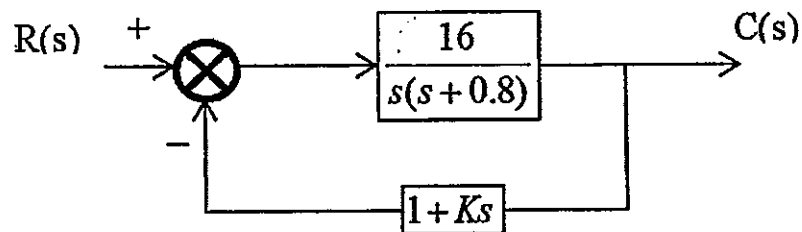


Figure C2 / Rajah C2

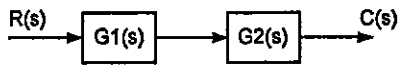
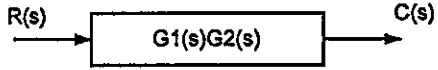
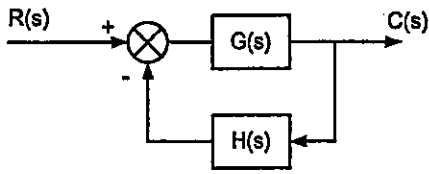
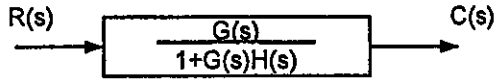
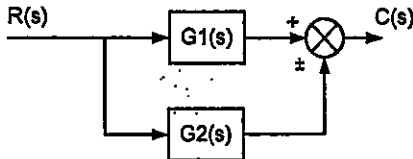
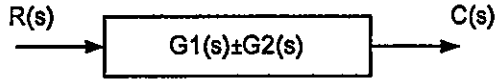
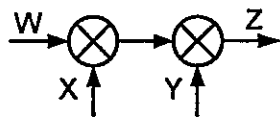
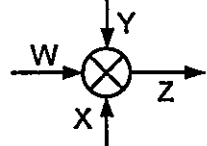
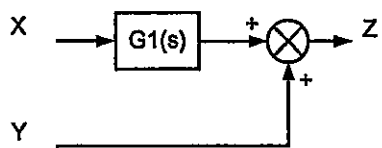
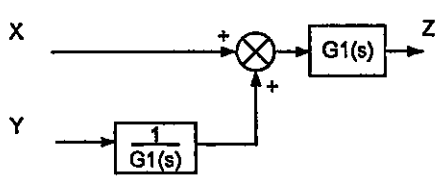
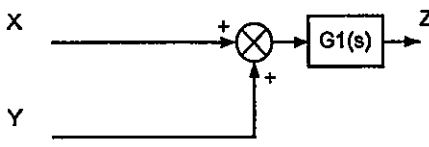
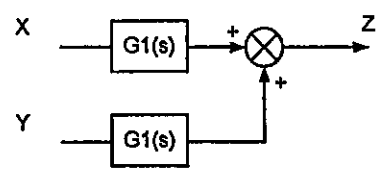
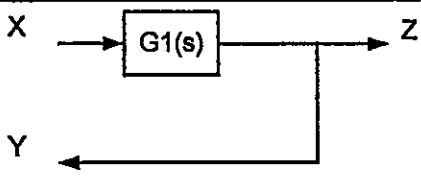
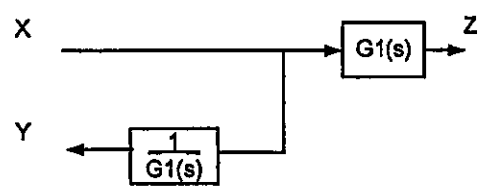
[15 marks]
[15 markah]

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

BLOCK DIAGRAM REDUCTION TABLE

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