

SULIT



BAHAGIAN PEPERIKSAAN DAN PENILAIAN  
JABATAN PENDIDIKAN POLITEKNIK  
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI DISEMBER 2016

**DEJ5163: CONTROL SYSTEMS**

**TARIKH : 09 APRIL 2017**

**MASA : 8.30 AM – 10.30 AM (2 JAM)**

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Kertas ini mengandungi **TUJUH (7)** halaman bercetak.

Bahagian A: Struktur (4 soalan)

Bahagian B: Esei (2 soalan)

Dokumen sokongan yang disertakan : **Kertas Semilog Graf, Kertas Graf**

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**JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN**

(CLO yang tertera hanya sebagai rujukan)

SULIT

## SECTION A : 60 MARKS

## BAHAGIAN A : 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) Operational Amplifier in analog controller can be applied as an inverter. Draw and label the circuit of an inverting amplifier.

*Penguat Kendalian dalam pengawal analog boleh digunakan sebagai penyongsang.*

*Lukis dan labelkan litar sebuah penguat penyongsang.*

[3 marks]

[3 markah]

CLO1  
C2

- (b) The non-inverting complete circuit is shown in Figure Q1(b). Given  $V_{in} = 5V$ ,

$R_{in} = 10k\Omega$  and  $R_f = 100k\Omega$ . Calculate :

- (i) Gain voltage,  $A_v$   
(ii) Output voltage,  $V_o$

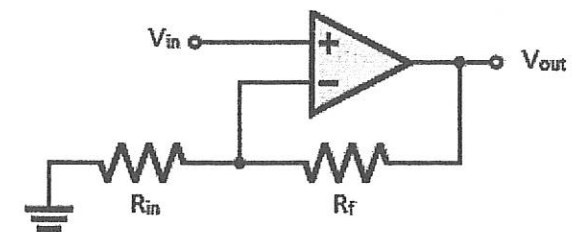


Figure Q1(b) / Rajah Q1(b)

Rajah Q1(b) menunjukkan sebuah litar lengkap penguat tak menyongsang. Diberi nilai  $V_{in} = 5V$ ,  $R_{in} = 10k\Omega$  dan  $R_f = 100k\Omega$ . Kirakan:

- (i) Gandan voltan,  $A_v$   
(ii) Keluaran voltan,  $V_o$ .

[5 marks]

[5 markah]

CLO2  
C3

(c) Given is the Integral controller which has the output of  $V_{out} = K_I \int V_E dt + V(0)$ .

The integration gain is  $K_I = \frac{1}{RC}$ . Suppose that  $V(0)=0$ . It is required that the controller output should saturate 25 seconds after a constant 10% error is applied. The input range is 0 – 10V and the output range is 0 – 15V. Calculate the integration gain and R if we assume  $C = 50\mu F$ .

*Di beri pengawal kamilan mempunyai keluaran  $V_{out} = K_I \int V_E dt + V(0)$ .*

*Gandaan kamilan adalah  $K_I = \frac{1}{RC}$ . Di beri  $V(0) = 0$ . Keluaran pengawal akan menjadi tepu dalam masa 25 saat selepas ralat konstan 10% di kenakan. Julat masukan adalah 0 – 10V dan julat keluaran adalah 0 – 15V. Kira gandaan kamilan dan nilai R sekiranya  $C = 50\mu F$*

[7 marks]

[7 markah]

## QUESTION 2

## SOALAN 2

CLO1  
C1

(a) Describe **TWO (2)** principles of Routh Hurwitz Criterion

*Huraikan DUA (2) prinsip Kriteria Routh Hurwitz.*

[3 marks]

[3 markah]

CLO1  
C2

(b) The characteristics equation of a system is  $s^4 + 4s^3 + 15s^2 + 30s + 20 = 0$ . Determine the stability of the system.

*Persamaan ciri bagi sistem diberi sebagai  $s^4 + 4s^3 + 15s^2 + 30s + 20 = 0$ . Tentukan kestabilan sistem.*

[5 marks]

[5 markah]

CLO2  
C3

(c) The characteristic equation for a system is given as  $s^3 + 3s^2 + 2s + K = 0$ . Calculate the stability range of  $K$  by using the Routh-Hurwitz Criterion.

*Persamaan ciri bagi sistem diberi sebagai  $s^3 + 3s^2 + 2s + K = 0$ . Kira julat kestabilan  $K$  dengan menggunakan kaedah Routh-Hurwitz Criterion.*

[7 marks]

[7 markah]

## QUESTION 3

## SOALAN 3

CLO1  
C1

(a) Define polar plot.

*Takrifkan plot kutub.*

[2 marks]

[2 markah]

(b) Calculate the phase of a system at input frequency,  $\omega(\text{rads}^{-1}) = 100$ . The transfer function given is:

*Kirakan fasa bagi suatu sistem pada frekuensi masukan,  $\omega(\text{rads}^{-1})=100$ . Rangkap pindah di beri sebagai:*

$$G(s)H(s) = \frac{5}{s(0.3s+1)(0.1s+1)}$$

[5 marks]

[5 markah]

(c) Based on the open loop transfer function below, sketch the polar plot by using the short cut method.

*Berdasarkan rangkap pindah gelung terbuka, lakarkan Plot Kutub dengan menggunakan kaedah pintasan.*

$$G(s) = \frac{20}{s(1+0.5s)}$$

[8 marks]

[8 markah]

## QUESTION 4

## SOALAN 4

CLO1  
C1

(a) Describe root locus

*Jelaskan londar punca.*

[3 marks]

[3 markah]

CLO1  
C2

(b) Identify the value of the angle asymptotes for the open loop system below :-

*Kenalpasti nilai sudut asimptot bagi sistem gelung buka di bawah :-*

$$G(s)H(s) = \frac{k(s+5)}{s(s+6)(s^2+2s+6)}$$

[4 marks]

[4 markah]

CLO2  
C3

(c) Based on the open loop system below, calculate the number of branches that end at infinity and its centroid point.

*Berdasarkan sistem gelung terbuka dibawah, kirakan jumlah cabang yang berakhir pada infiniti dan titik persilangan asimptot.*

$$G(s)H(s) = \frac{k(s+6)(s+8)}{s(s-1)(s+2)(s+4)}$$

[8 marks]

[8 markah]

## SECTION B: 40 MARKS

## BAHAGIAN B: 40 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  
C2

## QUESTION 1

## SOALAN 1

Based on the open loop transfer function given, draw the bode diagram and calculate the value of gain margin, phase margin and determine the stability of the system.

$$G(s)H(s) = \frac{30}{s(1+0.5s)(1+0.08s)}$$

(Scale y axis : 1cm: 10 dB, 1 cm: 45°)

(Scale x axis : Frequency  $\omega$  (rad/s) : 0.1, 1.0, 10 )*Berdasarkan rangkap pindah gelung terbuka yang diberi, lukiskan rajah Bode dan kirakan nilai jidar gandaan, jidar fasa dan nyatakan kestabilan sistem.*

$$G(s)H(s) = \frac{30}{s(1+0.5s)(1+0.08s)}$$

(Skala paksi y : 1cm: 10 dB, 1 cm: 45°)

(Skala paksi x : Frequency  $\omega$  (rad/s) : 0.1, 1.0, 10 )

[20 marks]

[20 markah]

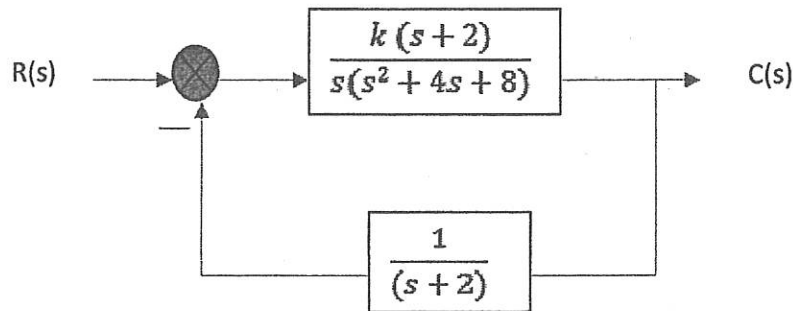
## QUESTION 2

## SOALAN 2

CLO2  
C4

Based on the control system below, sketch the Root Locus for the block diagram.

Berdasarkan rajah blok sistem kawalan dibawah, lakarkan rajah blok bagi Londa Punca.



Calculate the number of branches that end at infinity, centroid point, angle of asymptotes, angle of departure of root locus from the poles, breakaway point and the value of K at which root locus crosses the imaginary axis.

*Kirakan bilangan cabang yang berakhir di infiniti, titik centroid dan sudut asimptot, sudut berlepas dari punca-punca kutub, titik pecah dan nilai K di mana londa punca memotong pada paksi khayalan.*

(x axis scale and y axis scale : 2cm : 1 unit)

*(Skala paksi x dan y : 2cm : 1 unit)*

[20 marks]

[20 markah]

SOALAN TAMAT