UNIVERSITI MALAYSIA PERLIS

Peperiksaan Akhir Semester Pertama
Sidang Akademik 2025/2026

Januari/Februari 2026

EMK31103 – Control System Technology
[Teknologi Sistem Kawalan]

Masa : 2 jam

Please make sure that these question papers have **SEVEN (7)** printed pages including this front page before you start the examination.
*[Sila pastikan kertas soalan ini mengandungi **TUJUH (7)** muka surat yang bercetak termasuk muka hadapan sebelum anda memulakan peperiksaan ini.]*

This question paper has **FOUR (4)** questions. Answer **ALL** questions. Each question contributes 20 marks.
*[Kertas soalan ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan. Markah bagi tiap-tiap soalan adalah 20 markah.]*

Appendix is included.
[Lampiran disertakan.]

Dicetak oleh Unit Peperiksaan & Pengijazahan, Bahagian Pengurusan Akademik, Pusat Pengurusan Akademik UniMAP

Question 1
[Soalan 1]

(a) **Figure 1** shows the block diagram of closed-loop transfer function $\frac{C(s)}{R(s)}$.
*[**Rajah 1** menunjukkan gambarajah blok bagi rangkap pindah gelung tertutup $\frac{C(s)}{R(s)}$.]*

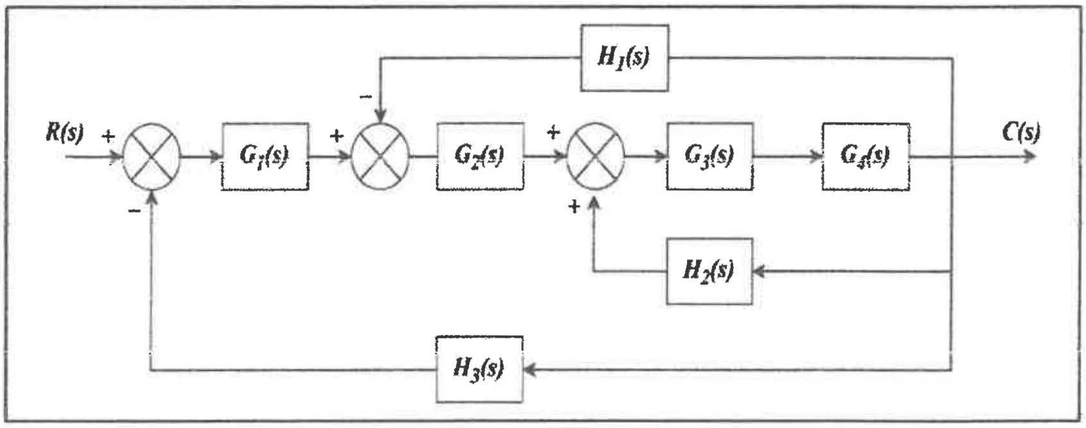

Figure 1
[Rajah 1]

(i) Obtain the transfer function $G(s) = \frac{C(s)}{R(s)}$ for the system using a block diagram reduction technique.
[Dapatkan rangkap pindah $G(s) = \frac{C(s)}{R(s)}$ bagi sistem berkenaan menggunakan teknik pengurangan gambarajah blok.]

(5 Marks / *Markah*)

(ii) Construct the signal flow graph for the system and use Mason's Rule to verify the transfer function obtained in **Question (a)(i)**.
*[Binakan graf aliran isyarat untuk sistem tersebut dan gunakan Peraturan Mason untuk menentukan rangkap pindah yang diperoleh dalam **Soalan (a)(i)**.]*

(10 Marks / *Markah*)

(b) Determine the transfer function, $G(s) = \frac{V_C(s)}{V(s)}$ for electrical network shown in **Figure 2**.

*[Tentukan rangkap pindah, $G(s) = \frac{V_C(s)}{V(s)}$ untuk rangkaian elektrik yang ditunjukkan pada **Rajah 2**.]*

(5 Marks / *Markah*)

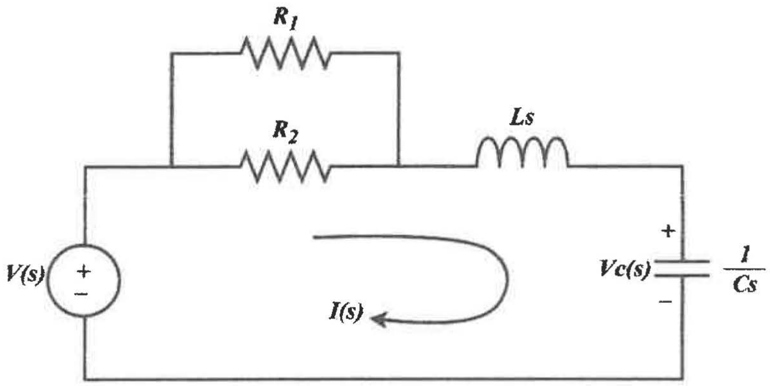

Figure 2

[Rajah 2]

Question 2
[Soalan 2]

(a) Cutting forces should be kept constant during machine operations to prevent changes in spindle speeds or work position. Such change would deteriorate accuracy of the work's dimensions. By using the Routh-Hurwitz stability criterion, analyze the stability of model for cutting machine shown in **Figure 3** and justify your answer.
*[Daya pemotongan harus dikekalkan malar semasa operasi mesin untuk mengelakkan perubahan dalam kelajuan pengumpar atau kedudukan kerja. Perubahan sedemikian akan menjejaskan ketepatan dimensi kerja. Dengan menggunakan nilai tara kestabilan Routh-Hurwitz, analisakan kestabilan model untuk mesin pemotong yang ditunjukkan dalam **Rajah 3** dan wajarkan jawapan anda.]*

(12 Marks/ *Markah*)

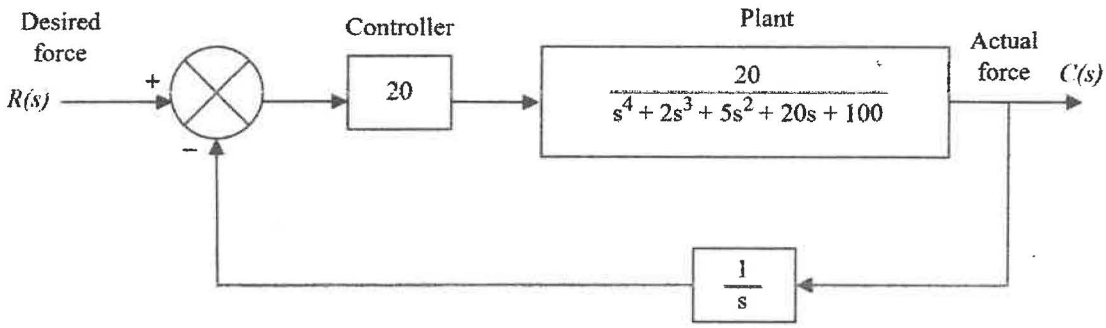

Figure 3
[Rajah 3]

(b) Given the transfer function for an underdamped second-order system. Determine the peak time, T_p, percent overshoot, $\%OS$ and settling time, T_s of the system.
[Diberikan rangkap pindah untuk sistem tertib-kedua yang kurang redam. Tentukan masa puncak, T_p, peratusan terlajak, $\%OS$ dan masa penetapan, T_s bagi sistem tersebut.]

$$G(s) = \frac{100}{s^2 + 15s + 100}$$

(8 Marks/ *Markah*)

Question 3
[Soalan 3]

(a) Given:
[Diberi:]

$$F(s) = \frac{(s+2)}{s^2 + 4s + 13}$$

Calculate the value of F(s) at the point $s = -7 + j9$ by evaluating the complex vector (showing real and imaginary parts and magnitude/phase).
[Cari nilai F(s) pada titik s= -7+j9 dengan menilai bentuk vektor kompleks (nyatakan bahagian nyata dan khayalan serta magnitud/fasa).]

(5 Marks/ *Markah*)

(b) Given a unity feedback control system with the forward transfer function, develop the root locus and provide extract critical information by:
[Diberi sistem suap balik unit dengan fungsi pemindahan ke hadapan, bangunkan londar punca dengan:]

$$G(s) = \frac{K}{s(s+2)(s+6)}$$

(i) Construct the root locus diagram by determining the value of the gain, *K*, at the point where the locus crosses the jω-axis.
[Binakan rajah londar punca untuk menentukan nilai gandaan, K, pada titik di mana londar melintasi paksi-jw.]

(7 Marks/ *Markah*)

(ii) Identify the precise imaginary-axis crossing points.
[Kenal pasti titik lintasan paksi khayalan yang tepat.]

(4 Marks/ *Markah*)

(iii) Compute the angle of departure from the complex poles. Use these analyses to interpret the stability and performance characteristics of the system.
[Hitung sudut bertolak dari kutub-kutub kompleks. Gunakan analisis ini untuk mentafsir ciri kestabilan dan ciri-ciri prestasi sistem.]

(4 Marks/ *Markah*)

Question 4
[Soalan 4]

(a) Given:
[Diberi:]

$$F(s) = \frac{10}{s(s+2)(s+5)}$$

(i) Develop the Bode log-magnitude.
[Bangunkan magnitude-log Bode.]

(9 Marks/ *Markah*)

(ii) Develop the phase plots.
[Bangunkan magnitud plot fasa.]

(3 Marks/ *Markah*)

(iii) Determine the Gain Margin (GM) and Phase Margin (PM) and justify the results for the system based on the equation.
[Tentukan Jidar Gandaan (GM) dan Jidar Fasa (PM) dan wajarkan keputusan untuk sistem berdasarkan persamaan ini.]

(2 Marks/ *Markah*)

(b) Describe the characteristics of P Controller and I Controller and recommend its application.
[Terangkan ciri-ciri Pengawal P dan Pengawal I dan mengesyorkan aplikasinya.]

(6 Marks/ *Markah*)

Appendix
[Lampiran]

Laplace Transform Table
[Jadual Transformasi Laplace]

Function, $f(t)$	Laplace Transform
Impulse Unit, $\delta(t)$	1
Step Unit, $u(t)$	$\frac{1}{s}$
Ramp Unit, t	$\frac{1}{s^2}$
Exponential, e^{-at}	$\frac{1}{s+a}$
Sine, $\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
Cosine, $\cos \omega t$	$\frac{s}{s^2+\omega^2}$
Sine Damping, $e^{-at} \sin \omega t$	$\frac{\omega}{(s+a)^2+\omega^2}$
Cosine Damping, $e^{-at} \cos \omega t$	$\frac{s+a}{(s+a)^2+\omega^2}$
Ramp Damping, $t\, e^{-at}$	$\frac{1}{(s+a)^2}$

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