FKEE

KOLEJ UNIVERSITI TEKNOLOGI TUN HUSSEIN ONN

PEPERIKSAAN AKHIR
SEMESTER II
SESI 2004/2005

NAMA MATA PELAJARAN	:	SISTEM KAWALAN
KOD MATA PELAJARAN	:	BTE 3163
KURSUS	:	3 BTR/3 BTD
TARIKH PEPERIKSAAN	:	MAC 2005
JANGKA MASA	:	3 JAM
ARAHAN	:	JAWAB **LIMA (5)** SOALAN SAHAJA DARIPADA TUJUH (7) SOALAN.

KERTAS SOALAN INI MENGANDUNGI 11 MUKA SURAT

SOALAN DALAM BAHASA MELAYU

S1 (a) Apakah objektif sistem kawalan?

(6 markah)

(b) Terangkan yang berikut dengan jelas dan ringkas
(i) Sistem kawalan
(ii) Sistem kawlan gelung buka
(ii) Sistem kawalan gelung tutup
(iii) Rangkap pindah

(8 markah)

(c) Anda mahu merekabentuk satu sistem kawalan stereng kereta. Lukiskan gambarajah blok sistem tersebut.

(6 markah)

S2 (a) Cari persamaan pembezaan bagi sistem yang ditunjukkan pada Rajah S2 (a)

(4 markah)

(b) Cari jelmaan Laplace bagi sistem yang ditunjukkan pada Rajah S2 (a)

(4 markah)

(c) Cari jelmaan Laplace songsang bagi $y(t)$ dalam soalan S2 (b). Andaikan masukan $r(t)$ bagi sistem ini adalah unit langkah.

(6 markah)

(d) Ulang soalan S2 (c) jika masukan adalah unit tanjakan.

(6 markah)

S3 (a) Satu sistem tertib pertama mempunyai rangkap pindah

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

Cari pemalar masa, T_c, masa pengenapan, T_s dan masa menaik, T_r.

(3 markah)

(b) Sistem seperti pada soalan S3 (a) dikembangkan dengan menambah beberapa elemen yang mempunyai rangkap pindah di bawah untuk menjadi sistem tertib kedua.

$$G_1(s) = \frac{5}{s+5}$$

Sistem ini ditunjukkan pada Rajah S3 (b). Jika masukannya ialah unit langkah, cari:

(i) ω_n
(ii) Masa puncak, T_p,
(iii) Masa pengenapan, T_s
(iv) Peratus lanjakan, %OS.

(8 markah)

(c) Tentukan jenis sambutan sistem dalam soalan Q3 (b).

(2 markah)

(d) Berdasarkan jawapan pada soalan S3 (b) dan S3 (c), lakarkan sambutan sistem yang diuja oleh masukan unit langkah.

(3 markah)

(e) Cari ralat keadaan mantap, $e(\infty)$ dan pemalar kedudukan, K_p untuk sistem dalam soalan S3 (b).

(4 markah)

S4 (a) Berikan definisi kestabilan bagi satu sistem.

(4 markah)

(b) Satu gambarajah blok bagi satu sistem penentu kedudukan kepala pemateri ditunjukkan pada Rajah S4 (b). Tentukan julat K dan a di mana sistem ini adalah stabil.

(8 markah)

(b) Sistem pada soalan S4 (b) telah ditambah dengan beberapa elemen untuk memperbaiki prestasinya. Rangkap pindah gelung bukanya yang baru adalah

$$\frac{128}{s(s^7 + 3s^6 + 10s^5 + 24s^4 + 48s^3 + 96s^2 + 128s + 192)}$$

Cari bilangan kutub pada satah kiri dan satah kanan dan di atas paksi $j\omega$ bagi sistem ini.

(8 markah)

S5 (a) Berikan definisi londar punca bagi satu sistem gelung tutup.

(4 markah)

(b) Diberi satu sistem suapbalik unit yang mempunyai rangkap pindah gelung buka

$$G(s) = \frac{K(s+2)}{(s^2 - 4s + 13)}.$$

Lakarkan londar punca sistem tersebut. Daripada londar punca yang diperolehi, cari:

(i) nilai pada paksi khayal yang dipintas.
(ii) nilai gandaan K pada paksi $j\omega$
(iii) titik lolos.
(iv) sudut pelepasan daripada kutub-kutub kompleks

(16 markah)

S6 (a) Apakah yang dimaksudkan dengan sambutan frekuensi sesuatu sistem?

(4 markah)

(b) Satu sistem kawalan kedudukan mempunyai rangkap pindah seperti berikut :

$$G(s) = \frac{K}{(1+s/5)(1+s)(1+s/10)(1+s/50)},$$

di mana $H(s)$=1 dan K=10. Lakarkan rajah Bode bagi sistem ini.

(8 markah)

(c) Tentukan lebar jalur bagi sistem pada soalan S6 (b).

(8 markah)

S7 (a) Apakah maksud pemampas dalam satu sistem kawalan?

(4 markah)

(b) Satu sistem kawalan kadar ketinggian sebuah pesawat terbang ditunjukkan pada Rajah S7(b). Apabila pesawat itu terbang dengan 4 kali kelajuan bunyi (Mach 4) pada ketinggian 100,000 kaki, parameter sistem tersebut adalah:

$$\frac{1}{\tau_a} = 1.0 \qquad K_1 = 1.0 \qquad \zeta\omega_a = 1.0 \qquad \text{and} \qquad \omega_a = 4$$

Reka satu pemampas $G_c(s)$ supaya sambutan untuk masukan langkah mempunyai peratus lajakan sebanyak 5% dan masa pengenapan kurang dari 5 saat.

(16 markah)

SOALAN DALAM BAHASA INGGERIS

Q1 (a) What are the objectives of control systems?

(6 marks)

(b) Explain the following concisely
(i) Control system
(ii) Open loop control system
(ii) Closed-loop control system
(iii) Transfer function

(8 marks)

(c) You want to design an automobile steering control system. Draw the block diagram of such system.

(6 marks)

Q2 (a) Find the differential equations of the systems shown in Figure Q2 (a)

(4 marks)

(b) Find the Laplace transforms of the systems shown in Figure Q2 (a)

(4 marks)

(c) Find the inverse Laplace transforms of $y(t)$ in question Q2 (b). Assume that the input, $r(t)$ for the system is unit step input.

(6 marks)

(d) Repeat question Q2 (c) if the input $r(t)$ is a unit ramp.

(6 marks)

Q3 (a) A first order system has a transfer function, $G(s) = \frac{20}{s+20}$. Find the time constant, T_c, settling time, T_s and rise time, T_r.

(3 marks)

(b) The system in question Q3 (a) is expanded by adding some elements which has a transfer function as below to be a second order system.

$$G_1(s) = \frac{5}{s+5}$$

The system is shown in Figure Q3 (b). If the input is unit step, find:

(i) ω_n
(ii) Peak Time, T_p,
(iii) Settling Time, T_s
(iv) Percent Overshoot, %OS.

(8 marks)

(c) Characterize the nature of the response of the system in question Q3(b).

(2 marks)

(d) Based on the answers of questions Q3(b) and Q3(c), sketch the system response excited by unit step input.

(3 marks)

(e) Find the steady-state error, $e(\infty)$ and position constant, K_p for the system in question Q3(b)

(4 marks)

Q4 (a) Define the meaning of stability of a system.

(4 marks)

(b) A block diagram of a welding head positioning system is shown in Figure Q4 (b). Determine the range of K and a for which the system is stable.

(8 marks)

(b) The system as in Q4(b) is added by some elements to improve its performance. Its new open loop transfer function is

$$\frac{128}{s(s^7 + 3s^6 + 10s^5 + 24s^4 + 48s^3 + 96s^2 + 128s + 192)}$$

Find the number of poles in the left half-plane, the right half-plane, and on the $j\omega$-axis for the system of the system.

(8 marks)

Q5 (a) What is the definition of root locus of a closed-loop system.

(4 marks)

(b) Given a unity feedback system that has the forward transfer function,

$$G(s) = \frac{K(s+2)}{(s^2 - 4s + 13)}$$

Sketch the root locus of the system. From the root locus, find:

(i) imaginary axis crossing.
(ii) gain, K, at the jw axis crossing.
(iii) break-in point.
(iv) angle of departure from the complex poles.

(16 marks)

Q6 (a) What is the definition of frequency response of a system?

(4 marks)

(b) A position control system has a transfer function

$$G(s) = \frac{K}{(1+s/5)(1+s)(1+s/10)(1+s/50)},$$

where $H(s)$=1 and K=10. Sketch the Bode diagram of this system.

(8 marks)

(c) Determine the bandwidth of the system in question Q6 (b).

(8 marks)

Q7 (a) What is the definition of compensator in control systems?

(4 marks)

(b) An attitude rate control aircraft system is shown in Figure Q7 (b). When the vehicle is flying at four times the speed of sound (Mach 4) at an altitude of 100,000 ft, the parameters are :

$$\frac{1}{\tau_a} = 1.0 \qquad K_1 = 1.0 \qquad \zeta\omega_a = 1.0 \qquad \text{and} \qquad \omega_a = 4$$

Design a compensator, $G_c(s)$ so that the response to a step input has an overshoot of 5% and a settling time less than 5 seconds.

(16 marks)

PEPERIKSAAN AKHIR

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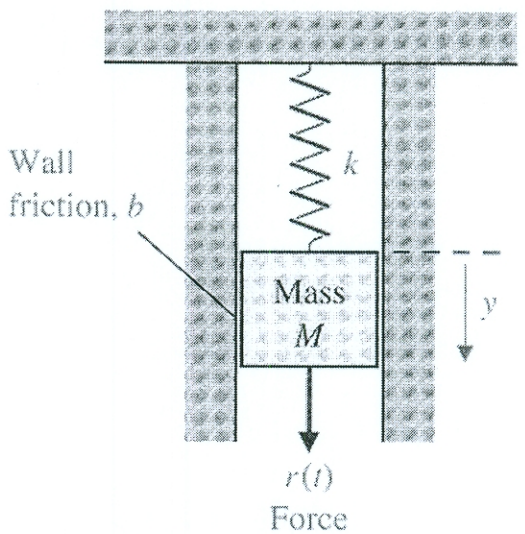
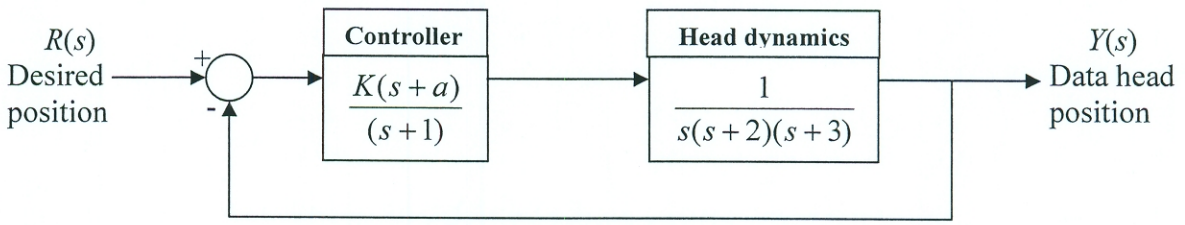


Rajah S2 (a)/Figure Q2 (a)

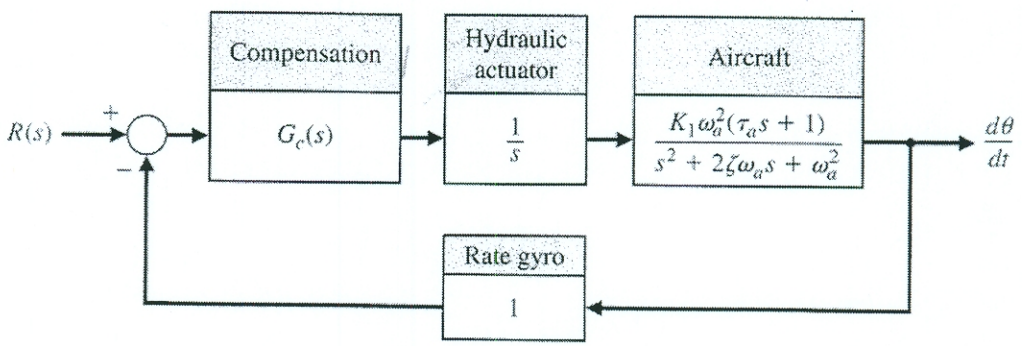
Rajah S3(b)/Figure Q3 (b)

PEPERIKSAAN AKHIR

SEMESTER.SESI : SEMESTER 2/2004/2005 KURSUS: 3BTR/3BTD
MATAPELAJARAN : SISTEM KAWALAN KOD MATAPELAJARAN: BTE3163



Rajah S4 (b)/Figure Q4 (b)



Rajah S7 (b)/Figure Q7 (b)

PEPERIKSAAN AKHIR

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MATAPELAJARAN : SISTEM KAWALAN

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Table 1 : Laplace Transform Pairs

Item no.	$f(t)$	$F(s)$
1.	$\delta(t)$	1
2.	$u(t)$	$\frac{1}{s}$
3.	$tu(t)$	$\frac{1}{s^2}$
4.	$t^n u(t)$	$\frac{n!}{s^{n+1}}$
5.	$e^{-at}u(t)$	$\frac{1}{s+a}$
6.	$\sin \omega t u(t)$	$\frac{\omega}{s^2+\omega^2}$
7.	$\cos \omega t u(t)$	$\frac{s}{s^2+\omega^2}$

PEPERIKSAAN AKHIR

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Table 2 : Laplace transform theorems

Item no.	Theorem	Name
1.	$\mathcal{L}[f(t)] = F(s) = \int_{0-}^{\infty} f(t)e^{-st}dt$	Definition
2.	$\mathcal{L}[kf(t)] = kF(s)$	Linearity theorem
3.	$\mathcal{L}[f_1(t) + f_2(t)] = F_1(s) + F_2(s)$	Linearity theorem
4.	$\mathcal{L}[e^{-at}f(t)] = F(s + a)$	Frequency shift theorem
5.	$\mathcal{L}[f(t - T)] = e^{-sT}F(s)$	Time shift theorem
6.	$\mathcal{L}[f(at)] = \frac{1}{a}F\left(\frac{s}{a}\right)$	Scaling theorem
7.	$\mathcal{L}\left[\frac{df}{dt}\right] = sF(s) - f(0-)$	Differentiation theorem
8.	$\mathcal{L}\left[\frac{d^2f}{dt^2}\right] = s^2F(s) - sf(0-) - \dot{f}(0-)$	Differentiation theorem
9.	$\mathcal{L}\left[\frac{d^nf}{dt^n}\right] = s^nF(s) - \sum_{k=1}^{n} s^{n-k}f^{k-1}(0-)$	Differentiation theorem
10.	$\mathcal{L}\left[\int_{0-}^{t} f(\tau)\,d\tau\right] = \frac{F(s)}{s}$	Integration theorem
11.	$f(\infty) = \lim_{s\to 0} sF(s)$	Final value theorem[1]
12.	$f(0+) = \lim_{s\to\infty} sF(s)$	Initial value theorem[2]

[1] For this theorem to yield correct finite results, all roots of the denominator of $F(s)$ must have negative real parts and no more than one can be at the origin.
[2] For this theorem to be valid, $f(t)$ must be continuous or have a step discontinuity at $t = 0$ (i.e., no impulses or their derivatives at $t = 0$).