
UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2004/2005
*First Semester Examination
2004/2005 Academic Session*

Oktober 2004
October 2004

ESA251/3 – Teori Sistem Kawalan
Theory of Control System

Masa : 3 jam
Hour : [3 hour]

ARAHAN KEPADA CALON: -
INSTRUCTION TO CANDIDATES:

Sila pastikan bahawa kertas soalan ini mengandungi **ENAM (6)** mukasurat dan **EMPAT (4)** soalan sebelum anda memulakan peperiksaan.

*Please ensure that this paper contains **SIX (6)** printed pages and **FOUR (4)** questions before you begin examination.*

Jawab **SEMUA** soalan sahaja.

*Answer **ALL** the questions only.*

Calon boleh menjawab semua soalan dalam Bahasa Malaysia. Sekiranya calon ingin menjawab dalam Bahasa Inggeris, sekurang-kurangnya satu soalan perlu dijawab dalam Bahasa Malaysia.

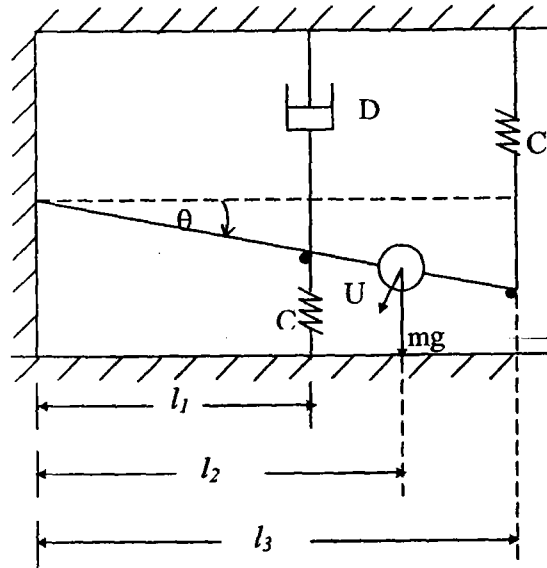
Student may answer all the questions in Bahasa Malaysia. If you want to answer in English, at least one question must be answered in Bahasa Malaysia.

Setiap soalan mestilah dimulakan pada mukasurat yang baru.

Each questions must begin from a new page.

1. Pertimbangkan sistem bandul pegas teredam seperti dalam Gambarajah 1 di bawah:

Consider the damped spring pendulum system shown in Figure 1 below:



Gambarajah 1: Sistem bandul pegas teredam dalam kedudukan terpesong
Figure 1: Damped Spring Pendulum System in the Deflected Position

Anggapkan bahawa daya pegas dan daya teredam yang bertindak ke atas bandul adalah sifar bila bandul berada dalam keadaan mendatar, atau $\theta = 0$. Anggapkan juga bahawa geseran yang terlibat boleh diabaikan dan sudut ayunan, θ adalah kecil.

Assume that the spring forces and damper force acting on the pendulum is zero when the pendulum is horizontal, or $\theta = 0$. Assume also that the friction involved is negligible and the angle of oscillation θ is small.

Dapatkan model matematik bagi sistem itu dalam bentuk :

Obtain the mathematical model of the system in form of

- (a) Persamaan pembezaan lurus;
 (Catatan : Untuk mendapatkan persamaan pembezaan lurus, persamaan tidak dilurus mesti di luruskan, sila tunjukkan proses linearisasi tersebut)

The linear differential equation

(Note : To get the linear differential equation, the nonlinear equation must be linearized about a operating point, please show the linearization process)

(35 markah/marks)

(b) Fungsi pindah

The transfer function

(20 markah/marks)

(c) Persembahan "State-space" dan "Block Diagram"

State-space representation and the Block Diagram

(30 markah/marks)

(d) Dapatkan parameter dinamik system:

Frekuensi tabii W_o , Nisbah redaman ρ , Faktor penguat K

Determine the dynamic parameter of the system:

Natural frequency W_o , Damping ratio ρ , Amplification factor K

(15 markah/marks)

2. (a) Pertimbangkan persamaan cirian

$$S^4 + KS^3 + S^2 + S + 1 = 0$$

Consider the characteristic equation

$$S^4 + KS^3 + S^2 + S + 1 = 0$$

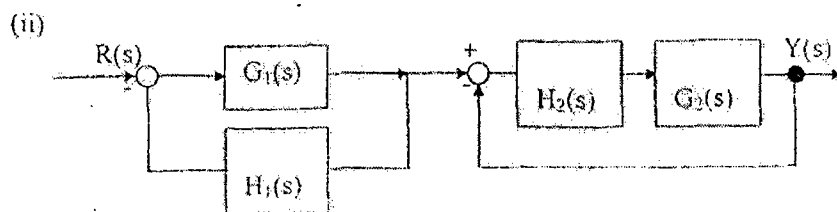
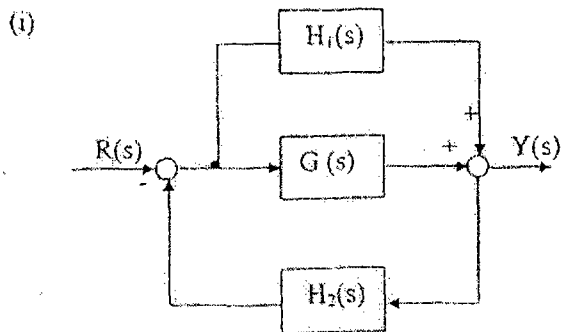
Tentukan julat bagi K untuk kestabilan menggunakan kriteria Routh tersebut.

Determine the range of K for stability by using Routh's criterion following.

(50 markah/marks)

- (b) Dapatkan fungsi pindah bagi sistem gelung tertutup yang berikut:

Obtain the transfer function of the following closed loop systems:

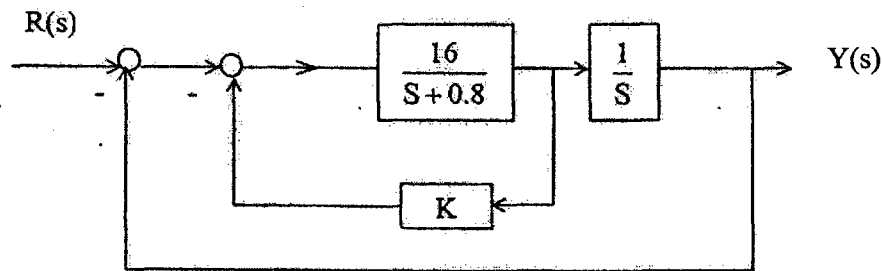


Gambarajah 2/ Figure 2

(50 markah/marks)

3. Pertimbangkan suatu sistem seperti yang ditunjukkan pada gambarajah 3. Tentukan nilai dari K sehingga nisbah redaman $\rho = 0.5$. Kemudian dapatkan masa naik t_r , masa puncak t_p , terlahak maksimum M_p , dan masa penetapan t_s untuk sambutan langkah unit

Consider a system as shown in Figure 3. Determine the value of K so that the damping ratio $\rho = 0.5$. Then calculate the rise time t_r , peak time t_p , maximum overshoot M_p , and setting time t_s for unit step response.

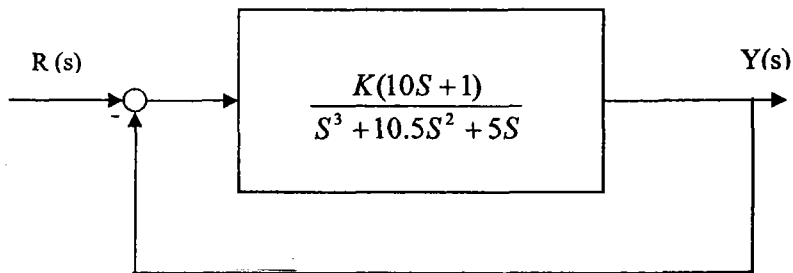


Gambarajah 3 : Sistem gelung Tertutup
Figure 3 : Closed Loop System

(100 markah/marks)

4. Pertimbangkan sistem seperti yang ditunjukkan dalam Gambarajah dibawah ini.

Consider the system shown in Figure below



Gambarajah 4 : Rajah Blok Penggerak Servo Hidraulik
Figure 4 : Block Diagram of Hydraulic Servo Actuator

- (a) Lukiskan rajah Bode fungsi pindah gelung terbuka

Draw a bode diagram of the open loop transfer function

(60 markah/marks)

- (b) Tentukan nilai gandaan K supaya margin fasa ialah 45°

Determine the value of the gain K such that the phase margin is 45°

(20 markah/marks)

- (c) Apakah margin gandaan bagi sistem dengan gandaan K di atas?

What is the gain margin of the system with this gain K?

(20 markah/marks)

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