Peperiksaan Semester Pertama
Sidang Akademik 2005/2006
*First Semester Examination*
*2005/2006 Academic Session*

November 2005
*November 2005*

**ESA 251/3 – Teori Sistem Kawalan**
*Theory of Control System*

Masa : 3 jam
*Duration : 3 hours*

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Sila pastikan bahawa kertas peperiksaan ini mengandungi LAPAN muka surat yang bercetak sebelum anda memulakan peperiksaan ini.

*Please check that this examination paper consists of EIGHT pages of printed material before you begin the examination.*

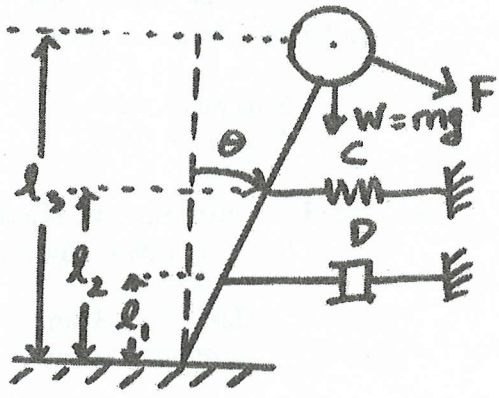
**Arahan**: Jawab **EMPAT (4)** soalan.

***Instructions*** **:** *Answer* ***FOUR (4)*** *questions.*

...2/-

1. Pertimbangkan sistem bandul pegas terendam seperti dalam **Gambarajah 1** di bawah.

*Consider the damped spring pendulum system below in **Figure 1**.*




**Gambarajah 1 : Sistem bandul pegas terendam dalam kedudukan terpesong**
***Figure 1 : Damped spring pendulum system in deflected position***

Anggapkan bahawa daya pegas dan daya terendam 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 $\theta$ adalah kecil.

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

(a) Dapatkan model matematik bagi sistem itu dalam bentuk

(i) Persamaan perbezaan
(ii) State Space Representation
(iii) Fungsi pindah

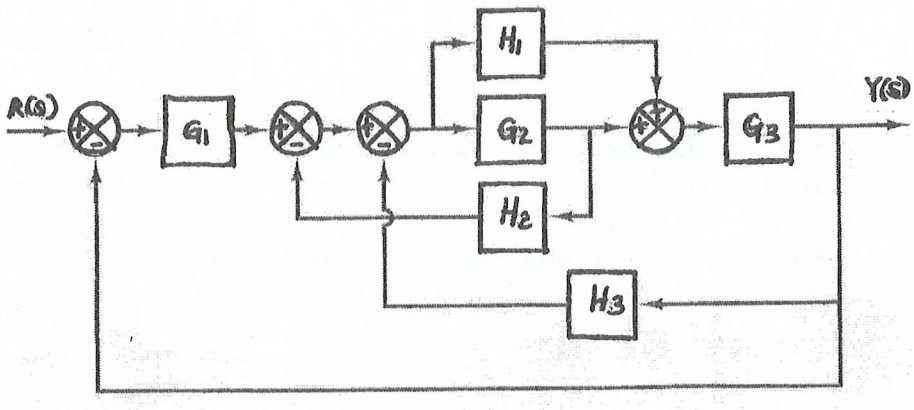
*Obtain the mathematical model of the system in form of*

*(i) The differential equation*
*(ii) State Space Representation*
*(iii) Transfer function*

**(50 markah/*marks*)**

2. Dapatkan fungsi alih litar tertutup untuk blok diagram berikut:

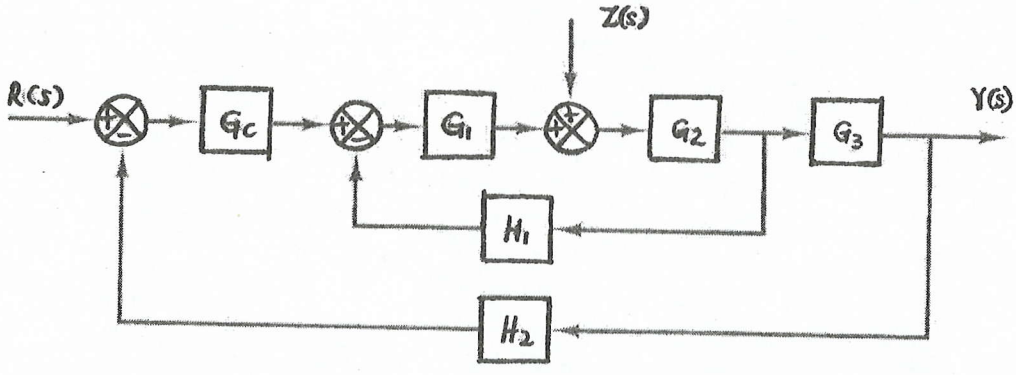
(a)




**Gambarajah 2(a) : Block Diagram of Closed Loop 1**
***Figure 2 (a) : Block Diagram of Closed Loop 1***

**(40 markah/*marks*)**

(b)



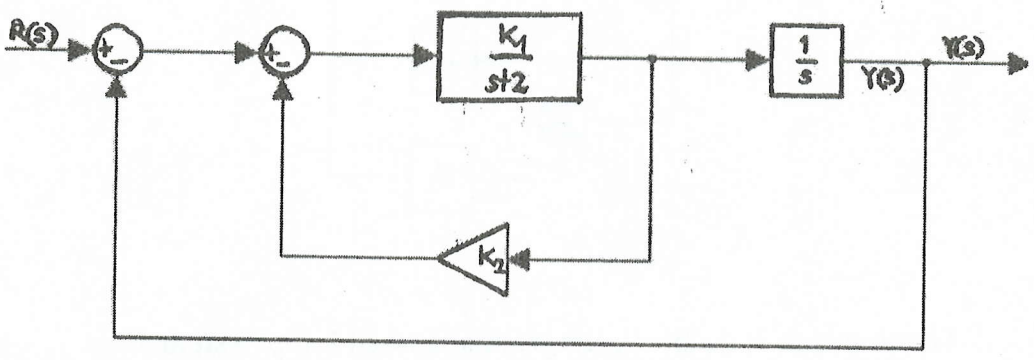

**Gambarajah 2(b) : Block Diagram of Closed Loop System 2**
***Figure 2 (b) : Block Diagram of Closed Loop 2***

**(30 markah/*marks*)**

...5/-

3. Merujuk kepada sistem yang ditunjukkan dalam Gambarajah 3 di bawah:

*Referring to the system shown in Figure 3 below:*




**Gambarajah 3 : Sistem Gelung Tertutup**
***Figure 3 : A Closed-Loop System***

(a) Tentukan nilai $K_1$ dan $K_2$ supaya sistem itu mempunyai nisbah redaman $\rho = 0.7$ dan frekuensi tabii tak terendam $W_o = 4\ ^{rad}/_{sec}$.

*Determine the valves of $K_1$ and $K_2$ such that the system has a damping ratio $\rho = 0.7$ and undamped natural frequency $W_o = 4\ ^{rad}/_{sec}$.*

**(50 markah/*marks*)**

(b) Dapatkan masa naik $t_r$, masa puncak $t_p$, maksimum terlajak $M_p$ dan masa pengenapan $t_s$ dalam unit sambut langkah dan gambarkan/cantumkan masa-masa tersebut dalam lakaran unit sambutan langkah.

*Obtain the rise time $t_r$, peak time $t_p$, maximum overshoot $M_p$, setting time $t_s$ in the unit step response and put the times into the sketch of step response.*

**(50 markah/*marks*)**

...7/-

4. (a) Pertimbangkan persamaan ciri-ciri yang berikut:

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

Tentukan julat K untuk kestabilan menggunakan Kriteria Routh.

*Consider the following characteristic equation:*

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

*Determine the range of K for stability using Routh's Criterion.*

**(50 markah/*marks*)**

(b) Pertimbangkan fungsi alih gelung terbuka

$$F_o(s) = \frac{K}{1 - TS} \quad ; K = 1.0$$

(i) Lakarkan plot polar $F_o(s)$ di atas.

(ii) Berdasarkan lakaran polar plot $F_o(s)$ di atas, tentukan sama ada belung tertutup $F_c(s)$ stabil atau tidak?.

*Consider the open-loop transfer function*

$$F_o(s) = \frac{K}{1 - TS} \quad ; K = 1.0$$

*(i) Draw polar plot for* $F_o(s)$ *above.*

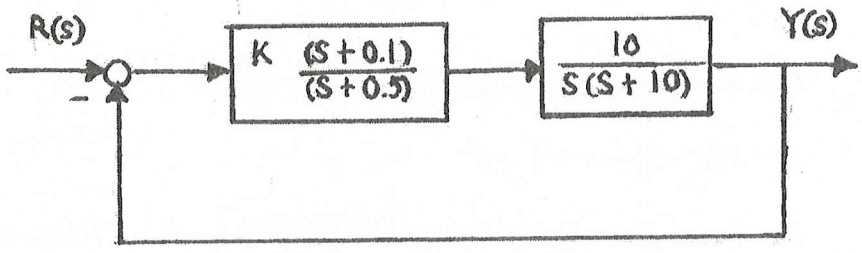
*(ii) Based on polar plot* $F_o(s)$*, determine whether the closed loop* $F_c(s)$ *stable or not using nyquist-stability criterion?.*

**(50 markah/*marks*)**

...8/-

5. Pertimbangkan sistem seperti yang ditunjukkan dalam Gambarajah 4.

*Consider the system shown in Figure 4.*




**Gambarajah 4 : Rajah blok bagi pengerak hidraulik**
***Figure 4 : Block diagram of hydraulic servo actuator***

(a) Lukiskan rajah bode bagi fungsi pindah gelung terbuka.

*Draw a bode diagram of open-loop transfer function.*

**(60 markah/*marks*)**

(b) Tentukan nilai gandaan K supaya margin fasa ialah $45^{o}$

*Determine the value of gain K such that the phase margin is $45^{o}$*

**(20 markah/*marks*)**

(c) Apakah margin gandaan bagi sistem untuk gandaan K di atas.

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

**(20 markah/*marks*)**

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