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FINAL
Examination Paper

(COVER PAGE)

Session : AUGUST 2012

Programmes : Diploma in Electrical and Electronic Engineering (DEE/I)

Course : EEE2108 : MODERN CONTROL SYSTEMS ENGINEERING

Date of Examination :

Time : Reading Time : Nil

Duration : 2 Hours

Special Instructions :

This paper consists of SIX (6) questions. Answer any FOUR (4) questions in the answer booklet provided. All questions carry equal marks.

Students are not allowed to remove this question paper from the examination venue.

Materials permitted :

Non-programmable scientific calculator

Materials provided :

Laplace Transform Table (Appendix)

Examiner(s) : **Chan Tse Wei**

Moderator :

This paper consists of 7 printed pages, including the cover page.

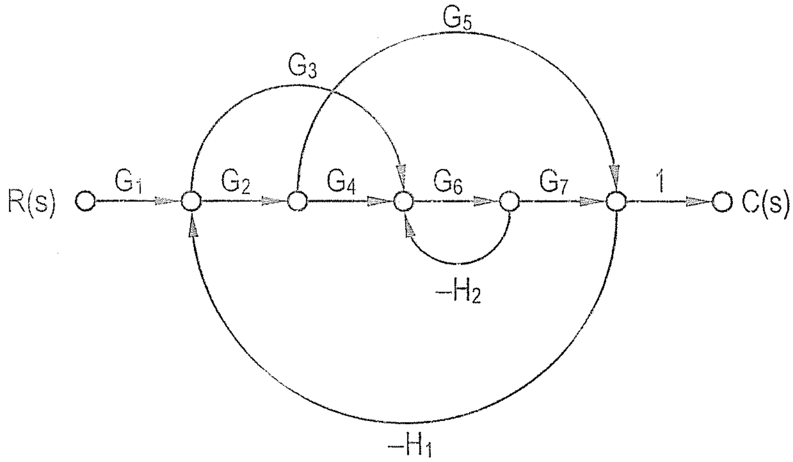

Figure-Q1(b)

Question 2

a. A system's transfer function is given by

$$\frac{C(s)}{R(s)}=\frac{s^2+5s+6}{s^4+9s^3+16s^2+15s+7}$$

i. How many poles and finite zeros are there for this system? [4]

ii. Show that the system has zero at infinity. [2]

iii. If one of the pole is located at $s=-1$ in the s-plane, determine the locations of the remaining poles and zeros. [5]

iv. Is this system stable? Explain why. [4]

b. A unity negative-feedback control system has an open-loop transfer function consisting of two poles, two zeros and a variable positive gain K. The zeros are located at -2 and -1, and the poles at -0.1 and 1.

Using the Routh-Hurwitz stability criterion, determine the ranges of values of the gain constant K for which the closed-loop system has the following number of poles in the right-half s-plane.

i. 0 pole [4]

ii. 1 pole [4]

iii. 2 poles [2]

Question 4

a. Sketch the asymptotic Bode magnitude plot for the following transfer functions:

i. $\frac{1}{j\omega}$ [2]

ii. $\frac{1}{1+j0.5\omega}$ [3]

iii. $\frac{1}{(1+j0.025\omega)^2}$ [3]

iv. $\frac{1}{j\omega(j0.5\omega)(1+j0.025\omega)^2}$ [5]

b. Figure-Q4(b) shows an asymptotic magnitude (in dB) versus frequency (log scale) sketch of an open loop transfer function, $G(s)$ having a constant gain K. There are no right half plane poles or zeros present in the transfer function.

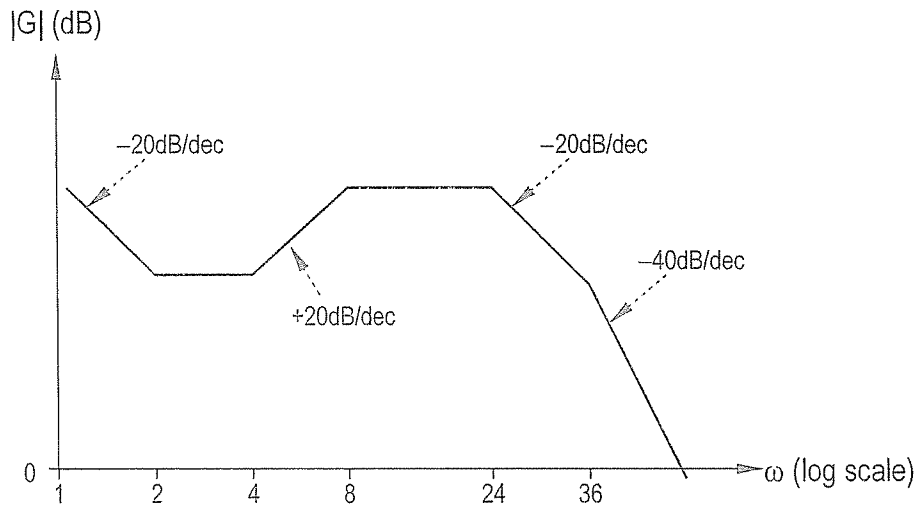

Figure-Q4(b)

i. Determine the expression of $G(s)$ in terms of K. [8]

ii. Determine the value of K. [4]

b. A unity feedback control system has an open-loop transfer function $G(s) = \frac{10}{s(s+1)}$.

i. Determine the phase margin of the system. [5]

ii. If a compensator $G_C(s) = \frac{1 + 14.28s}{1 + 142.8s}$ is cascaded with $G(s)$, how does it affect the phase margin? [7]

– THE END –

	Definition	$f(t)$ from $t > 0$	$F(s) = \mathcal{L}\left[f(t)\right] = \int_0^{\infty} f(t) e^{-st}\, dt$
17.	n^{th} order ramp	t^n	$\dfrac{n!}{s^{n+1}}$
18.	Exponential decay	e^{-at}	$\dfrac{1}{s+a}$
19.	Exponential growth	$1 - e^{-at}$	$\dfrac{a}{s(s+a)}$
20.	Exponential $\times\, t$	te^{-at}	$\dfrac{1}{(s+a)^2}$
21.	Exponential $\times\, t^n$	$t^n e^{-at}$	$\dfrac{n!}{(s+a)^{n+1}}$
22.	Difference of exponentials	$e^{-at} - e^{-bt}$	$\dfrac{b-a}{(s+a)(s+b)}$
23.	Difference of exponentials	$\dfrac{1}{b-a}\left(be^{-bt} - ae^{-at}\right)$	$\dfrac{s}{(s+a)(s+b)}$
24.	Sine	$\sin \omega t$	$\dfrac{\omega}{s^2 + \omega^2}$
25.	Phase-advanced sine	$\sin(\omega t + \phi)$	$\dfrac{\omega \cos\phi + s \sin\phi}{s^2 + \omega^2}$
26.	Sine $\times\, t$	$t \sin \omega t$	$\dfrac{2\omega s}{\left(s^2 + \omega^2\right)^2}$
27.	Exponentially decaying sine	$e^{-at} \sin \omega t$	$\dfrac{\omega}{(s+a)^2 + \omega^2}$
28.	Cosine	$\cos \omega t$	$\dfrac{s}{s^2 + \omega^2}$
29.	Phase-advanced cosine	$\cos(\omega t + \phi)$	$\dfrac{s \cos\phi - \omega \sin\phi}{s^2 + \omega^2}$
30.	Cosine $\times\, t$	$t \cos \omega t$	$\dfrac{s^2 - \omega^2}{\left(s^2 + \omega^2\right)^2}$
31.	Exponentially decaying cosine	$e^{-at} \cos \omega t$	$\dfrac{s+a}{(s+a)^2 + \omega^2}$