INTI International College Penang

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**August 2021**
Programme	:	Diploma in Electrical & Electronic Engineering (DEEI)
Course	:	**EEE2108: Modern Control Systems Engineering**
Date of Examination	:	4 December 2021 (Saturday)
Time	:	8.00am – 11.00am Reading Time : Nil
Duration	:	3 Hours

Special Instructions :

This paper consists of **FOUR (4)** questions. All questions carry equal marks.

Material permitted	:	Programmable Scientific Calculator
Materials provided	:	Nil

Examiner(s)	:	**Alan Wong Kam Mun**
Chief Moderator	:	Chai Yoon Yik

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

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2108: MODERN CONTROL SYSTEMS ENGINEERING
FINAL ALTERNATIVE ASSESSMENT: AUGUST 2021 SESSION

Instructions: This paper consists of **FOUR (4)** questions. All questions carry equal marks.
Important notice: Computer software are NOT allowed in this exam except software to access the Question Paper and to submit the Answer Script. Answers are expected to be hand-written and required graph are to be manually plotted. Copy/paste and computer plotted graph will get zero marks.

Question 1 [25]

(a) The characteristic equation of a system is given as:

$$s^5 + 2s^4 + 24s^3 + 48s^2 - 25s - 50 = 0$$

(i) Using the Routh-Hurwitz Table, find the stability of the system. [5]

(ii) Find the values of all the poles. [5]

(iii) What you can expect to observe at the output with unit-step input. [2]

(b) A system with transfer function F(s) is given by:

$$\mathrm{F(s)} = \frac{\mathrm{Y(s)}}{\mathrm{R(s)}} = \frac{24(s+1)}{s^4+6s^3+21s^2+36s+20}$$

(i) Using the Routh-Hurwitz Table, find the stability of the system. [7]

(ii) Find the steady state output value of the system to a unit step input. [6]

Question 2

(a) (i) For the following transfer function, draw the Bode plot for ω= 0.01 to 200 rad/s.

$$G(s) = \frac{1.43}{s(1+0.5s)(1+0.01s)}$$

Label the plot showing the gradient of the various part of the plot. 6

(ii) Label and determine the Gain Margin (dB) and Phase Margin (degree). 2

(iii) Comment and justify its stability. 2

(b) The open-loop frequency response of a unity-feedback system is given below.

ω(rad/s)	1	3	6	10
|G| dB	12.0	-4.2	-12.0	-15.5
∠G (in degree)	-110	-136	-158	-172

Transfer the Open-loop frequency response data into a Nichols chart and find:

(i) Closed-loop frequency response (tabulate in table form) [5]

(ii) Gain Margin, GM [2]

(iii) Phase margin, PM [2]

(iv) -3dB Bandwidth, BW [2]

(v) Resonance peak, Mp [2]

(vi) Resonance frequency, ω [2]

Question 3

A unity feedback system is having $G(s) = \frac{K}{(s+10)(S^2+4s+7)}$

Show clearly all the procedure used to sketch the root-locus of the system.

(a) Find the number of root-locus branches. [1]

(b) Find the number of root-locus asymptotes. [1]

(c) Find the intersection point of the asymptotes on the real-axis. [2]

(d) Find the angles of asymptotes made with the real-axis. [2]

(e) Find the break-in and/or break-away point. [1]

(f) Find the imaginary-axis crossing points of the root-locus. [6]

(g) Find the angle of departure and/or angle of arrival. [4]

(h) Sketch and label the root-locus. [3]

(i) A unity feedback system is having $G(s) = \frac{K}{(S^2+4s+7)}$ [5]

Calculate the gain K for the system to achieve damping factor ξ = 0.50

Question 4

(a) A unit-step input is input into a unity feedback system having

$$G(s) = \frac{K}{s(Ts+1)}$$

The peak overshoot Mp is 50% and occurred at peak time Tp= 2.0 s

(i) Find the value of K. [5]

(ii) Find the value of T. [5]

(b) A unit-step input is input into a unity feedback system having

$$G(s) = \frac{K}{s(Ts+1)}$$

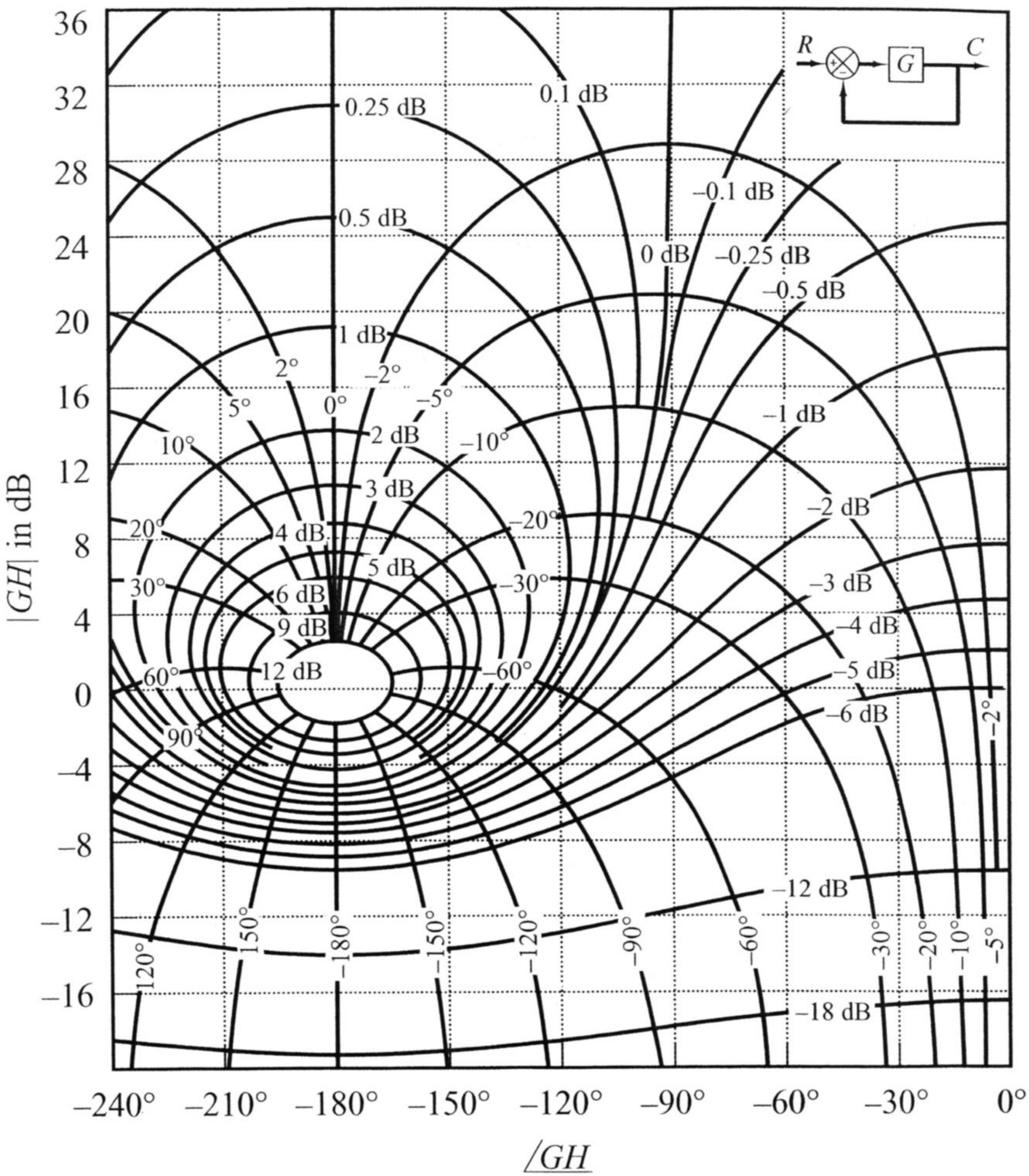
Given the peak overshoot Mp is 5% and the settling time Ts (for $\pm$ 2% of final value) is 2 s.

(i) Find the value of K and T [10]

(ii) Explain whether it is possible for the system to fulfill additional requirement of peak time Tp = 0.50 s. [5]

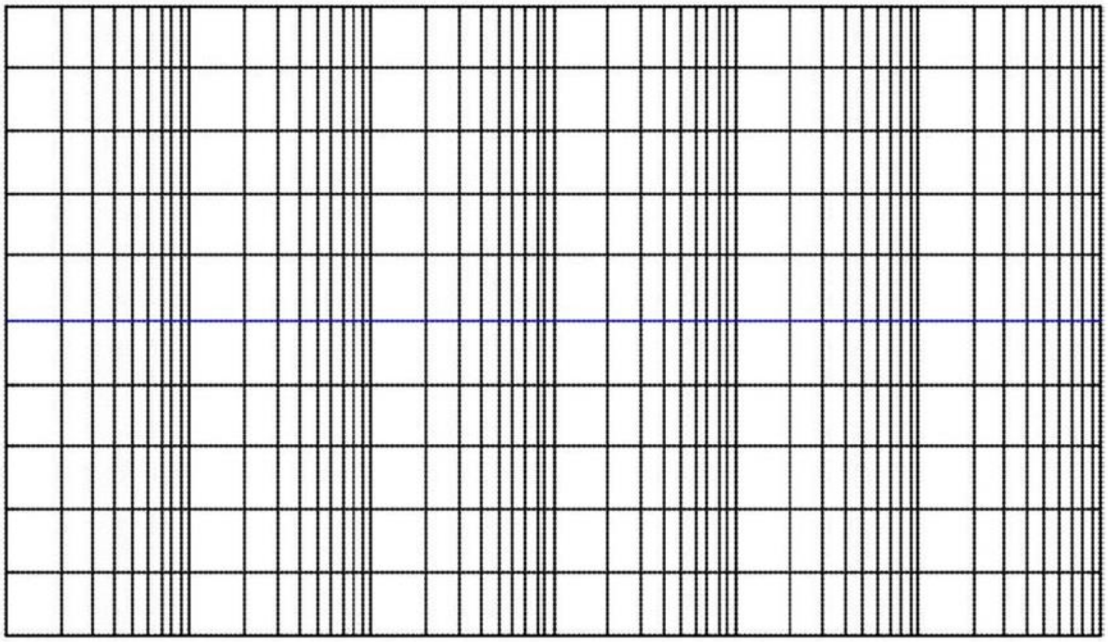
~THE END~

Number	$F(s)$	$f(t), t \geq 0$
1	1	$\delta(t)$
2	$1/s$	$1(t)$
3	$1/s^2$	t
4	$2!/s^3$	t^2
5	$3!/s^4$	t^3
6	$m!/s^{m+1}$	t^m
7	$1/(s+a)$	e^{-at}
8	$1/(s+a)^2$	te^{-at}
9	$1/(s+a)^3$	$\frac{1}{2!}t^2e^{-at}$
10	$1/(s+a)^m$	$\frac{1}{(m-1)!}t^{m-1}e^{-at}$
11	$\frac{a}{s(s+a)}$	$1-e^{-at}$
12	$\frac{a}{s^2(s+a)}$	$\frac{1}{a}(at-1+e^{-at})$
13	$\frac{b-a}{(s+a)(s+b)}$	$e^{-at}-e^{-bt}$
14	$\frac{s}{(s+a)^2}$	$(1-at)e^{-at}$
15	$\frac{a^2}{s(s+a)^2}$	$1-e^{-at}(1+at)$
16	$\frac{(b-a)s}{(s+a)(s+b)}$	$be^{-bt}-ae^{-at}$
17	$a/(s^2+a^2)$	$\sin at$
18	$s/(s^2+a^2)$	$\cos at$
19	$\frac{s+a}{(s+a)^2+b^2}$	$e^{-at}\cos bt$
20	$\frac{b}{(s+a)^2+b^2}$	$e^{-at}\sin bt$
21	$\frac{a^2+b^2}{s[(s+a)^2+b^2]}$	$1-e^{-at}\left(\cos bt+\frac{a}{b}\sin bt\right)$


R
G
C
0.25 dB
0.1 dB
0.5 dB
−0.1 dB
0 dB
−0.25 dB
−0.5 dB
1 dB
2°
−2°
5°
0°
−5°
−1 dB
10°
2 dB
−10°
3 dB
−2 dB
20°
4 dB
−20°
5 dB
30°
6 dB
−30°
−3 dB
9 dB
−4 dB
60°
12 dB
−60°
−5 dB
90°
−6 dB
−2°
−12 dB
120°
150°
−180°
−150°
−120°
−90°
−60°
−30°
−20°
−10°
−5°
−18 dB
36
32
28
24
20
16
12
8
4
0
−4
−8
−12
−16
|GH| in dB
−240°
−210°
−180°
−150°
−120°
−90°
−60°
−30°
0°
/GH

BODE PLOT

$20\log_{10}|TF|$



Angle of TF