FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**April 2022**
Programme	:	Diploma In Electrical and Electronics Engineering (DEEI)
Course	:	**EEE2108 Modern Control Systems Engineering**
Date of Examination	:	03 August 2022(Wednesday)
Time	:	08.00am-11.00am Reading Time : Nil
Duration	:	03 hours

Special Instructions :

This paper consists of **FIVE (5)** questions. Answer **ALL** questions in the answer booklet provided.

Material permitted :

Non-Programmable Scientific Calculator

Materials provided :

Nil

Examiner(s)	:	Ronald Anak Jackson
Chief Moderator	:	Alan Wong

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

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
EEE2108 MODERN CONTROL SYSTEMS ENGINEERING
FINAL ALTERNATIVE ASSESSMENT: APRIL 2022 SESSION

Instructions: This paper consists of **FOUR (4) questions**. **Answer all the questions**. All the questions carry equal marks. Start each question **on a new page** and carefully identify your answers with the correct question number.

Question 1

(a) For the pole a location plot in **Figure 1(a)**. Find the

(i) Damping ratio (2 marks)

(ii) Natural frequency (2 marks)

(iii) Peak time (2 marks)

(iv) Settling time (2% error) (2 marks)

(v) Rise time (2 marks)

(vi) Percent overshoot (2 marks)

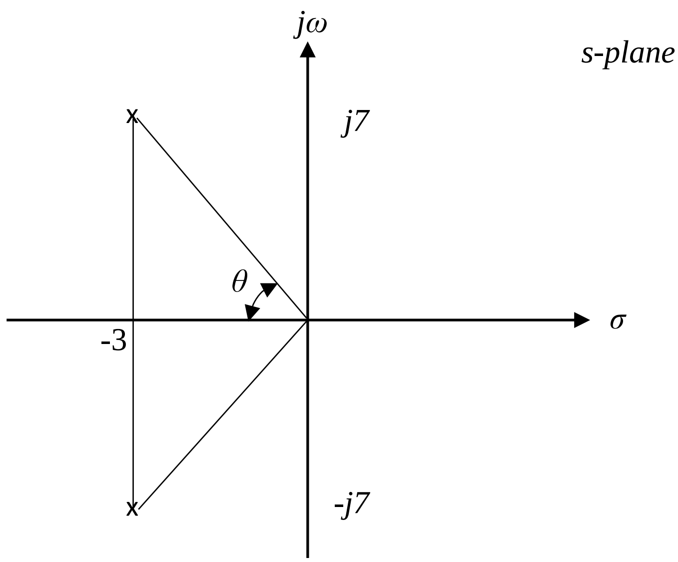


Figure 1(a)

(b) A unity feedback system has the following open loop transfer function:

$$G(s) = \frac{10(s+2)}{s^2(s+1)}$$

(i) Find the position, velocity, and acceleration error constants

(6 marks)

(ii) Find the steady state error when the input is

$$R(s) = \frac{3}{s} - \frac{2}{s^2} + \frac{1}{3s^3}$$

(7 marks)

Question 2

(a) Apply the Routh-Hurwitz method for transfer function below.

$$T(s) = \frac{s^3 + 7s^2 - 21s + 10}{s^6 + s^5 - 6s^4 - s^2 - s + 6}$$

Find the following:

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

(13 marks)

(ii) Determine the stability of the system and justify.

(2 marks)

(b) For a unity feedback system with the forward transfer function given below:

$$G(s) = \left(\frac{2K}{s^3 + 4s^2 + 5s + 2}\right)$$

Find the range of K to make the system stable where K>0.

(10 marks)

Question 3

(a) Define the root locus as applied in control system engineering.

(4 marks)

(b) Consider the simplified form of a transfer function for position servomechanism used in an antenna tracking system as shown in **Figure Q3(b)**. An electric motor is used to rotate a radar antenna which automatically tracks an aircraft. By using root locus, do the following:

(i) Find the starting and ending points of the loci.

(4 marks)

(ii) Find the number of branches.

(1 marks)

(iii) Find the number of asymptotes.

(2 marks)

(iv) Find the breakaway and break-in points.

(6 marks)

(v) Find the departure angle.

(4 marks)

(vi) Sketch the root locus.

(4 marks)

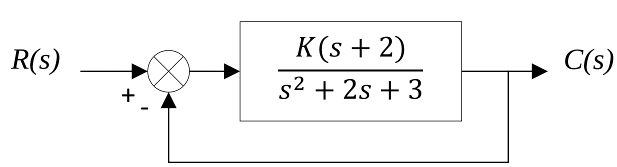


Figure Q3(b)

Question 4

(a) A transfer function of a ship's roll stabilizing system is shown in **Figure 4(a)**.

(i) Show the equation for magnitude |G(s)| and phase of G(s).

(3 marks)

(ii) Sketch the Bode plot of the system for ω(rad/s) = 1, 2, 4, 5, 10

(8 marks)

(iii) Find the gain Margin (dB) and Phase Margin (degree) from plot. Verify the stability of the system.

(4 marks)

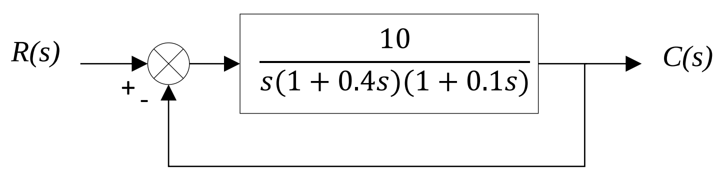


Figure Q4(a)

(b) Sketch the Nyquist diagram for a system shown in **Figure 4(b)** below where

$$G(s) = \frac{1}{(s+2)(s+4)}$$

Comment whether the system is stable.

(10 marks)

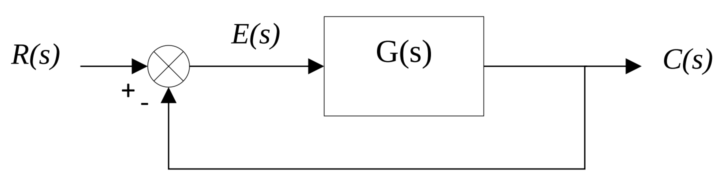
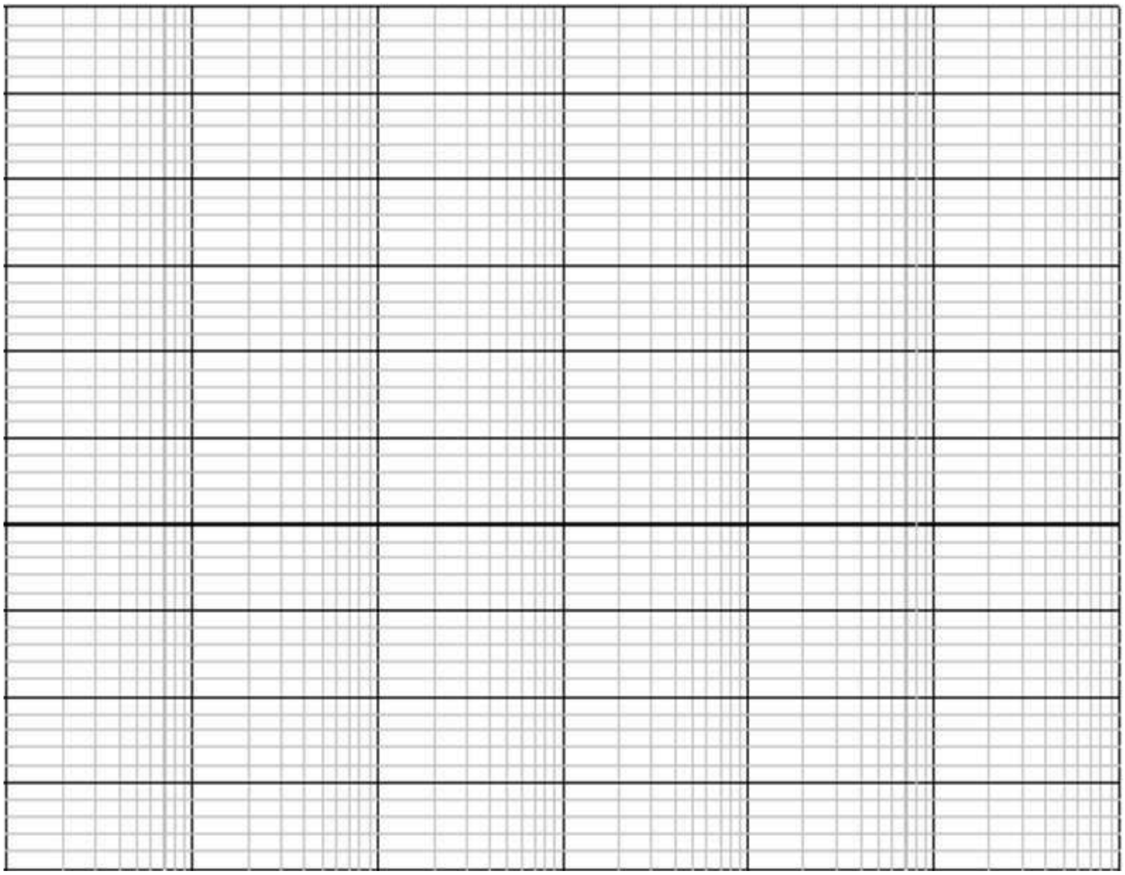


Figure Q4(b)

Appendix A – Bode Diagram



Appendix B – Table of Laplace Transformations

f(t)	***F(s)***
$\delta(t)$	1
$u(t)$	$\frac{1}{s}$
$tu(t)$	$\frac{1}{s^2}$
$t^n u(t)$	$\frac{n!}{s^{n+1}}$
$e^{-at}u(t)$	$\frac{1}{s+a}$
$sin\ \omega tu(t)$	$\frac{\omega}{s^2+\omega^2}$
$cos\ \omega tu(t)$	$\frac{s}{s^2+\omega^2}$

~THE END~