TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

Department of Mechanical Engineering

UNIVERSITY EXAMINATION FOR:

Diploma in Mechanical Engineering (Plant)
Diploma in Mechanical Engineering (Production Option)

EMC2328: Control Systems and Instrumentation 1I

END OF SEMESTER EXAMINATION

SERIES: JULY 2025

TIME: 2 HOURS

DATE: JULY 2025

Instructions to Candidates

You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of **five** Questions; Attempt any **THREE** Questions.
Do not write on the question paper.

QUESTION ONE

a) With the aid of schematic diagrams, explain the principle of operation of the following resistance transducers
   i) Potentiometer
   ii) Thermistor
   iii) Potentiometer **(12 Marks)**

b) i) State any **one** advantage and **one** disadvantage of each of the transducers described above.
   ii) List any **two** applications of piezoelectric transducers **(8 Marks)**

QUESTION TWO

a) Explain the working principle of the following types of transducers
   I) Linear Variable Differential Transformer (LVDT)
   II) Pyroelectric Sensor **(10 Marks)**

b) i) Distinguish between 'Seebeck effect' and 'Thomson effect'
   ii) Explain with the aid of a diagram the working principle of a thermocouple
   iii) State any **two** applications of the transducer in b(ii) **(10 Marks)**

QUESTION THREE

a) i) Distinguish between the following:

I) Time response and Frequency response

II) Absolutely Stable System and Conditionally Stable System

ii) Determine and plot on the S-plane the **poles** and **Zeros** of

$$F(s)=\frac{s^2-9}{s^3(s+2)(s-6)}$$

iii) State Routh-Hurwitz Stability Criterion **(10 Marks)**

b) State and explain any **Three** techniques for finding poles and zeros in a transfer function

i) List the **Two** conditions that a Linear Time Invariant (LTI) system must satisfy to be stable.

ii) Define the term 'System stability' **(10Marks)**

2. a) i) State the **TWO** difficulties encountered while applying Routh Stability criterion

ii) The transfer function of the forward path of a unity feedback system is found to be $\frac{K}{2s^3+8s^2+22S}$.Using the Routh-Hurwiz stability criterion, investigate the system stability. **(10 Marks)**

b) For any given point G(s)= x+jy of a polar plot G(jw) show that constant M-circles are circles given by in the complex plane with radius:

$$r=\frac{m}{1+m^2} \quad \text{centered at} \left(\frac{m^2}{1+m^2}, y = 0\right)$$

(10Marks)

3. a) i) State Nyquist stability criterion

ii) With respect to the Nyquist polar plot, define the following

I) Phase Margin

II) Gain Margin

(8 Marks)

b) A system has the following open-loop frequency response:

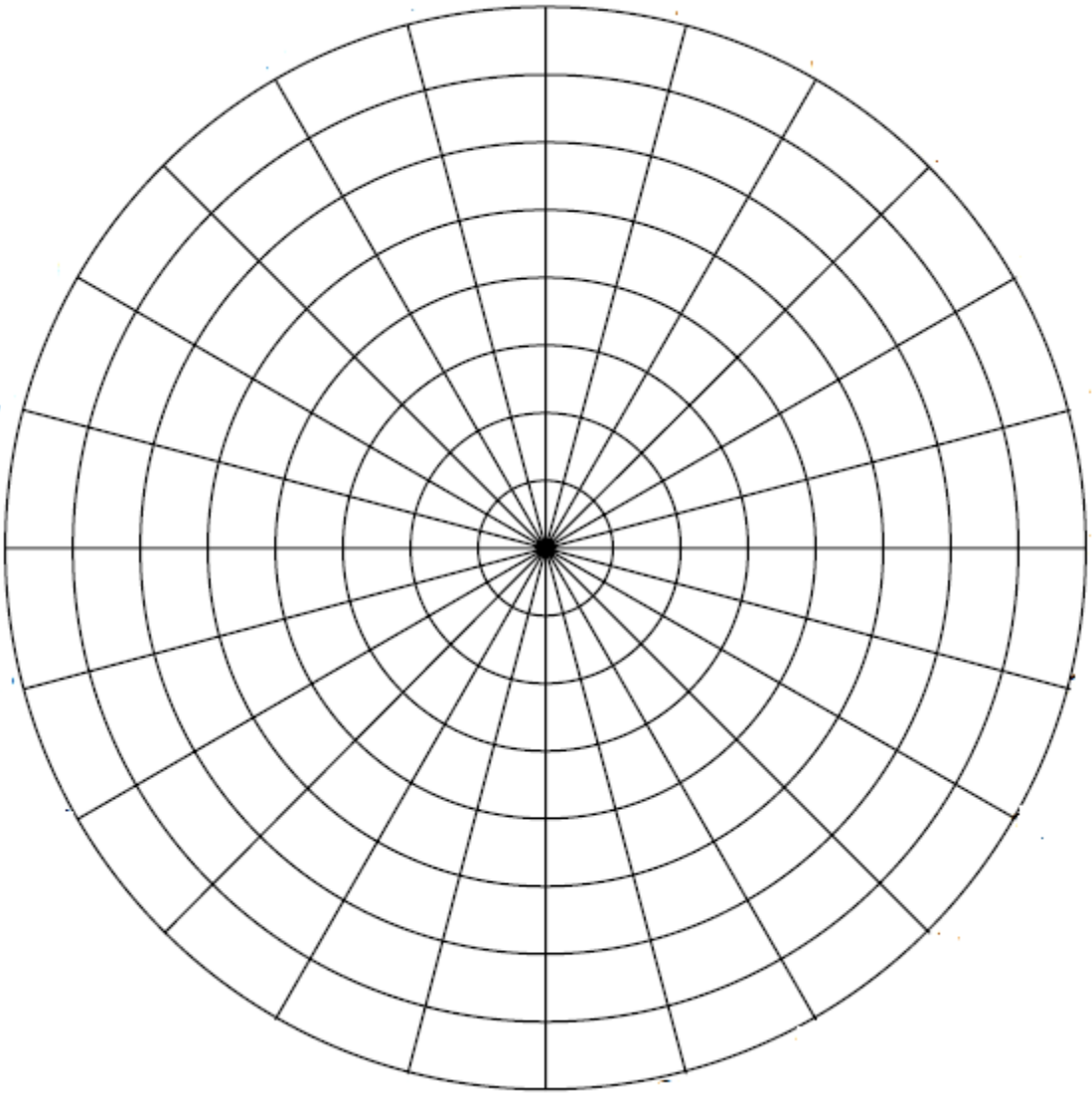
W(rad/s)	2	3	4	5	6	8	10	30
Gain	.2.8	1.9	1.3	0.9	0.68	0.4	0.26	0.12
θ (degrees)	-120	-130	-140	-149	-157	-170	-180	-300

Plot the Nyquist diagram and determine:

i) Phase Margin

ii) Gain Margin

iii) Deduce from these values, whether the system is stable or unstable giving reasons for your answer. **(12 Marks)**



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