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)

EMC 2328: Control Systems and Instrumentation 1I

END OF SEMESTER EXAMINATION

SERIES: MAY 2025

TIME: 2 HOURS

DATE: MAY 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) Piezoresistive
   ii) Strain Gauge
   iii) Photoresistor (LDR) (**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) With one example in each case, explain the working principle of the following types of transducers
   I) Variable inductive transducer
   II) Variable capacitance **(10 Marks)**

b) i) Distinguish between 'Peltier 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) Define the following terms as applied in control engineering:

I) Marginally stable system
II) Absolutely Stable System
III) Conditionally Stable System
IV) Asymptotically stable systems
V) Characteristic equation
VI) Poles
VII) Zeros

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

$$F(s) = \frac{(S+2)(S-5)}{S(S+2+j)(S+2-j)}$$

(12 Marks)

b) i) State Routh-Hurwitz Stability Criterion

ii) Explain with the aid of sketches the following input signals used for testing control systems. Give their mathematical representation

I) Step
II) Ramp
III) Parabolic
IV) Impulse **(8 Marks)**

QUESTION FOUR

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 $\frac{K}{s(s^2+s+1)(s+4)+k}$.Using the Routh-Hurwitz stability criterion:

I) Determine the characteristic equation
II) Form Routh Array
III) Calculate the minimum positive values of K at which the system becomes unstable
IV) Determine the range of values of K for which the system is stable

(10 Marks)

b) Find the stability of the control system whose characteristic equations are given below

I) $2s^5+2s^4+4s^3+4s^2+6s+10=0$
II) $2s^5+6s^4+2s^3+6s^2+2s+6=0$ **(10Marks)**

QUESTION FIVE

a) i) State Nyquist stability criterion

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

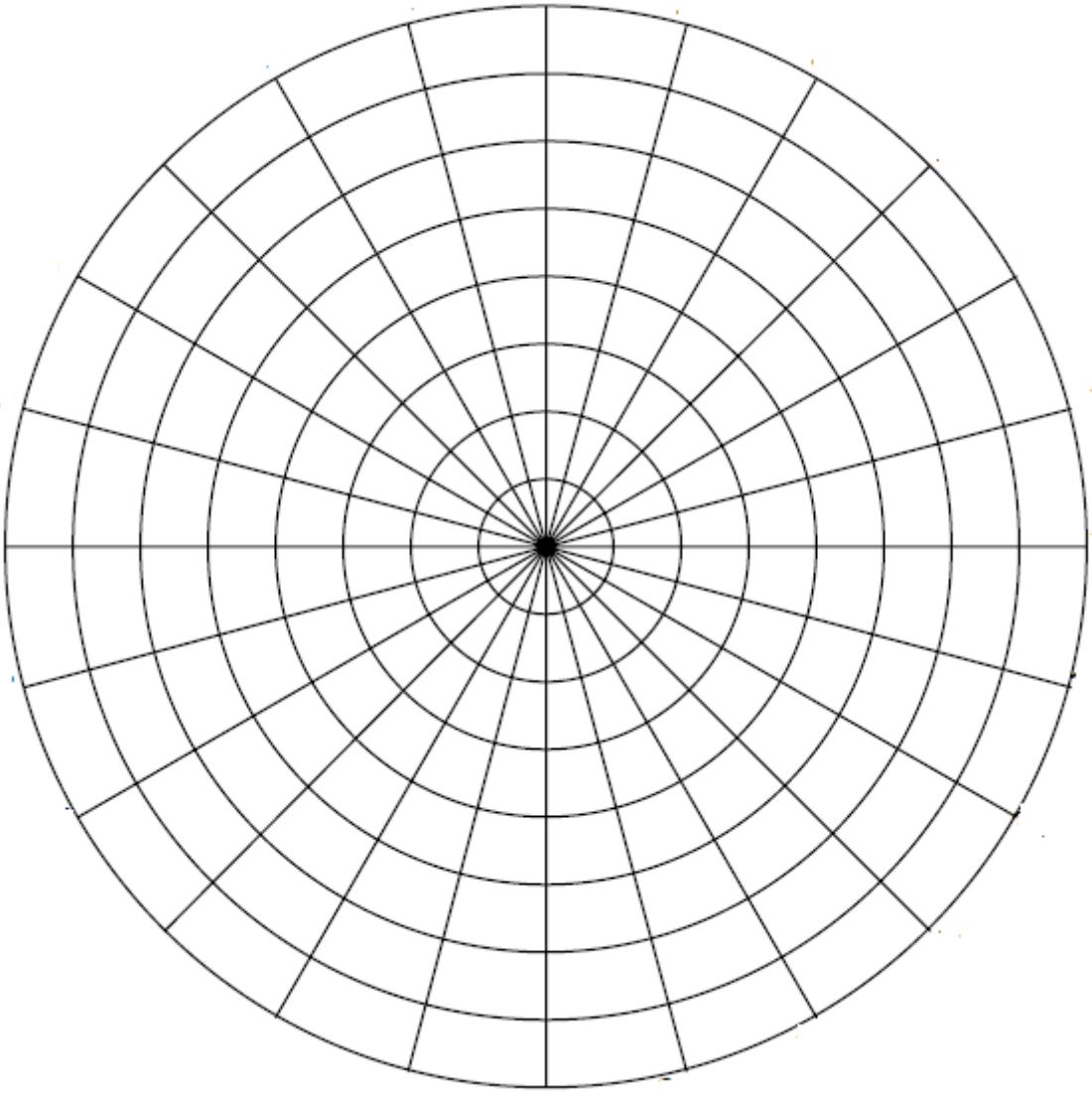
I) Phase Margin
II) Gain Margin **(8 Marks)**

iii) An open-loop transfer function is given by

$$G(jw)=\frac{50}{1+j2.5w)(1+j0.5w}$$

Plot the Nyquist diagram and determine for w = 0,3, 0,4, 0.5, 0.7, 1, 2, 3, 4, 8, and 32

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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