PP I

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

Department of Electrical & Electronic Engineering

UNIVERSITY EXAMINATION FOR:

Bachelor of Technology (Electrical & Electronic Engineering)

TEE 4309: CONTROL ENGINEERING I.

END OF SEMESTER EXAMINATION

SERIES: APRIL 2025

TIME: 2 HOURS

DATE: APRIL 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; Question ONE is compulsory. In addition attempt any Other TWO Questions.
Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a) For the control system depicted in **Figure Q1a**, determine the values of the flow signals at the salient points for an output value of C = 100.

[10 marks]

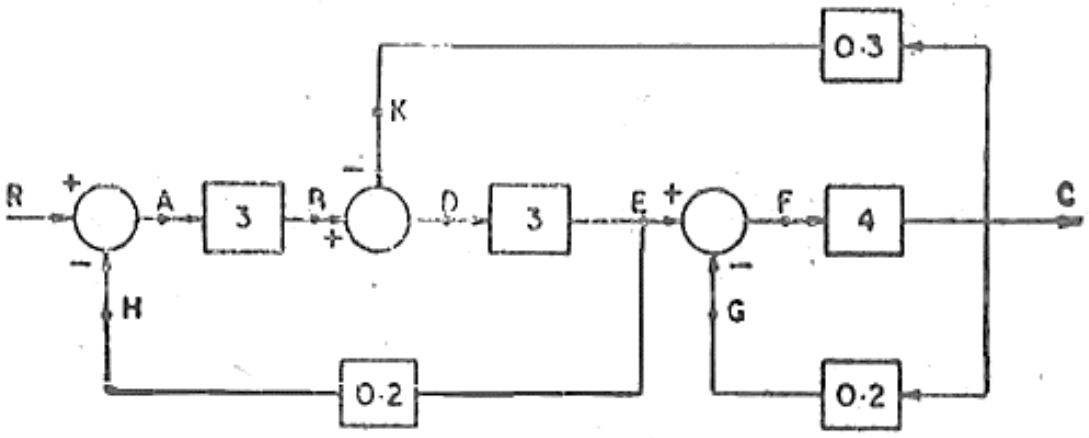


Figure Q1a

b) The forward path gain of an open loop system is 50. If the system is made into a closed loop system with negative ' feedback of 5, determine the percentage reduction in the overall gain.

[5 marks]

c) For a system with an open loop transfer function given by

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

i) Determine the stability when the value of K = 2

ii) Find the critical values of K for stability

[5 marks]

d) Outline any **five** advantages of frequency response analysis

[10 marks]

Question TWO

a) (i) State the Routh stability criterion.

(ii) Outline the procedure of obtaining then Routh array in determination of stability of a control system.

[7 marks]

b) The system shown has the oscillation of 2.5 rad/sec determine the values of K_{max} and p

[7 marks]

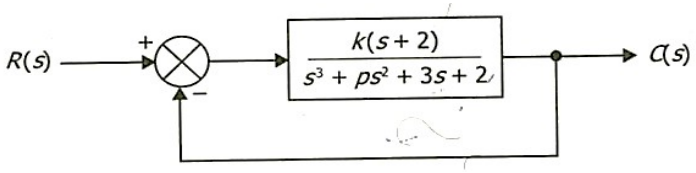


Figure Q2b

c) The pole zero configurations of a closed loop transfer function is plotted as in figure Q2b. Determine:

(i) The band width of the system

(ii) The band width of the system after a zero is added to the closed loop transfer function as in figure Q2bii

[6 marks]

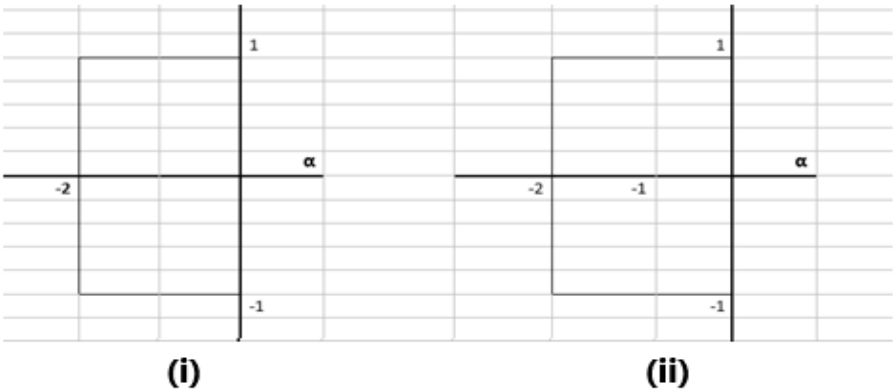


Figure Q2b

Question THREE

a) A system is described by the following differential equation

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 16y = 9x$$

For a unit step input, determine;

i) Undamped natural frequency
ii) Damped natural frequency
iii) Damping ratio
iv) Rise time
v) Delay time
vi) Peak time
vii) Maximum percent overshoot
viii) Output

[16 marks]

b) State any Two advantages and two disadvantages of open loop control systems

[4 marks]

Question FOUR

a) Obtain the transfer function of the automobile suspension system in Figure 4Qa, the input ***u*** is a displacement input.

[10 marks]

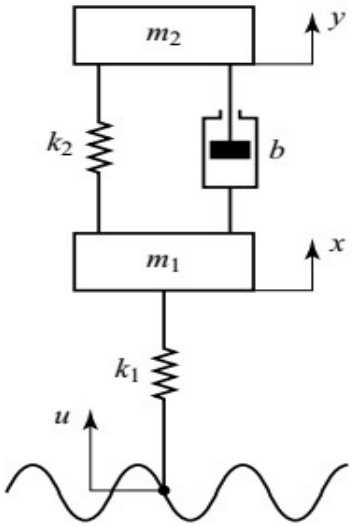


Figure Q4a

b) Derive the expression of M Circles and hence draw the family of circles

[10 marks]

Question FIVE

a) The block diagram of a space vehicle control system is shown in Figure Q5a. Determine the value of K such that the phase margin is 50^0.

[6 marks]

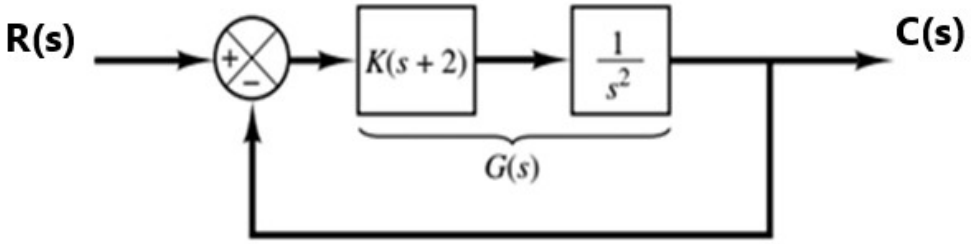


Figure Q5a

b) For the transfer function G(s) given below, sketch an open loop frequency response locus on a Nichols chart

From the sketch, determine:

i) The phase margin

ii) The gain margin

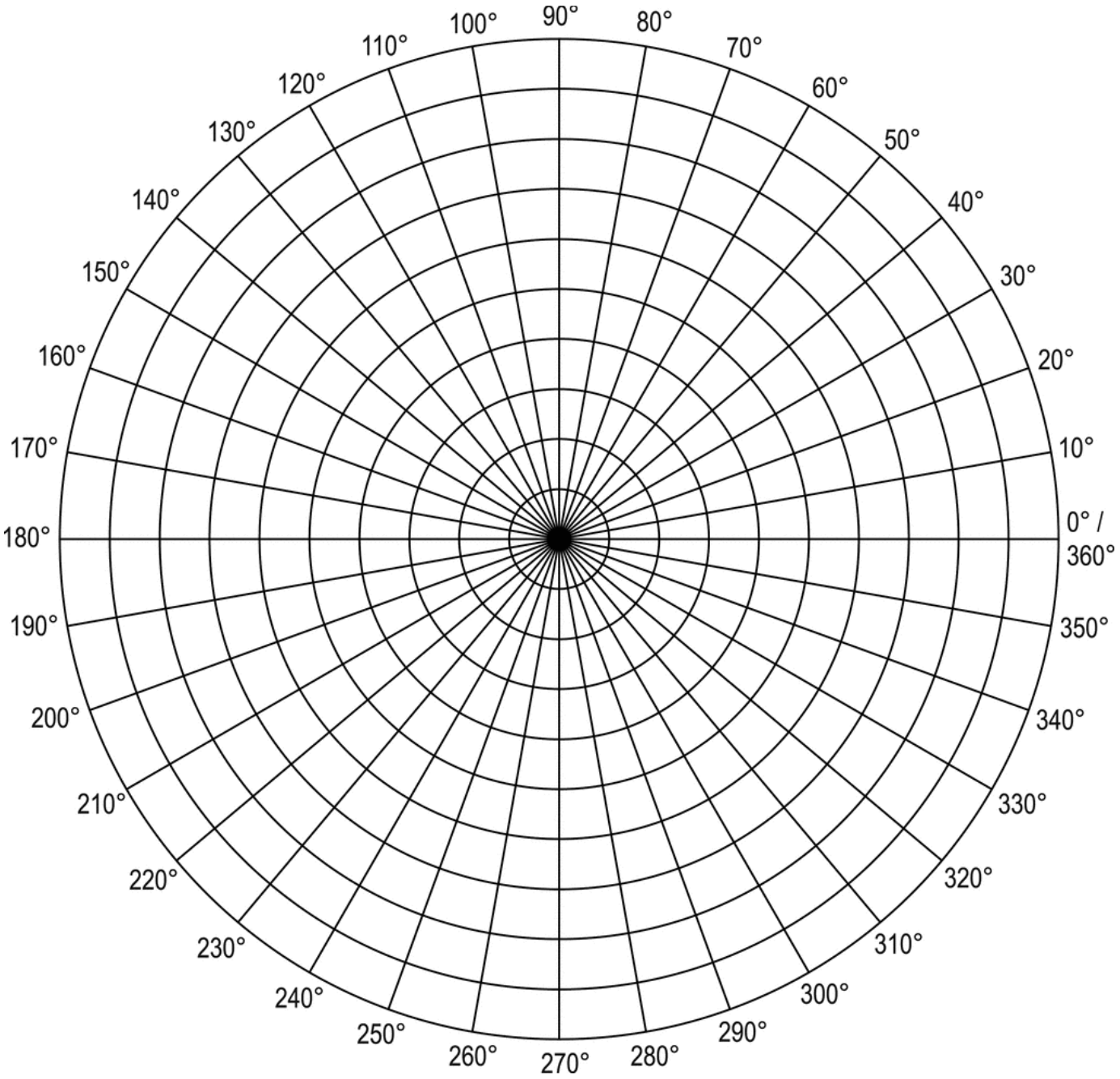
iii) Phase crossover frequency

iv) Gain crossover frequency

v) Bandwidth

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

[14 marks]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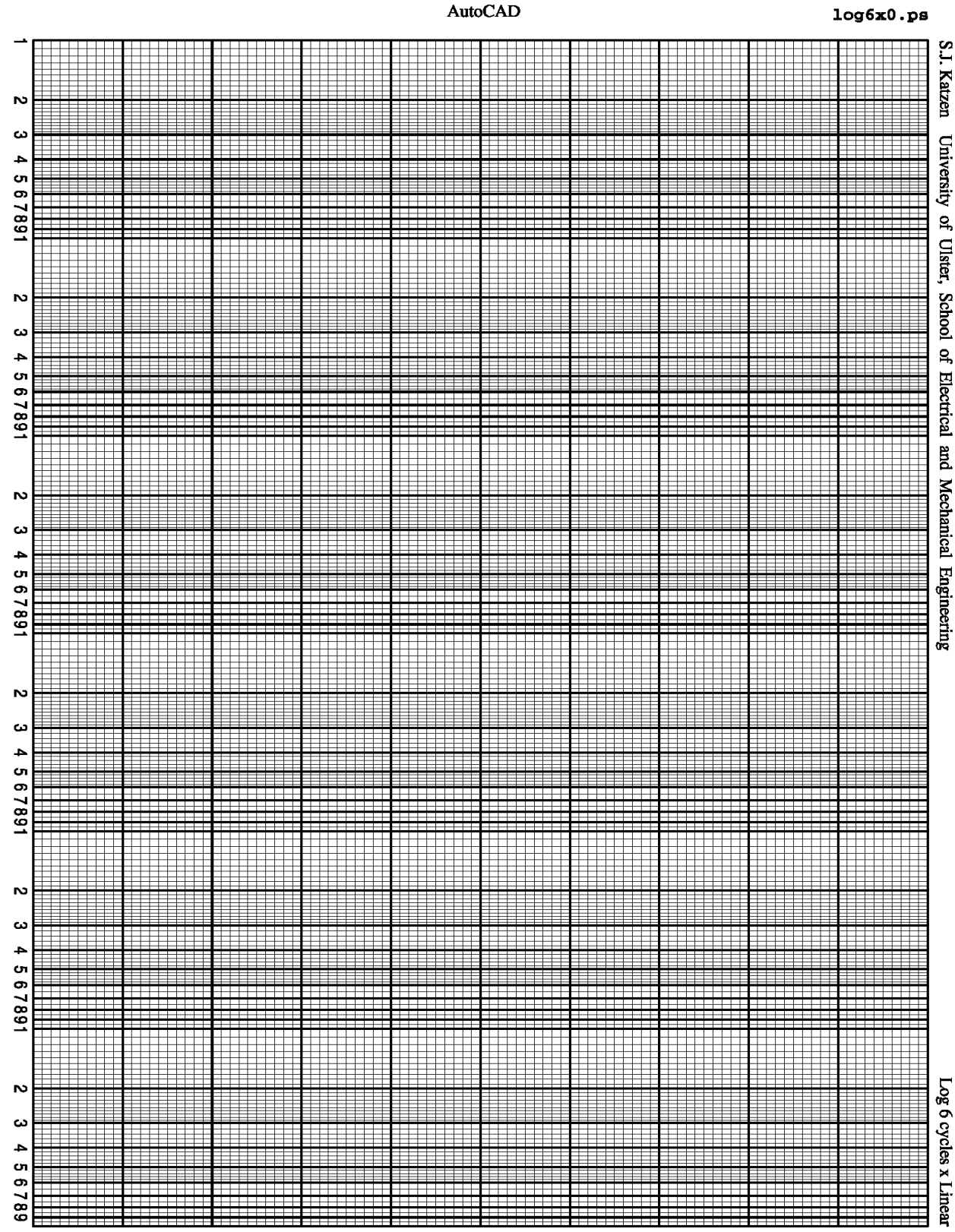
AutoCAD
log6x0.ps
S.J. Katzen University of Ulster, School of Electrical and Mechanical Engineering
Log 6 cycles x Linear
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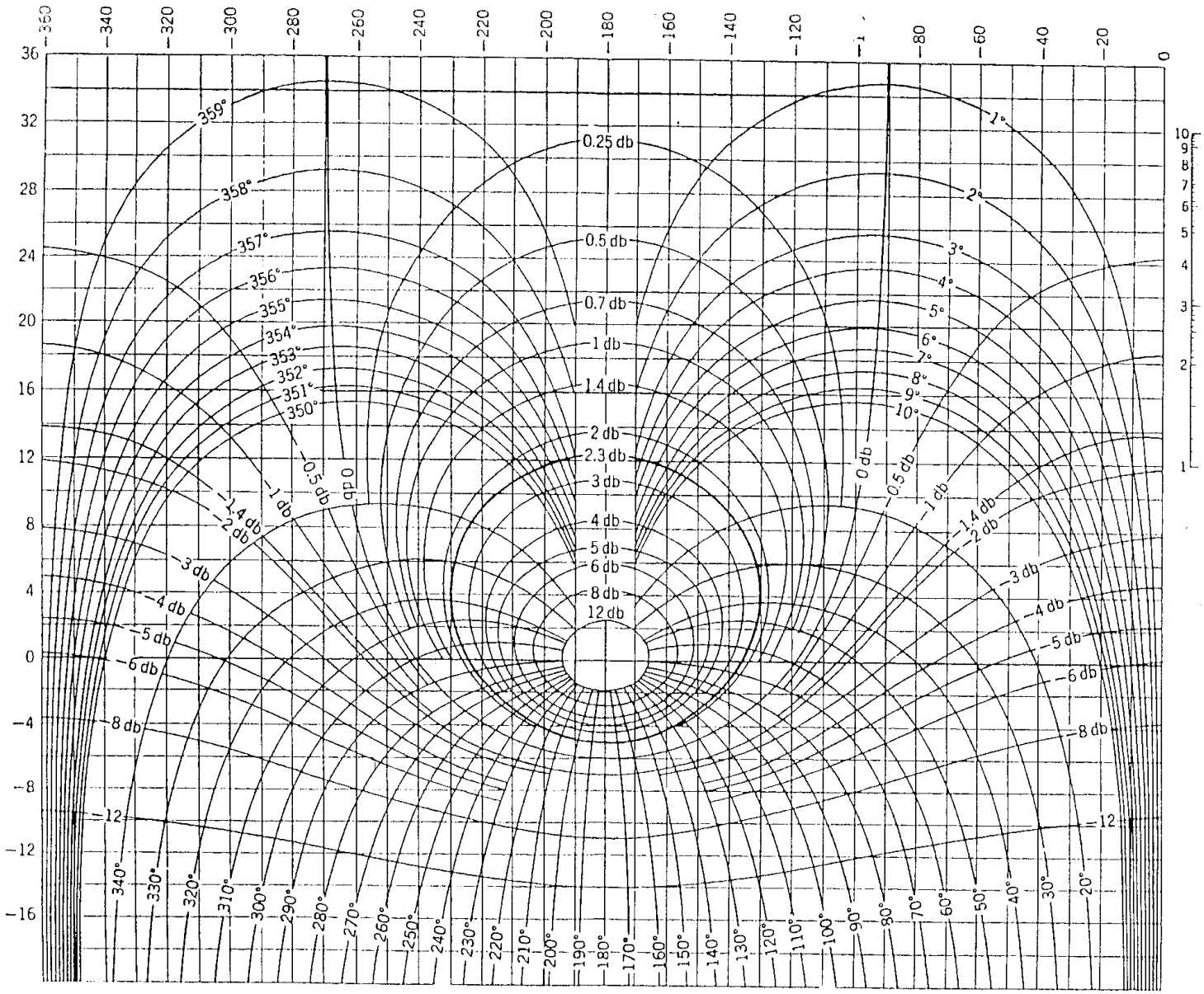
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