TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

Department of Mechanical and Automotive Engineering

UNIVERSITY EXAMINATION FOR:

Diploma in Chemical Engineering

ECI 2230: CONTROL SYSTEMS I

END OF SEMESTER EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2 HOURS

DATE: Sep 2018

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) When the system of Figure Q1a is subjected to a unit step input of P = 2 Newton, the system output oscillates as in Figure Q1b. Determine the values of *m*, *b* and *k* from the response curve.

(8 marks)

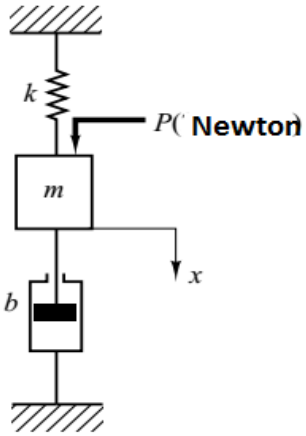


Figure Q1a

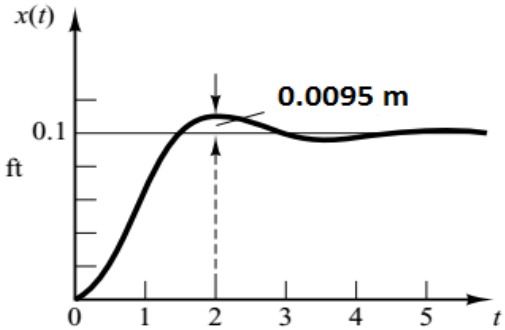


Figure Q1b

b) A system is describe by the following equation

$$\frac{d^2y}{dt^2} + 8\frac{dy}{dt} + 25y(t) = 50x(t)$$

Evaluate the response and maximum output for a step of 2.5 units

(15 marks)

c) Given the following characteristic equation, determine the value of K for stability

(7 marks)

$$s^4 + Ks^3 + s^2 + s + 1 = 0$$

Question TWO

a) Determine the transfer function $\mathbf{X_2}(S)/\mathbf{U}(S)$

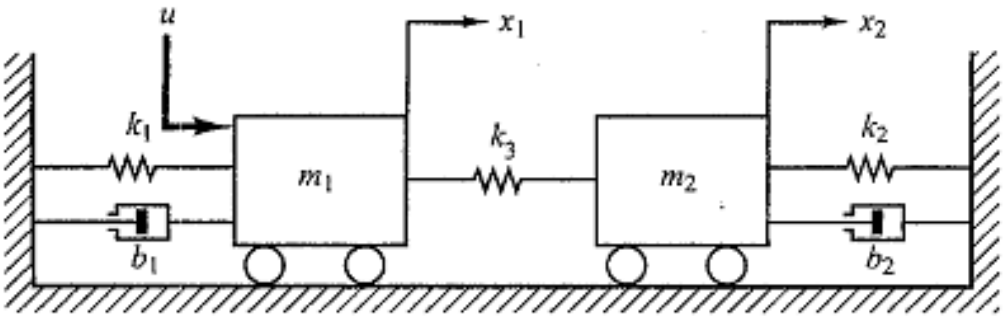


Figure 1

(12 marks)

b) Obtain the signal from diagrams from the following equations

$$x_1 = a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + b_1u_1$$

$$x_2 = a_{21}x_1 + a_{22}x_2 + a_{23}x_3$$

$$x_3 = a_{31}x_1 + a_{32}x_2 + a_{33}x_3$$

(8 marks)

Question THREE

a) The liquid level system of Figure Q3a has an outflow rate Q m3/ Sec through the outflow valve related to the head H by

$$Q = K\sqrt{H} = 0.01\sqrt{H}$$

Assume that when the inflow rate Q_i is 0.015 m^3/sec the head stays constant. For t < 0 the system is at steady state (Q_i = 0.015 m3/sec). At t = 0 the inflow valve is closed so there is no inflow for t ≥ 0. Find the time necessary to empty the tank to half the original head. The capacitance of the tank is 2 m^2

(12 marks)

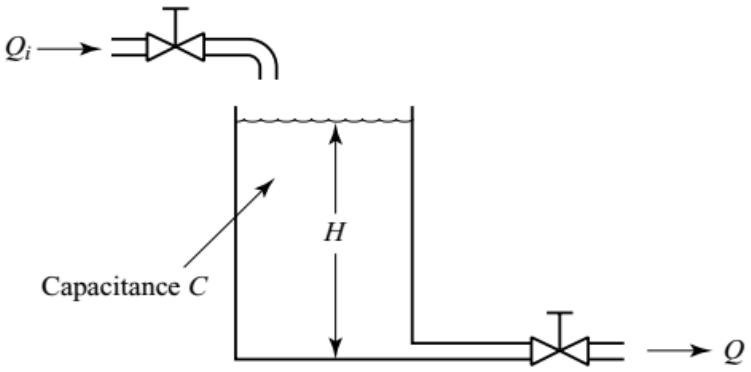


Figure Q3a

b) Using Obtain the equivalent spring constants for the systems in Figure Q3bi and Figure Q3bii

(8 marks)

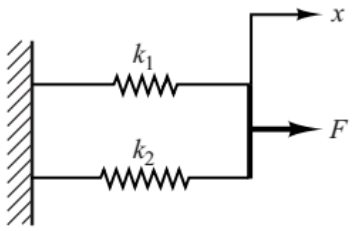


Figure Q3bi

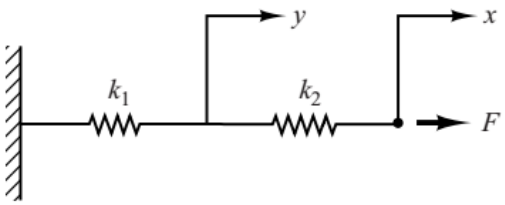


Figure Q3b ii

Question FOUR

a) Using block diagram algebra, reduce the block diagram of Figure Q4a and obtain the closed loop transfer function

(10 marks)

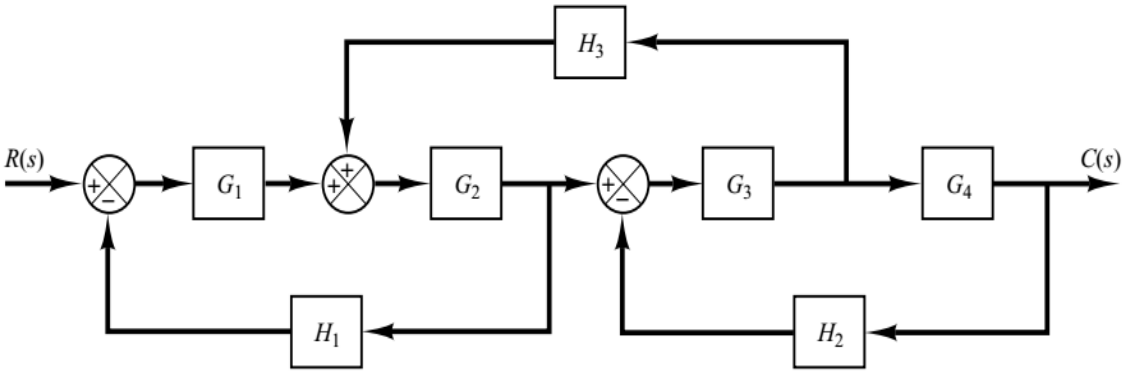


Figure Q4a

b) Obtain the closed loop transfer function of the system of Figure Q4b using masons gain Formula

(10 marks)

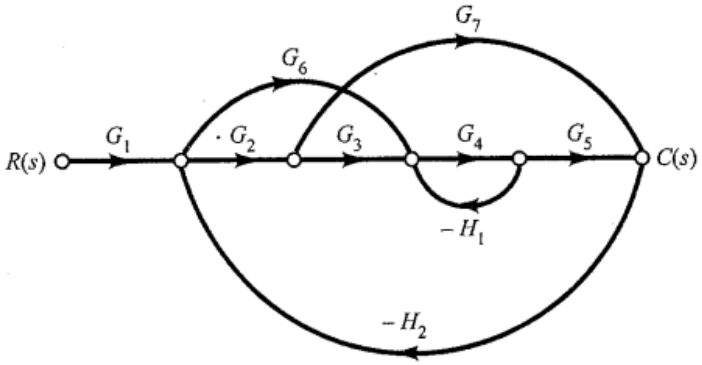


Figure Q4b

Question FIVE

a) 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

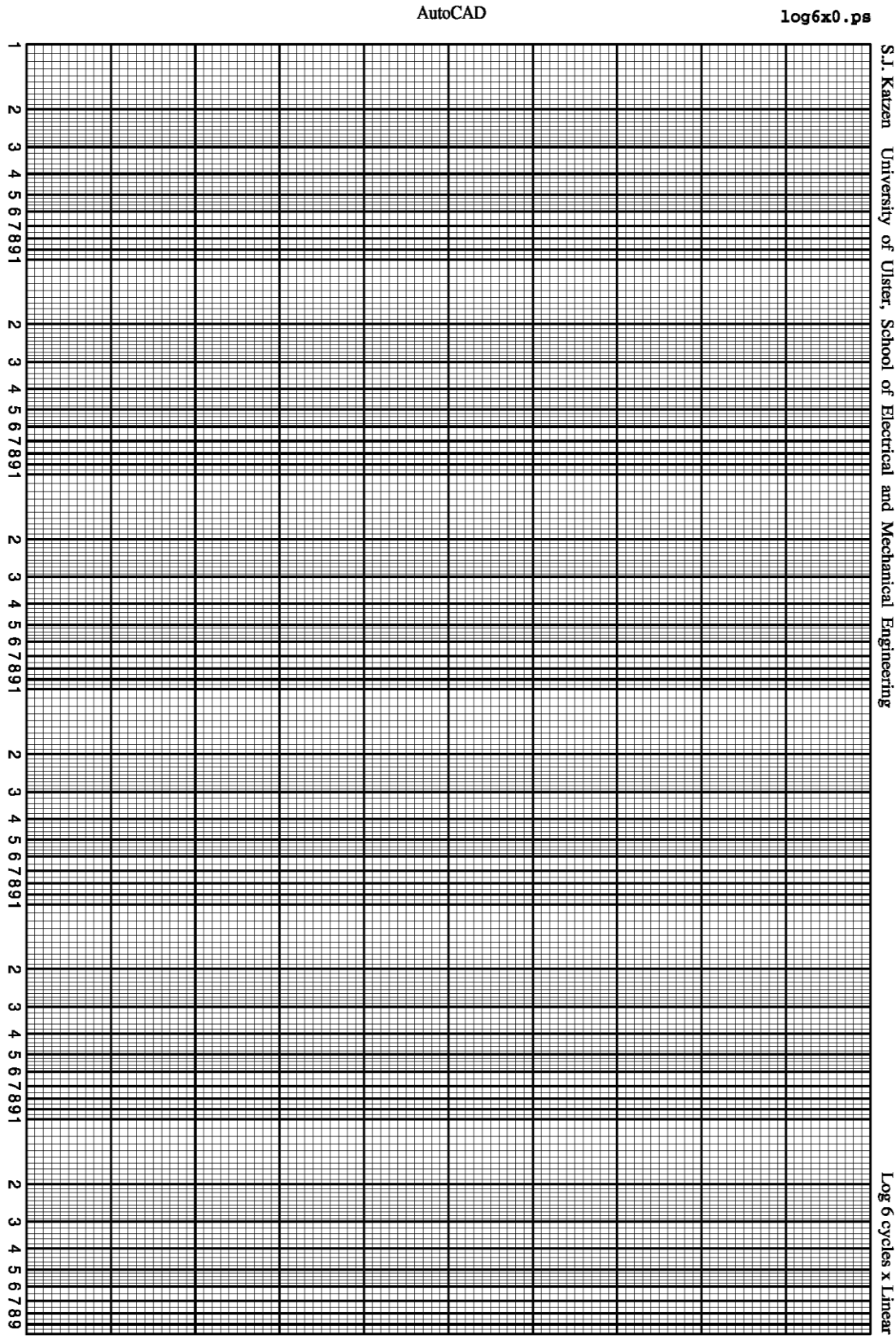
$$G(s) = \frac{1}{s(s+1)(0.5s+1)}$$

(14 marks)

a) Explain the following terms.

i) Disturbances
ii) Plants
iii) Systems

(6 marks)


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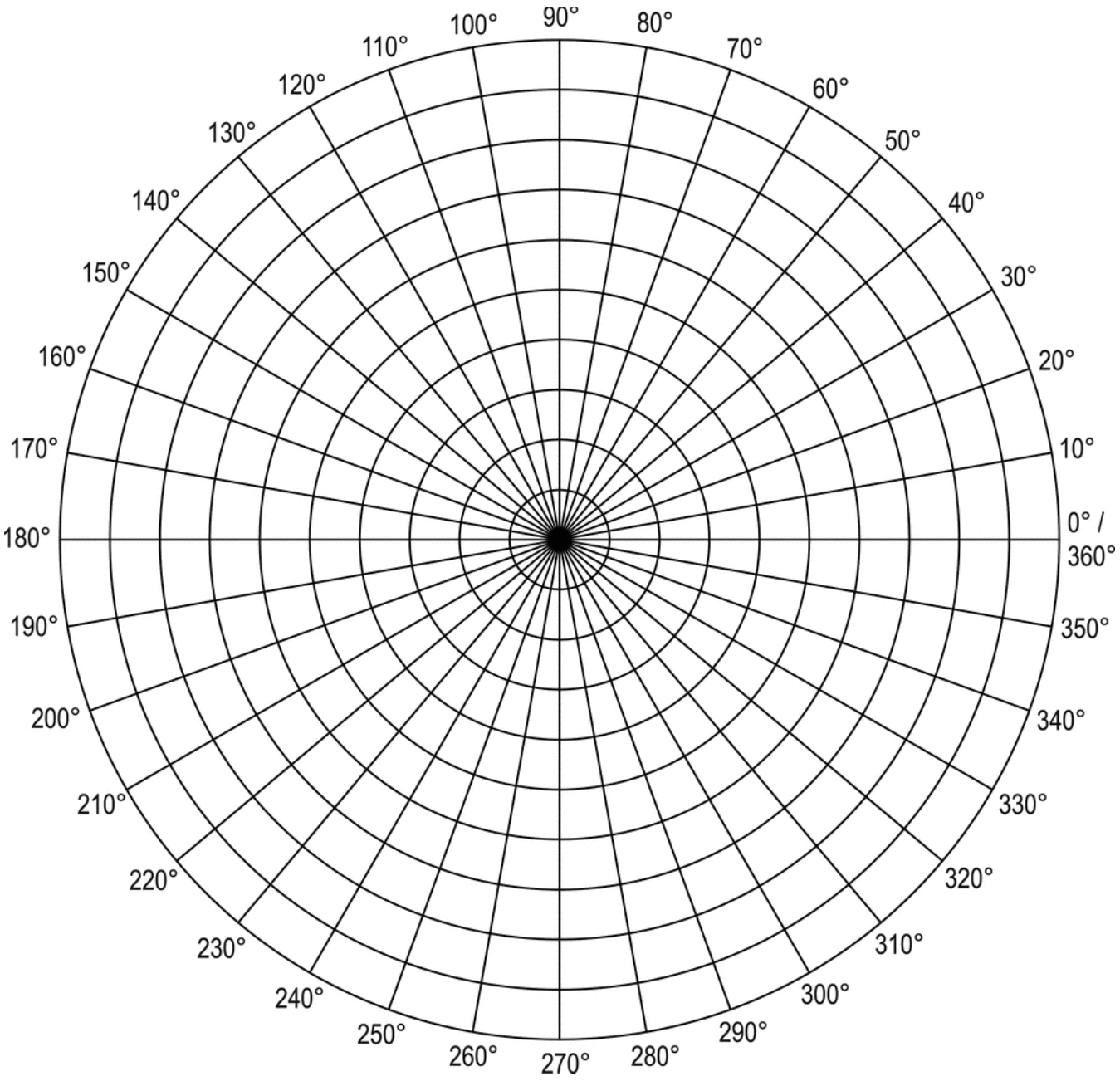
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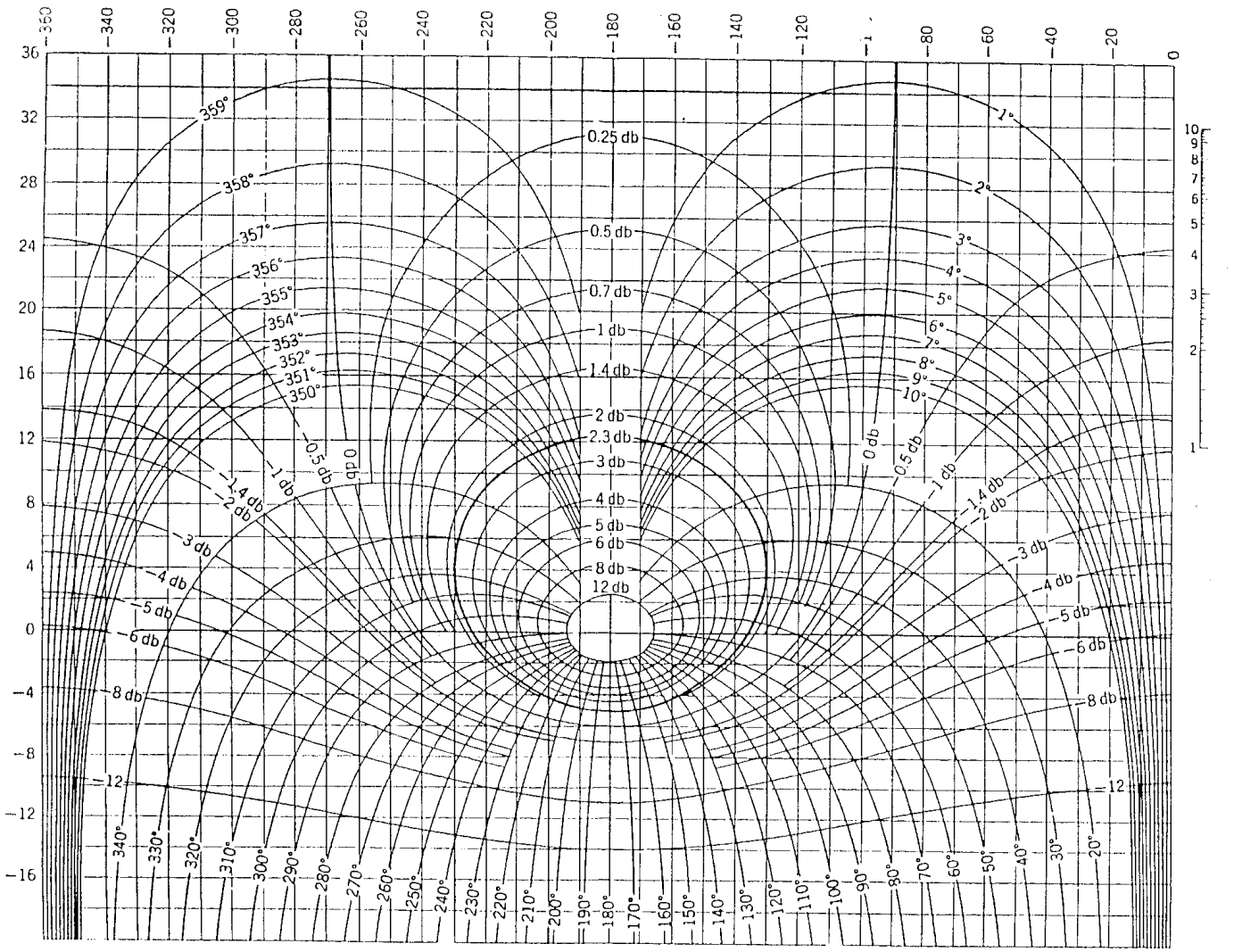
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