PP II

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering & Technology

Department of Electrical & Electronic Engineering

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE (ELECTRICAL & ELECTRONIC ENGINEERING)

EEE 4303: CONTROL ENGINEERING I.

END OF SEMESTER EXAMINATION

SERIES: JULY 2025

TIME: 2 HOURS

DATE: JULY 2025

I0nstructions 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) (i) Define the term control systems
(ii) Explain the features of closed loop and open loop control systems.
(iii) Outline any FOUR advantages and limitations of open loop control systems.

[13 marks]

b) For **Figure Q1b** determine the transfer function $\frac{Y_2(s)}{F(s)}$

[10 marks]

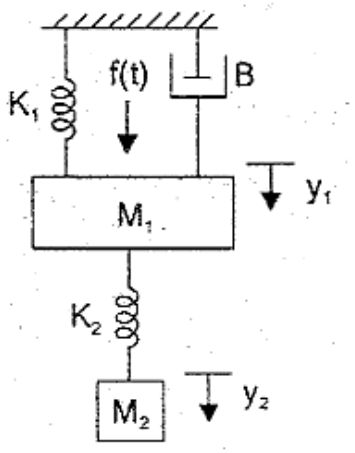


Figure Q1b

c) The response of a servomechanism is $c(t)= 1 + 0.2\ e^{-60t} - 1.2e^{-10t}$ when subject to a unit step.

(i) Obtain an expression for closed loop transfer function

(ii) Determine the undamped natural frequency

(iii) The damping ratio

[7 marks]

Question TWO

a) Determine hydraulic actuator **Figure Q2a** the nonlinear differential equations relating the movement *0* of the control surface to the input displacement *x* of the valve.

[10 marks]

b) Determine the linear approximation to the equations of motion when y = constant, with and without an applied load-that i.e. when $F_i = 0$ and when $F = 0$. Assume that *8* motion is small.

[5 marks]

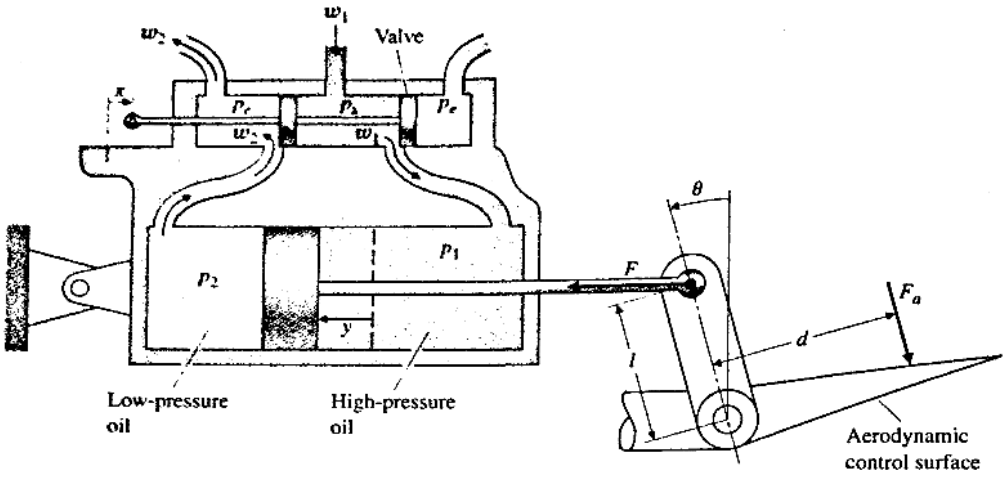


Figure Q2a

Question THREE

a) Using block diagram reduction technique, determine closed loop transfer function C(s)/R(s)of figure Q3a

[11 marks]

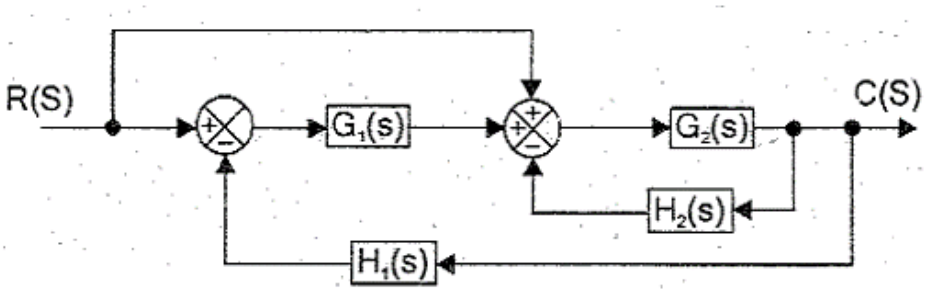


Figure Q3a

b) Draw a signal flow diagram of the system whose block diagram is Figure 3Qb. Apply Masons gain formula to determine the overall transmittance of the system

[9 marks]

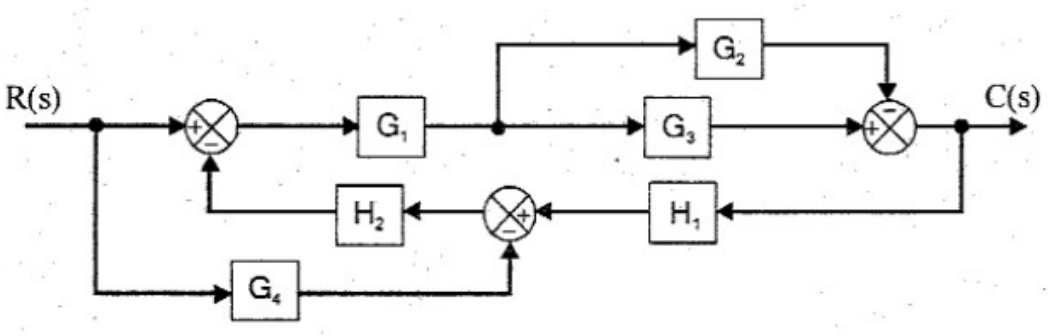


Figure Q3b

Question FOUR

a) With the aid of diagram explain the following as applied to control systems.

(i) Delay time

(ii) Rise time

(iii) Peak time

[6 marks]

b) Figure Q4b is a positional control system with velocity feedback. Given that $\xi = 0.5$. for a unit step input, determine;

(i) The response c(t)

(ii) Rise time

(iii) Peak time

(iv) Maximum overshoot

(v) Settling time

[14 marks]

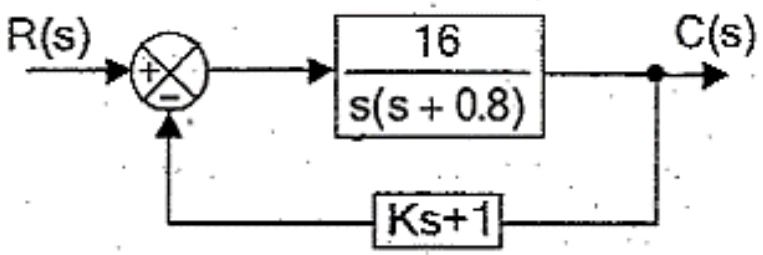


Figure Q4b

Question FIVE

a) A Consider the liquid-level system shown in **Figure 5a**. In the system, $\overline{Q}_1$ and $\overline{Q}_2$ are steady-state inflow rates $\overline{H}_1$ and $\overline{H}_2$ are steady-state heads. The quantities $q_{i1}, q_{i2}, h_1, h_2, q_1, \text{and} q_o$ are considered small. Obtain a state-space representation for the system when h_1 and h_2 are the outputs and q_{i1} and q_{i2} are the inputs.

[11 marks]

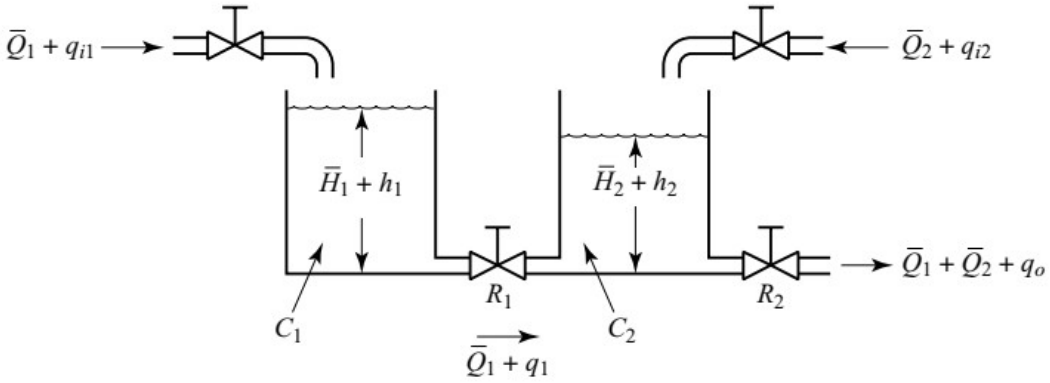


Figure 5a

b) Define the following terms with the aid of diagrams

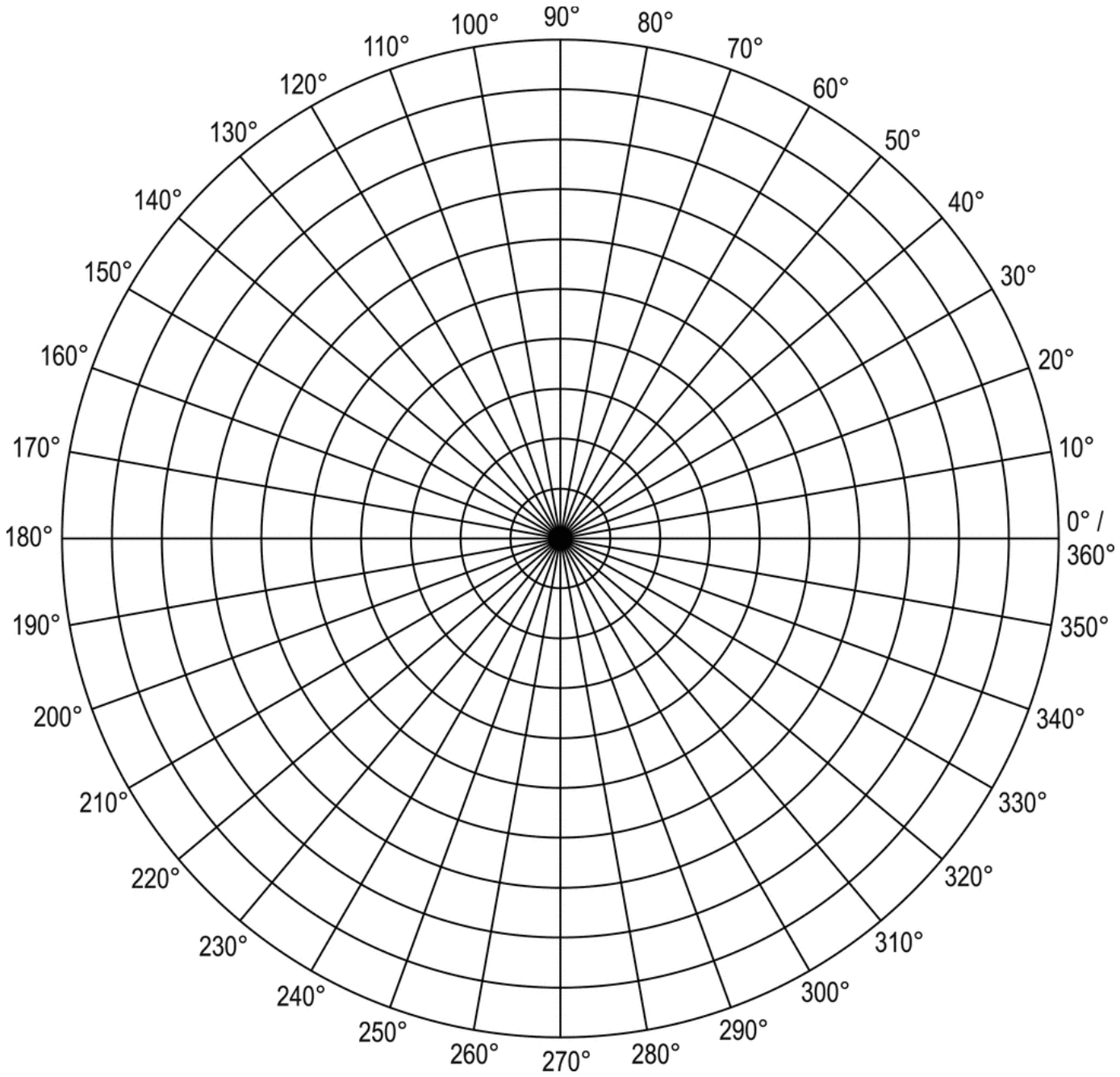
(i) Resonant peak

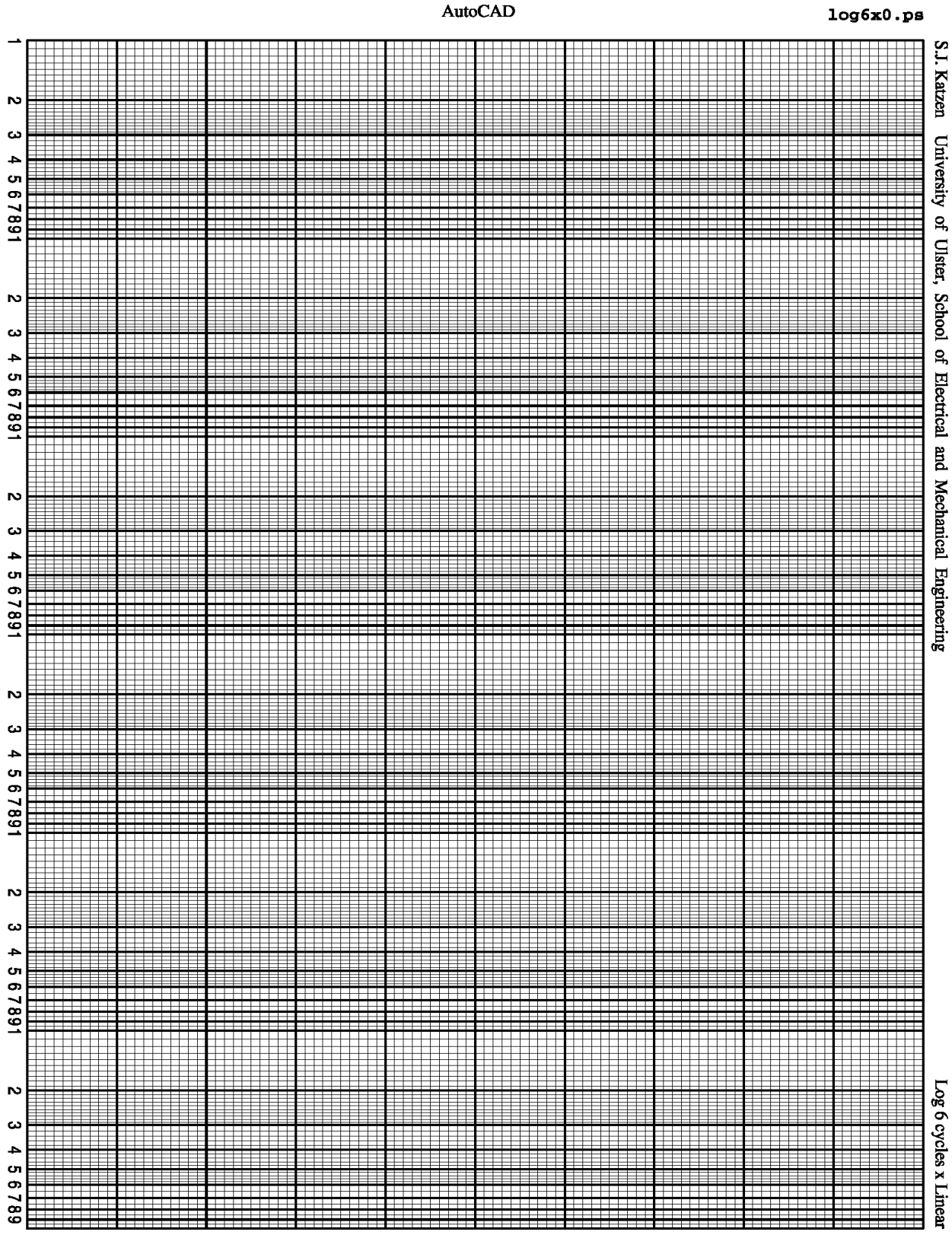
(ii) Resonant frequency

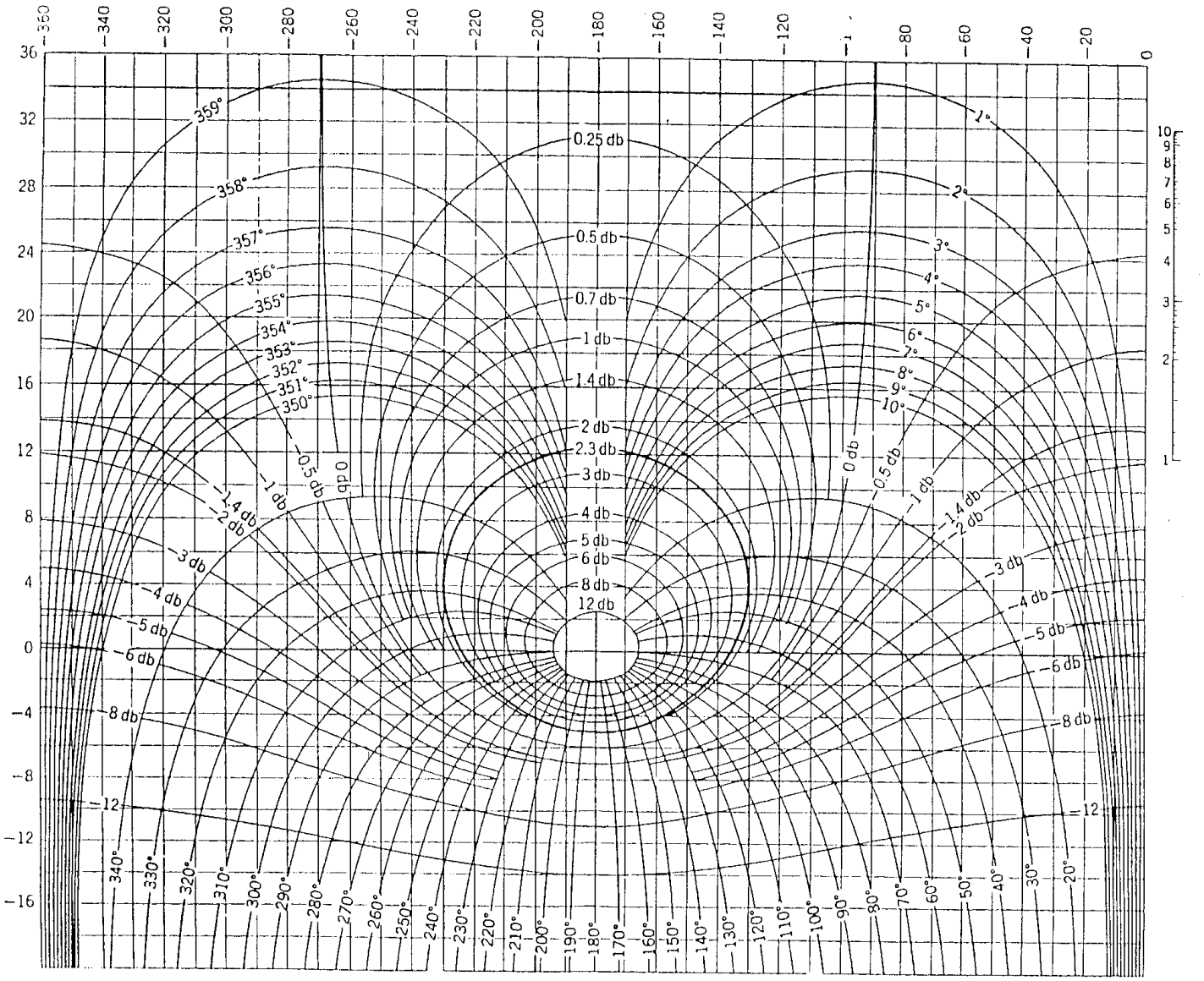
(iii) Band width

(iv) Cutoff rate

[9 marks]


90°
80°
70°
60°
50°
40°
30°
20°
10°
0° /
360°
350°
340°
330°
320°
310°
300°
290°
280°
270°
260°
250°
240°
230°
220°
210°
200°
190°
180°
170°
160°
150°
140°
130°
120°
110°
100°


AutoCAD
log6x0.ps
S.J. Katzen University of Ulster, School of Electrical and Mechanical Engineering
Log 6 cycles x Linear
1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9


0.25 db
0.5 db
0.7 db
1 db
1.4 db
2 db
2.3 db
3 db
4 db
5 db
6 db
8 db
12 db
0 db
0.5 db
1 db
1.4 db
2 db
3 db
4 db
5 db
6 db
8 db
12
1°
2°
3°
4°
5°
6°
7°
8°
9°
10°
350°
351°
352°
353°
354°
355°
356°
357°
358°
359°