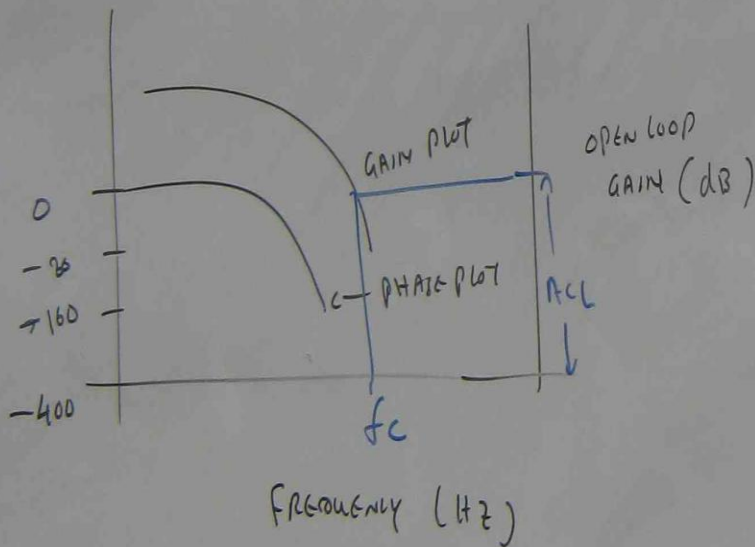


PHASE MARGIN & CLOSED LOOP BANDWIDTH

STABLE AMPLIFIER, $f_c = (\text{upper 3 dB cut off frequency})$

HORIZONTAL CLOSED LOOP GAIN
 A_{CL}

CUT OPEN LOOP GAIN GRAPH \rightarrow CLOSED LOOP BANDWIDTH



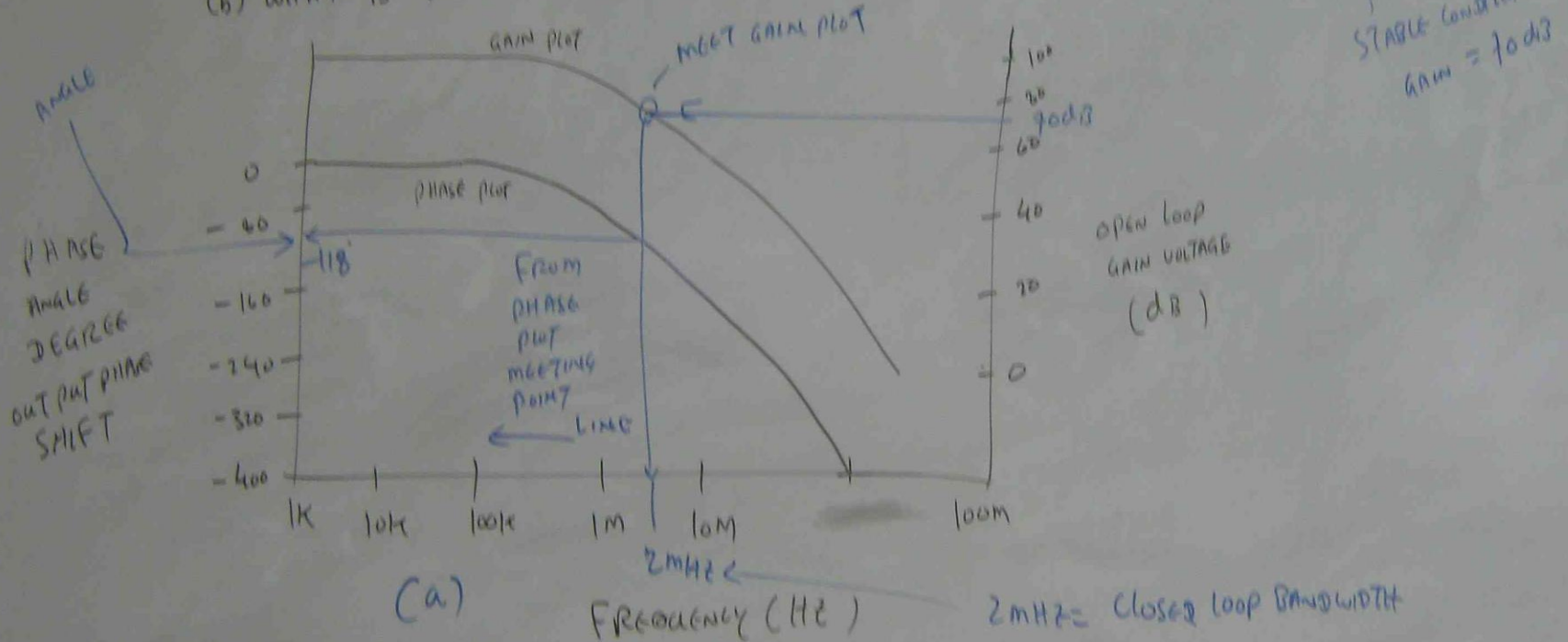
PHASE MARGIN = DIFFERENCE BETWEEN THE ANGLE AT STABILITY AND -180°

Pb

THE GAIN AND PHASE PLOTS OF AN AMPLIFIER ARE GIVEN BELOW

(a) ESTIMATE THE CLOSED LOOP BANDWIDTH AND PHASE MARGIN FOR A CLOSED LOOP GAIN OF 70 dB

(b) WHAT IS THE CLOSED LOOP GAIN WHICH GIVES A PHASE MARGIN OF 45°



PHASE ANGLE = -118° AT STABILITY

$$\text{PHASE MARGIN} = |-180 - (-118)|$$

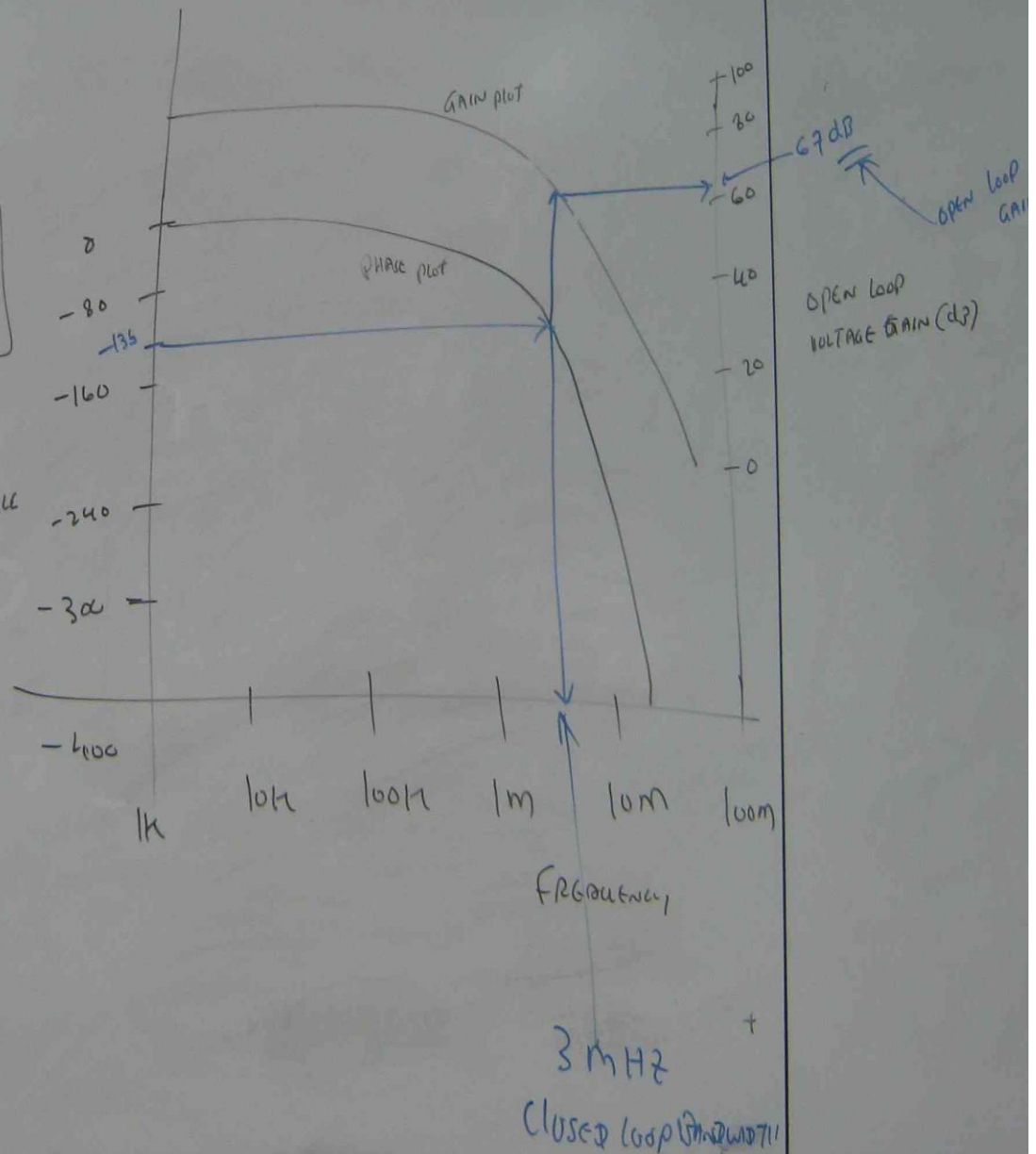
$$= 62^\circ$$

ANGLE AT STABILITY = PHASE MARGIN - 180
ANGLE

$$\phi = 45 - 180$$

$$= -135$$

PHASE ANGLE



$$\text{ANGLE AT STABILITY} = \text{PHASE MARGIN} - 180$$

$$\phi = 45 - 180$$
$$= -135$$

PHASE ANGLE

0

-80

-135

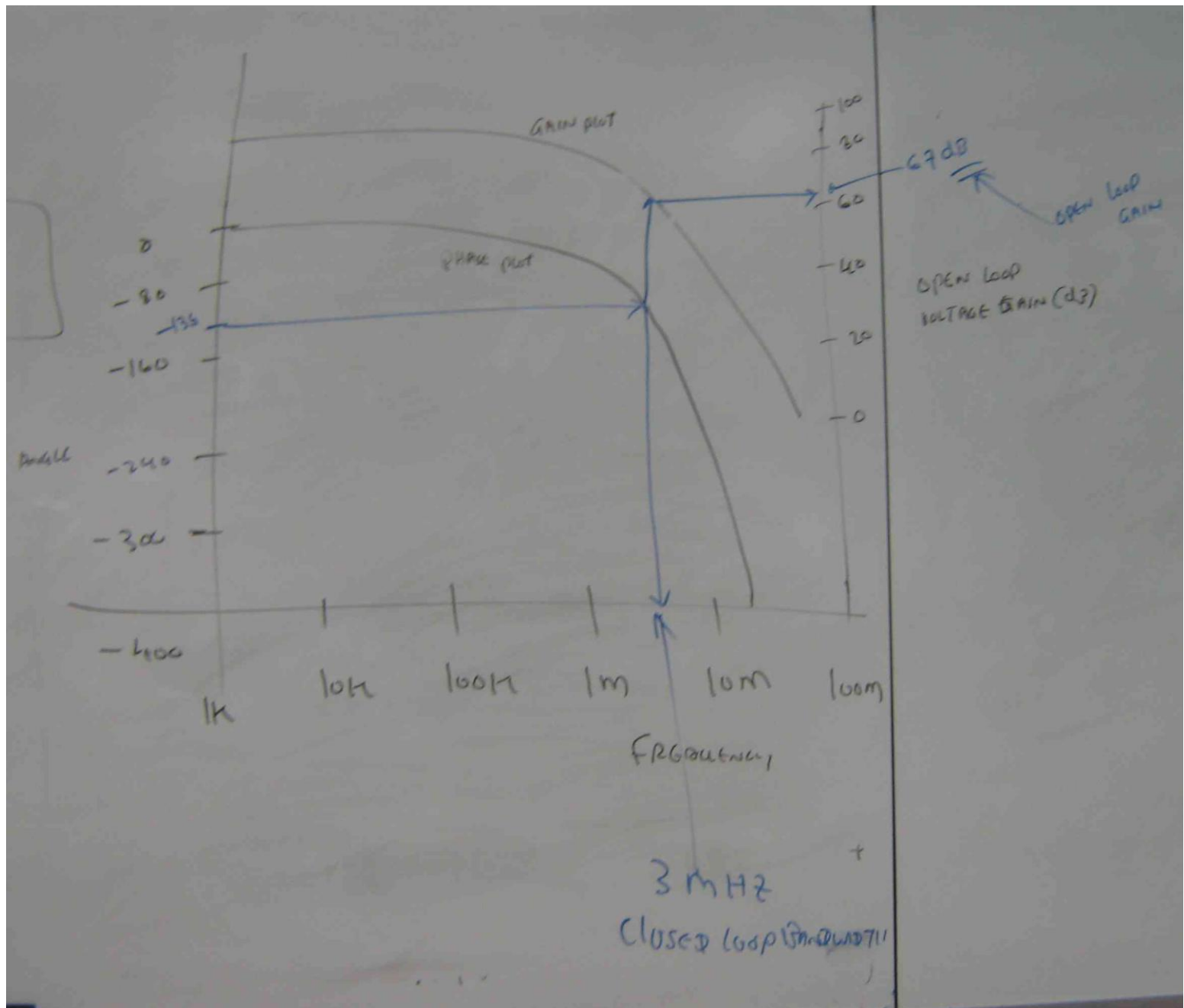
-160

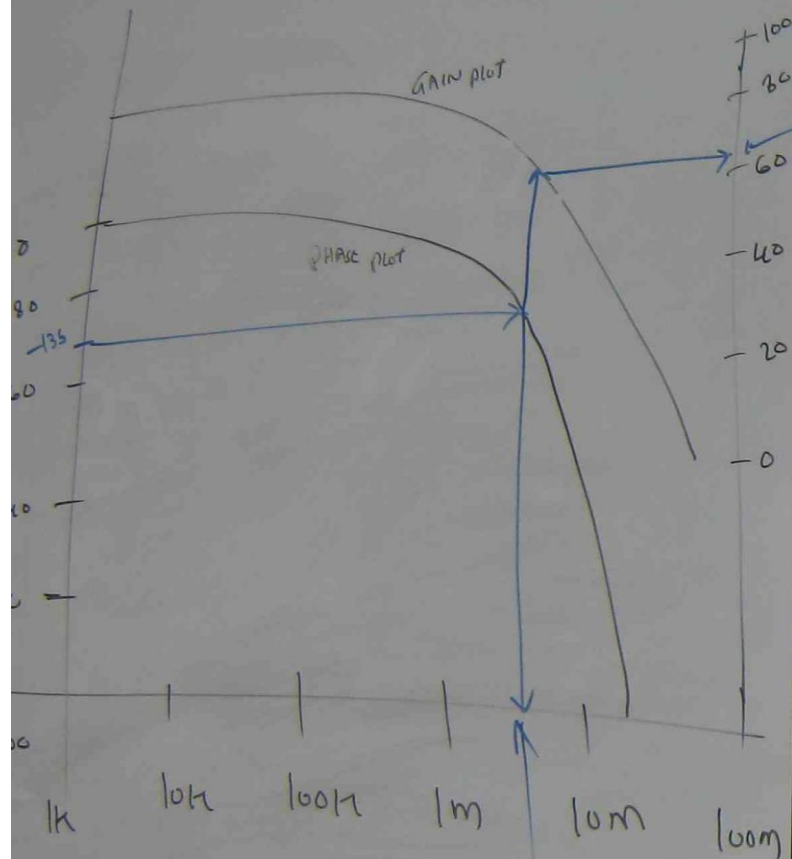
-240

-300

-400

1k





Frequency

3 mHz
Closed loop bandwidth

Open loop
Voltage Gain (dB)

$$A_{CL}(dB) = 20 \log_{10} A_{CL}$$

$$67 = 20 \log_{10} A_{CL}$$

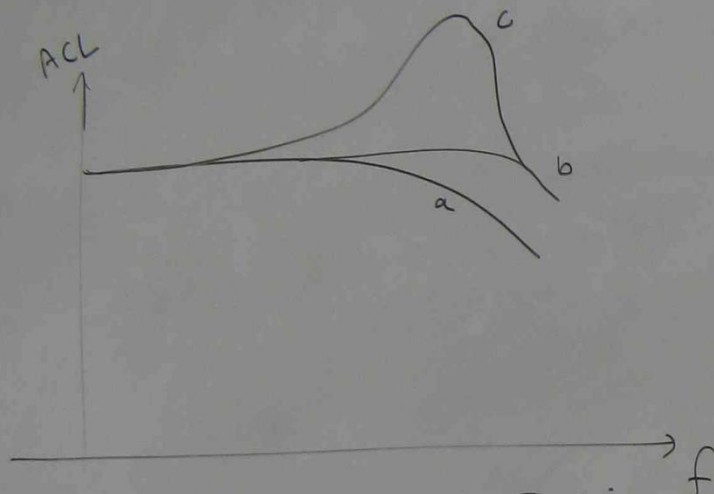
$$\frac{67}{20} = \log_{10} A_{CL}$$

$$3.35 = \log_{10} A_{CL}$$

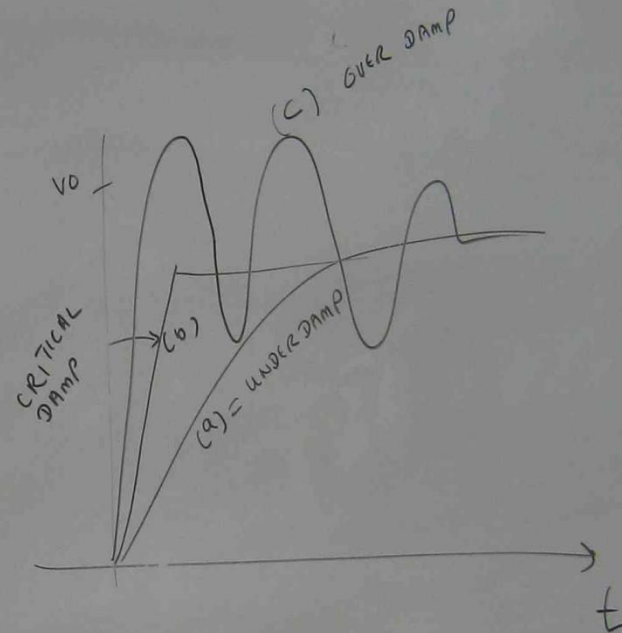
$$A_{CL} = 10^{3.35} = 2240$$

< Closed loop gain >

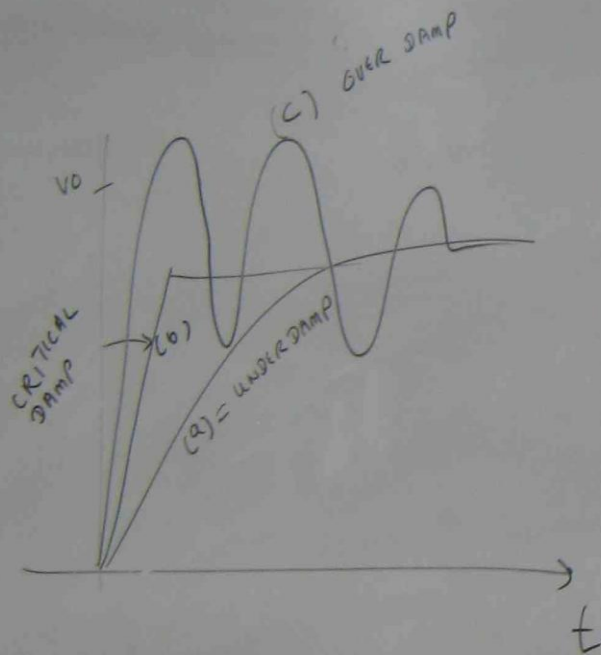
EFFECT OF PHASE MARGIN AND CLOSED LOOP RESPONSE



- (a) = PHASE MARGIN TOO HIGH CLOSE TO 90°
- (b) CORRECT PHASE MARGIN CLOSE TO 45°
- (c) TOO LOW PHASE MARGIN CLOSE TO 0°



- THE DIFFERENCE BETWEEN ANGLE AT STABILITY AND -180° DETERMINES THE PHASE MARGIN.
- IF PHASE MARGIN IS TOO HIGH AND CLOSE TO 90° , IT CAUSES UNDER DAMP (FOR DIGITAL METER, IT TAKES TOO LONG TO INDICATE THE VALUE).
 - IF PHASE MARGIN IS TOO LOW AND CLOSE TO 0° , IT CAUSES OVER DAMP. (THE INDICATION IS FLUATING AND



- THE DIFFERENCE BETWEEN ANGLE AT STABILITY AND -180° DETERMINES THE PHASE MARGIN.
- IF PHASE MARGIN IS TOO HIGH AND CLOSE TO 90° , IT CAUSES UNDER DAMP (FOR DIGITAL METER, IT TAKES TOO LONG TO INDICATE THE VALUE).
 - IF PHASE MARGIN IS TOO LOW AND CLOSE TO 0° , IT CAUSES OVER DAMP. (THE INDICATION IS FLUATING AND

DIFFICULT TO READ IT'S VALUE.

- IF PHASE MARGIN IS CORRECT AND CLOSE TO 45° , IT WILL BE CRITICAL DAMP THE METER INDICATE THE VALUE IN RIGHT TIME.

TO DESIGN THE AMPLIFIER / ANALOGUE CIRCUITS IT NEEDS TO

- PLOT OUTPUT PHASE SHIFT
- FIND THE DIFFERENCE FROM -180°
- SUCH A DIFFERENCE NEEDS TO BE CLOSE TO 45°
- IF NOT, CIRCUIT PARAMETERS ARE TO BE ADJUSTED TO GET IT.