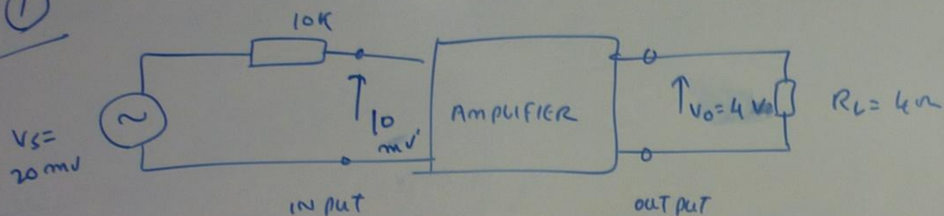
# POWER AMPLIFIER CIRCUIT CALCULATIONS

pb 1




FIND (a) VOLTAGE GAIN (b) INPUT CURRENT
(c) OUTPUT CURRENT (d) CURRENT GAIN.
(e) OUTPUT POWER (f) POWER GAIN
(g) TRAN RESISTANCE (h) TRANS CONDUCTANCE.

(a) VOLTAGE GAIN $(A_V) = \dfrac{V_0}{V_{IN}} = \dfrac{4}{10 \times 10^{-3}}$

$= \dfrac{4000}{10} = 400$

(b) VOLTAGE DROP ACROSS 10 K$\Omega$ RESISTOR $= 20 - 10 = 10$ mV

$I = \dfrac{10 \text{ mV}}{10k} = \dfrac{10 \times 10^{-3}}{10 \times 10^{3}} = 1 \times 10^{-6}$

$= 1 \mu A$

(c) $I_{OUT} = \dfrac{4V}{4\Omega} = 1A$

(d) CURRENT GAIN $= \dfrac{I_{OUT}}{I_{IN}}$

$= \dfrac{1}{1 \mu A}$

$= \dfrac{1}{1 \times 10^{-6}}$

$= \dfrac{10^6}{1}$

$= 10^6$

(e) $P_{OUT} = V_{OUT} \times I_{OUT}$

$= 4 \times 1 = 4W$

(f) $P_{IN} = V_{IN} \times I_{in} = 10 \times 10^{-3} \times 1 \times 10^{-6}$

$= 10 \times 10^{-9}$ W

$P_{OUT} = 4W$

$R_L = 4\Omega$

$\ldots \times 10^{-3}$

$\frac{4000}{10} = 400$

$\ldots$ mV

$1\times10^{-6}$

$= 1\,\mu A$

(c) $I_{OUT} = \frac{4V}{4\Omega} = 1A$

(d) CURRENT GAIN $= \frac{I_{OUT}}{I_{IN}}$

$= \frac{1}{1\,\mu A}$

$= \frac{1}{1\times10^{-6}}$

$= \frac{10^6}{1}$

$= 10^6$

(e) $P_{OUT} = V_{OUT} \times I_{OUT}$

$= 4 \times 1 = 4W$

(f) $P_{IN} = V_{IN} \times I_{in} = 10\times10^{-3} \times 1\times10^{-6}$

$= 10\times10^{-9}$ W

$P_{OUT} = 4W$

$A_P = \frac{P_{OUT}}{P_{IN}} = \frac{4}{10\times10^{-9}} = \frac{4\times10^9}{10}$

$= 0.4\times10^9$

$= 4\times10^8$

(g) TRAN RESISTANCE $= \frac{V_{OUT}}{I_{IN}}$

$= \frac{4}{1\times10^{-6}} = 4\times10^6\ \Omega$

$= 4M\Omega$

(h) TRANS CONDUCTANCE $= \frac{I_{OUT}}{V_{IN}}$

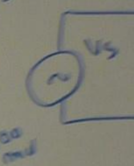
$= \frac{1}{10\,mV}$

$= \frac{1}{10\times10^{-3}}$

$= \frac{10^3}{10}$

$= 100$ ℧

pb 2




IN ABOVE…

(b) TOT…

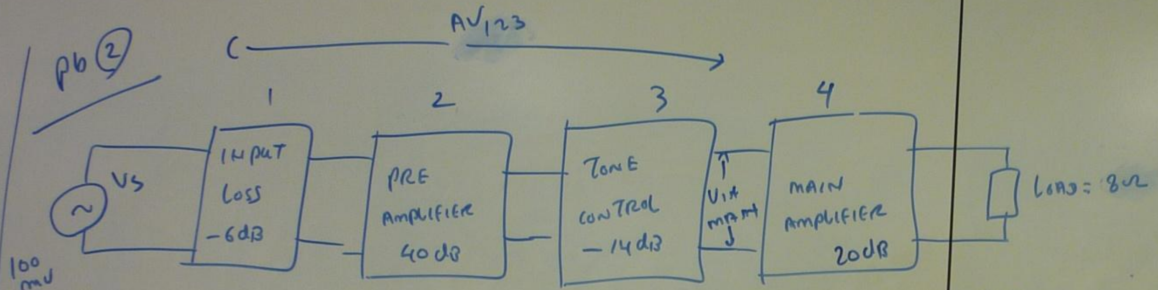
PRE-AM…

(c) OUT…

$A_V$

(a) $dB_T$…

pb ②




IN ABOVE CIRCUIT, FIND (a) TOTAL VOLTAGE GAIN IN dB (b) TOTAL VOLTAGE GAIN IN DIRECT RATIO (c) INPUT VOLTAGE OF PRE-AMPLIFIER (d) INPUT VOLTAGE OF MAIN AMPLIFIER (e) OUTPUT VOLTAGE OF AMPLIFIER

$$A_V(dB) = 20\log_{10}\frac{V_2}{V_1}$$

$$\frac{V_2}{V_1} = 10^{\frac{AV(dB)}{20}}$$

$$A_V = 10^{\frac{AV(dB)}{20}}$$

$$dB_T = dB_1 + dB_2 + dB_3$$

$$AV_T = A_1 \times AV_2 \times AV_3$$

(a) $dB_T = dB_1 + dB_2 + dB_3 + dB_4$

$$= (-6) + (40) + (-14) + 20 = 40$$

(b) $AV_T = AV_1 \times AV_2 \times AV_3 \times AV_4$

$$= 10^{\frac{AV_1(dB)}{20}} \times 10^{\frac{AV_2(dB)}{20}} \times 10^{\frac{AV_3(dB)}{20}} \times 10^{\frac{A4(dB)}{20}}$$

$$= 10^{\frac{-6}{20}} \times 10^{\frac{40}{20}} \times 10^{\frac{-14}{20}} \times 10^{\frac{20}{20}}$$

$$= 10^{-0.3} \times 10^{2} \times 10^{-0.7} \times 10^{1}$$

$$= 10^{(-0.3)+2+(-0.7)+1}$$

$$= 10^{2} = 100$$

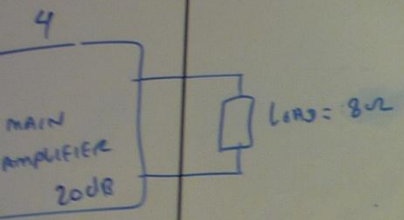
(c) $AV_{123} = 10^{\frac{AV_1(dB)}{20}} \times 10^{\frac{AV_2(dB)}{20}} \times 10^{\frac{AV_3(dB)}{20}}$

$$= 10^{-0.3} \times 10^{2} \times 10^{-0.7}$$

$$= 10^{-0.3+2+(-0.7)} = 10^{1} = 10$$

(d) $V_{IN}$

(e) V




dB

...TAGE OF

...FIER

dB3

AU3

(b) $A_{V_T} = A_{V_1} \times A_{V_2} \times A_{V_3} \times A_{V_4}$

$= 10^{\frac{A_{V_1}(dB)}{20}} \times 10^{\frac{A_{V_2}(dB)}{20}} \times 10^{\frac{A_{V_3}(dB)}{20}} \times 10^{\frac{A_4(dB)}{20}}$

$= 10^{\frac{-6}{20}} \times 10^{\frac{40}{20}} \times 10^{\frac{-14}{20}} \times 10^{\frac{20}{20}}$

$= 10^{-0.3} \times 10^{2} \times 10^{-0.7} \times 10^{1}$

$= 10^{(-0.3)+2+(-0.7)+1}$

$= 10^{2} = 100$

(c) $A_{V_{123}} = 10^{\frac{A_{V_1}(dB)}{20}} \times 10^{\frac{A_{V_2}(dB)}{20}} \times 10^{\frac{A_{V_3}(dB)}{20}}$

$= 10^{-0.3} \times 10^{2} \times 10^{-0.7}$

$= 10^{-0.3+2+(-0.7)} = 10^{1} = 10$

(d) $V_{IN\,(MAIN)} = V_S \times A_{V_{123}}$

$= (100 \times 10^{-3}) \times 10$

$= 100 \times 10^{-3} \times 10$

$= 1V$

(e) $V_{OUT} = V_{IN\ MAIN} \times A_{V_4}$

$= 1 \times 10^{\frac{A_{V_4}(dB)}{20}}$

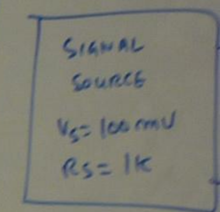
$= 1 \times 10^{\frac{20}{20}}$

$= 1 \times 10^{1}$

$= 10V$

pb(3)

FOR THE...

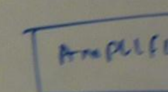



(a) DRAW THE E...

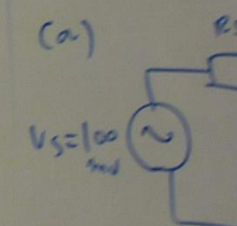
(b) DETERMINE ...

(c) DETERMINE ...

(d) DETERMINE ...
TO ACHIEVE ...




(a)



(d) $V_{IN\,(MAIN)} = V_S \times A_{V123}$

$= (100 \times 10^{-3}) \times 10$

$= 100 \times 10^{-3} \times 10$

$= 1V$

(e) $V_{OUT} = V_{IN\,MAIN} \times A_{V4}$

$= 1 \times 10^{\frac{A_{V4}(dB)}{20}}$

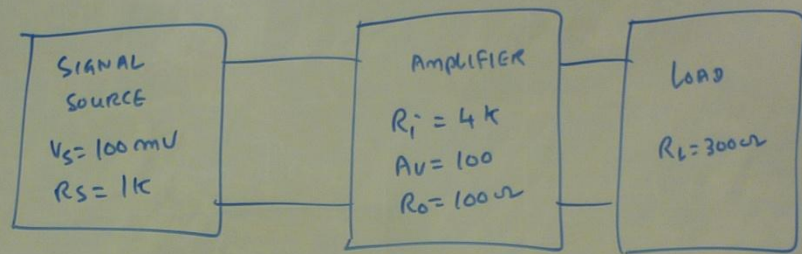
$= 1 \times 10^{\frac{20}{20}}$

$= 1 \times 10^{1}$

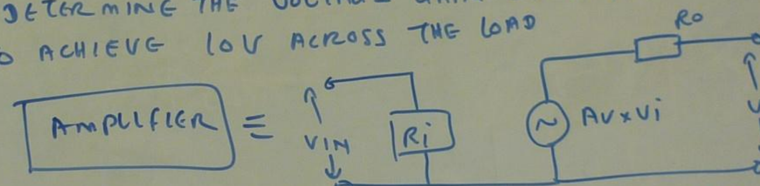
$= 10V$

pb(3)

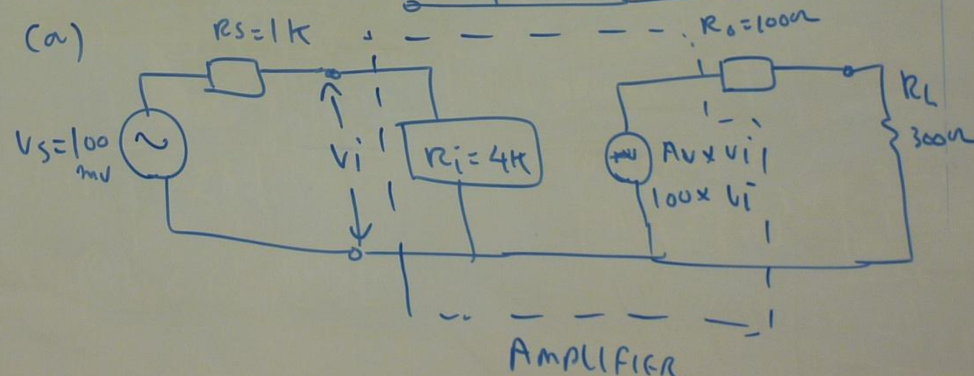
FOR THE AMPLIFIER CONNECTION BELOW




(a) DRAW THE EQUIVALENT CIRCUIT
(b) DETERMINE THE INPUT VOLTAGE OF AMPLIFIER
(c) DETERMINE THE OUTPUT VOLTAGE OF AMPLIFIER
(d) DETERMINE THE VOLTAGE GAIN OF AMPLIFIER TO ACHIEVE 10V ACROSS THE LOAD




(a)




(b) $v_i = V_S \times \frac{R_i}{R_S + R_i}$

(c) $V_{OUT} = A_V \times V_i$

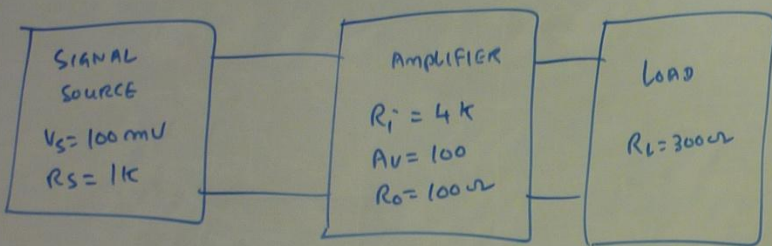
(d) $V_{OUT} = 10V$

$V_{IN} = 80mV$

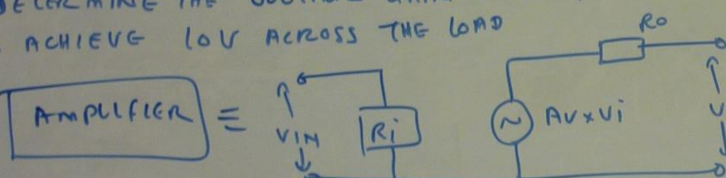
$A_V = \frac{V_{OUT}}{V_{IN}}$

## Pb(3)

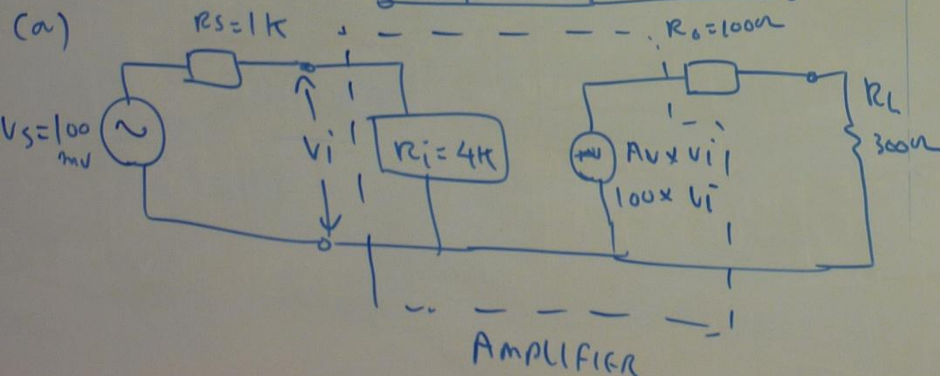
FOR THE AMPLIFIER CONNECTION BELOW




(a) DRAW THE EQUIVALENT CIRCUIT
(b) DETERMINE THE INPUT VOLTAGE OF AMPLIFIER
(c) DETERMINE THE OUTPUT VOLTAGE OF AMPLIFIER
(d) DETERMINE THE VOLTAGE GAIN OF AMPLIFIER TO ACHIEVE 10V ACROSS THE LOAD




(a)




(b) $V_i = V_S \times \dfrac{R_i}{R_S + R_i} = 100 \times \dfrac{4}{1+4} = \dfrac{100 \times 4}{8} = 80\,mV$

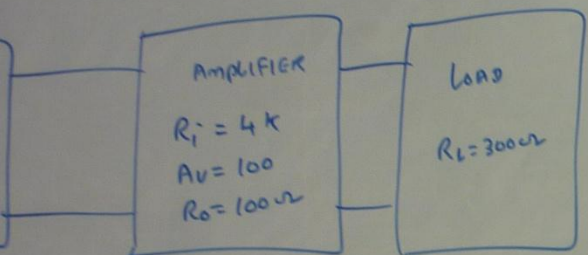
(c) $V_{OUT} = A_V \times V_i = 100 \times 80\,mV = 100 \times 80 \times 10^{-3} = 8\,V$

(d) $V_{OUT} = 10V$

$V_{IN} = 80\,mV$

$$A_V = \frac{V_{OUT}}{V_{IN}} = \frac{10}{80 \times 10^{-3}} = \frac{1000}{80} = 12.5$$

E AMPLIFIER CONNECTION BELOW



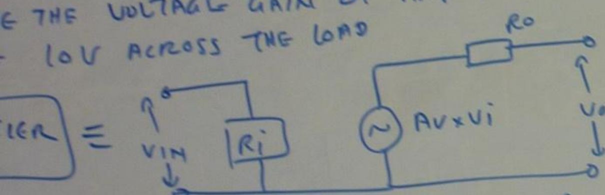

QUIVALENT CIRCUIT

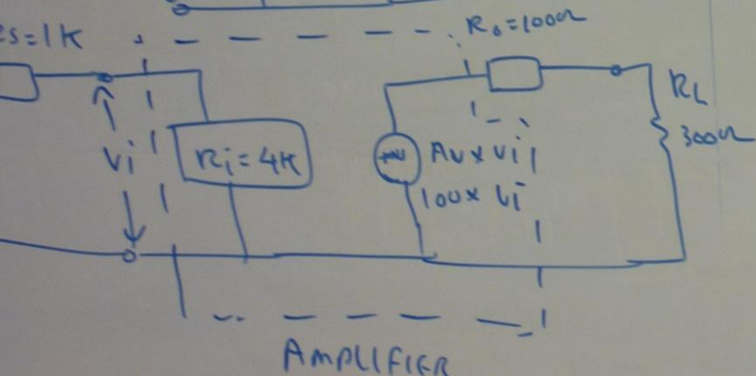
THE INPUT VOLTAGE OF AMPLIFIER

THE OUTPUT VOLTAGE OF AMPLIFIER

E THE VOLTAGE GAIN OF AMPLIFIER

10V ACROSS THE LOAD




(b) $v_i = V_s \times \dfrac{R_i}{R_s + R_i} = 100 \times \dfrac{4}{1+4} = \dfrac{100 \times 4}{5} = 80\,mV$

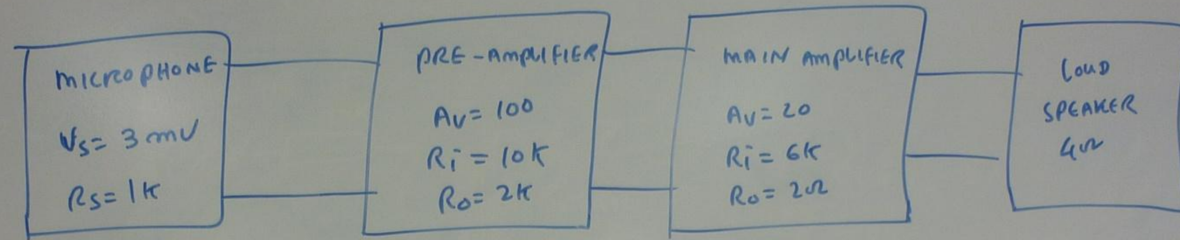
(c) $V_{OUT} = A_V \times V_i = 100 \times 80\,mV = 100 \times 80 \times 10^{-3} = 8V$

(d) $V_{OUT} = 10V$

$V_{IN} = 80\,mV$

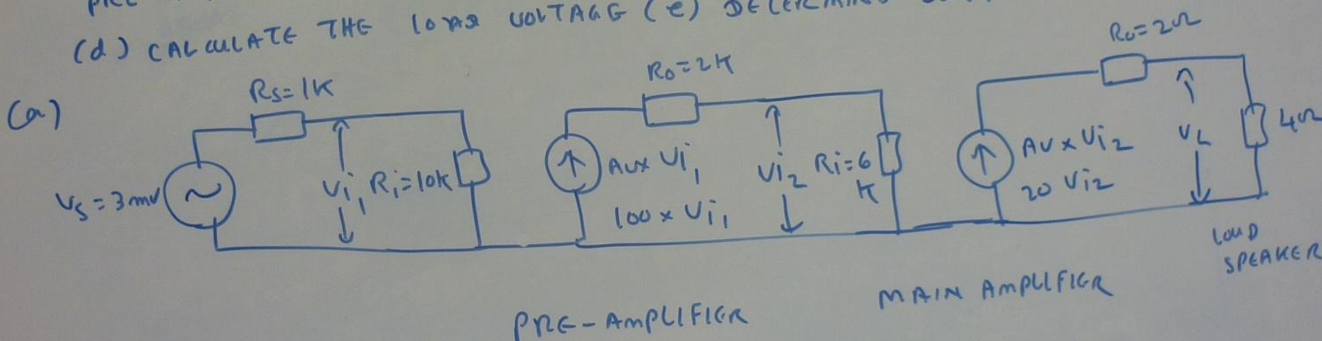
$A_V = \dfrac{V_{OUT}}{V_{IN}} = \dfrac{10}{80 \times 10^{-3}} = \dfrac{1000}{80} = 12.5$

Pb 4




THE ABOVE DIAGRAM IS A MULTI STAGE AMPLIFIER
(a) DRAW AN EQUIVALENT CIRCUIT (b) CALCULATE THE INPUT VOLTAGE OF PRE-AMPLIFIER (c) CALCULATE THE INPUT VOLTAGE OF MAIN AMPLIFIER
(d) CALCULATE THE LOAD VOLTAGE (e) DETERMINE OUTPUT POWER.

(a)




(b) $V_{i_1} = ?$

$$V_{i_1} = V_s \times \frac{R_i}{R_s + R_i} = 3\,mV \times \frac{10k}{(1+10)k} = 2.72\ mV$$

(c) $A_v \times V_{i_1} = 2.72 \times 100 = 272\ mV$
mV

$V_{i_2} =$

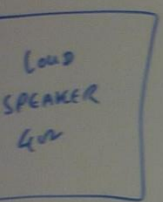
=

=

(d) AV x

$V_L =$

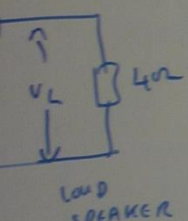
=




OF

R

2Ω




72 mV

$$Vi_2 = AV \times vi_1 \times \frac{Ri}{Ri + Ro}$$

$$= 272 \times \frac{6}{6+2}$$

$$= 204\,mV$$

(d) $AV \times Vi_2 = 20 \times 204\,mV$

$$= 20 \times 0.204$$

$$= 4.08\,V$$

$$V_L = (AV \times Vi_2) \times \frac{RL}{Ro + RL}$$

$$= 4.08 \times \frac{4}{4+2}$$

$$= \frac{4.08 \times 4}{6} = \frac{16.32}{6}$$

$$= 2.7\,V$$

$$P_{OUT} = \frac{V_{OUT}^2}{RL}$$

$$= \frac{(2.7)^2}{4}$$

$$= \frac{2.7 \times 2.7}{4}$$

$$= 1.8225\,W$$

pb 5 PLOT THE FREQUENCY RES

FROM AN AMPLIFIER AND INDICAT

VOLTAGE GAIN $AV = \frac{Vo}{Vi}$ ,

POWER AT LOAD $= \frac{V_o^2}{R}$ , PO

| FREQUENCY (HZ) | Vi (mV) | Vo (V) | VOLTAGE |
|---|---|---|---|
| 10 | 100 | 1 | $\frac{1}{100 \times 10^{-3}}$ |
| 20 | 100 | 1.96 | $\frac{1.96}{100 \times 10^{-3}}$ |
| 40 | 100 | 3.71 | 37 |
| 100 | 100 | 7.07 | 70 |
| 200 | 100 | 8.44 | 8 |
| 400 | 100 | 9.28 | 0 |
| 1k | 100 | 9.95 | |
| 2k | 100 | 10 | |
| 4k | 100 | 10 | |
| 10k | 100 | 9.95 | |
| 20k | 100 | 9.81 | |

MID BAND

$$P_{OUT} = \frac{V_{OUT}^2}{R_L} = \frac{(2.7)^2}{4} = \frac{2.7 \times 2.7}{4} = 1.8225\ W$$

**pb 5** PLOT THE FREQUENCY RESPONSE OF THE FOLLOWING DATA OBTAINED FROM AN AMPLIFIER AND INDICATE MID BAND AND HALF POWER POINT.

VOLTAGE GAIN $A_V = \frac{V_O}{V_I}$ , VOLTAGE GAIN (dB) $= 20 \log_{10} \frac{V_O}{V_I}$

POWER AT LOAD $= \frac{V_O^2}{R}$ , POWER GAIN (dB) $= 10 \log \frac{\text{POWER AT LOAD}}{\text{BASE POWER}}$

| FREQUENCY (HZ) | Vi (mV) | Vo (V) | VOLTAGE GAIN | VOLTAGE GAIN (dB) | LOAD POWER 10Ω | POWER GAIN (dB) 1mW = 0 dB |
|---|---|---|---|---|---|---|
| 10 | 100 | 1 | $\frac{1}{100 \times 10^{-3}} = 10$ | $20 \log_{10} \frac{1}{100 \times 10^{-3}} = 20$ | $\frac{1^2}{10} = 0.1\ W$ | $10 \log \frac{0.1}{1 \times 10^{-3}} = 10$ |
| 20 | 100 | 1.96 | $\frac{1.96}{100 \times 10^{-3}} = 19.6$ | $20 \log_{10} \frac{1.96}{100 \times 10^{-3}} = 25.8$ | $\frac{1.96^2}{10} = 0.384\ W$ | $10 \log \frac{0.384}{1 \times 10^{-3}} = 15.3$ |
| 40 | 100 | 3.71 | 37.1 | 31.3 | 1.376 | 31.3 |
| 100 | 100 | 7.07 | 70.7 | 36.9 | 4.99 | 36.9 |
| 200 | 100 | 8.94 | 89.4 | 39 | 7.94 | 39.02 |
| 400 | 100 | 9.28 | 92.8 | 39.3 | 8.61 | 39.35 |
| 1k | 100 | 9.95 | 99.5 | 19.5 | 9.9 | 39.95 |
| 2k | 100 | 10 | 100 | 40 | 10 | 40 |
| 4k | 100 | 10 | 100 | 40 | 10 | 40 |
| 10k | 100 | 9.95 | 99.5 | 39.9 | 9.9 | 39.95 |
| 20k | 100 | 9.81 | 98.1 | 39.8 | 9.62 | 39.83 |

MID BAND

HALF P

MID

FRE

$\frac{V_{out}^2}{R_L}$

$\frac{(2.7)^2}{4}$

$\frac{2.7 \times 2.7}{4}$

1.8225 W

pb 5

PLOT THE FREQUENCY RESPONSE OF THE FOLLOWING DATA OBTAINED FROM AN AMPLIFIER AND INDICATE MID BAND AND HALF POWER POINT.

VOLTAGE GAIN $A_V = \frac{V_o}{V_i}$ , VOLTAGE GAIN (dB) $= 20 \log_{10} \frac{V_o}{V_i}$

POWER AT LOAD $= \frac{V_o^2}{R}$ , POWER GAIN (dB) $= 10 \log \frac{\text{POWER AT LOAD}}{\text{BASE POWER}}$

| FREQUENCY (HZ) | Vi (mV) | Vo (V) | VOLTAGE GAIN | VOLTAGE GAIN (dB) | LOAD POWER 10Ω | POWER GAIN (dB) 1mW = 0 dB |
|---|---|---|---|---|---|---|
| 10 | 100 | 1 | $\frac{1}{100 \times 10^{-3}} = 10$ | $20 \log_{10} \frac{1}{100 \times 10^{-3}} = 20$ | $\frac{1^2}{10} = 0.1$ W | $10 \log \frac{0.1}{1 \times 10^{-3}} = 10$ |
| 20 | 100 | 1.96 | $\frac{1.46}{100 \times 10^{-3}} = 14.6$ | $20 \log_{10} \frac{1.46}{100 \times 10^{-3}} = 25.8$ | $\frac{1.46^2}{10} = 0.384$W | $10 \log \frac{0.384}{1 \times 10^{-3}} = 15.3$ |
| 40 | 100 | 3.71 | 37.1 | 31.3 | 1.376 | 31.3 |
| 100 | 100 | 7.07 | 70.7 | 36.9 | 4.99 | 36.9 |
| 200 | 100 | 8.94 | 89.4 | 39 | 7.94 | 39.02 |
| 400 | 100 | 9.28 | 92.8 | 39.3 | 8.61 | 39.35 |
| 1k | 100 | 9.95 | 99.5 | 19.5 | 9.9 | 39.95 |
| 2k | 100 | 10 | 100 | 40 | 10 | 40 |
| 4k | 100 | 10 | 100 | 40 | 10 | 40 |
| 10k | 100 | 9.95 | 99.5 | 39.9 | 9.9 | 39.95 |
| 20k | 100 | 9.81 | 98.1 | 39.8 | 9.62 | 39.83 |

MID BAND

HALF POWER POINT(

MID BAND

FREQUENCY (

40k

100k

200k

400k

1m

| FREQUENCY (HZ) | Vi (mV) | Vo (V) | VOLTAGE GAIN | VOLTAGE GAIN (dB) | 10Ω LOAD POWER | POWER GAIN (dB) |
|---|---|---|---|---|---|---|
| 40K | 100 | 9.28 | 92.8 | 39.8 | 8.61 | 39.35 |
| 100K | 100 | 7.07 | 70.7 | 36.9 | 4.99 | 36.9 |
| 200K | 100 | 4.47 | 44.7 | 33 | 1.99 | 32.9 |
| 400K | 100 | 2.43 | 24.3 | 27.7 | 0.59 | 27.7 |
| 1M | 100 | 1 | 10 | 20 | 0.1 | 10 |

HALF POWER POINT (2)

...ER GAIN (dB)

...mW = 0 dB

$\frac{0.1}{1\times10^{-3}} = 10$

$\frac{0.384}{1\times10^{-3}} = 15.3$

31.3

36.9

39.02

39.35

39.45

40

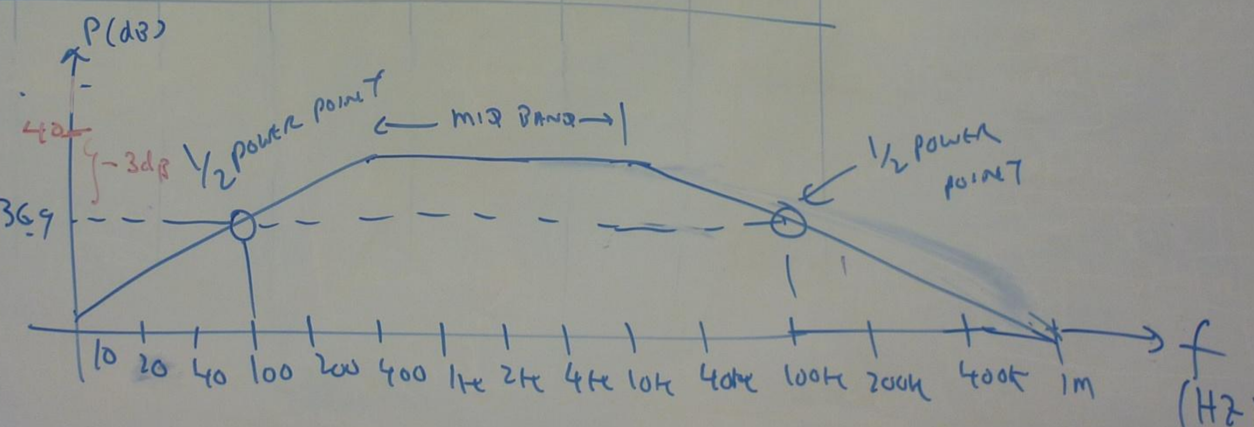
40

39.45

39.83

HALF POWER POINT (1)

MID BAND




pb 6

A...

An...

Em...

FR...

pb 7

pb 6

AN AUDIO SIGNAL GENERATOR WHOSE SOURCE RESISTANCE IS 600 Ω IS CONNECTED TO AN AMPLIFIER WHICH HAS A 3 kΩ INPUT RESISTANCE. A 1 μF COUPLING CAPACITOR IS EMPLOYED THE SIGNAL SOURCE AND THE AMPLIFIER. DETERMINE THE LOWER HALF POWER FREQUENCY.

$$f_{L-3dB} = \text{LOWER HALF POWER FREQUENCY} = \frac{1}{2\pi (R_S + R_i) C}$$

$R_S$ = SOURCE RESISTANCE, $R_i$ = INPUT RESISTANCE OF AMPLIFIER, C = COUPLING CAPACITOR

$$f_{L-3dB} = \frac{1}{2 \times 3.1416 \times (600 + 3\times10^{3}) \times 1 \times 10^{-6}} = 44.2 \text{ Hz}$$

pb 7

AN AMPLIFIER HAS AN INPUT IMPEDANCE 10 kΩ. CALCULATE THE VALUE OF COUPLING CAPACITOR REQUIRED FOR 40 Hz LOWER −3dB FREQUENCY. SOURCE RESISTANCE = 600 Ω

$$40 = \frac{1}{2 \times 3.1416 (600 + 1000) C}$$

$$C = \frac{1}{2 \times 3.1416 \times 40 \times 1600} = 2.486 \mu F$$

f

(Hz)