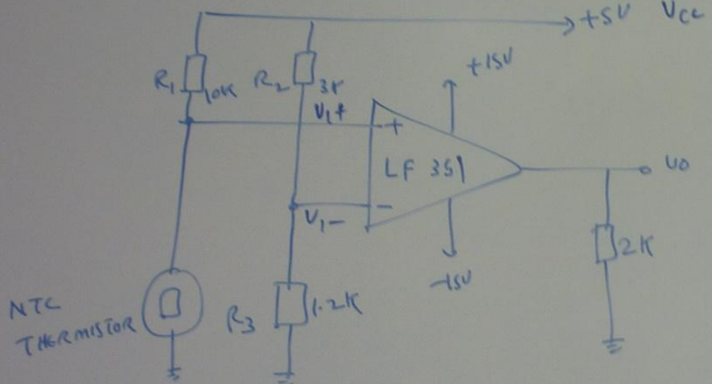
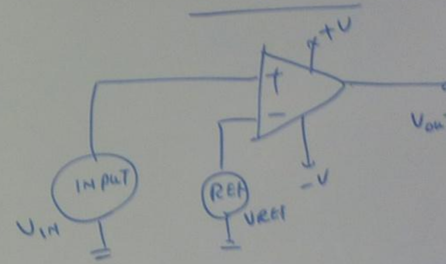
PB → AN NTC (NEGATIVE TEMPERATURE COEFFICIENT) THERMISTOR IS EMPLOYED TO CONTROL THE TEMPERATURE AS SHOWN BELOW



COMPARATOR



$V_{OUT} = (V_{IN} - V_{REF}) \times A_V$

$\boxed{R_t = R_0(1 + \alpha \Delta t)}$

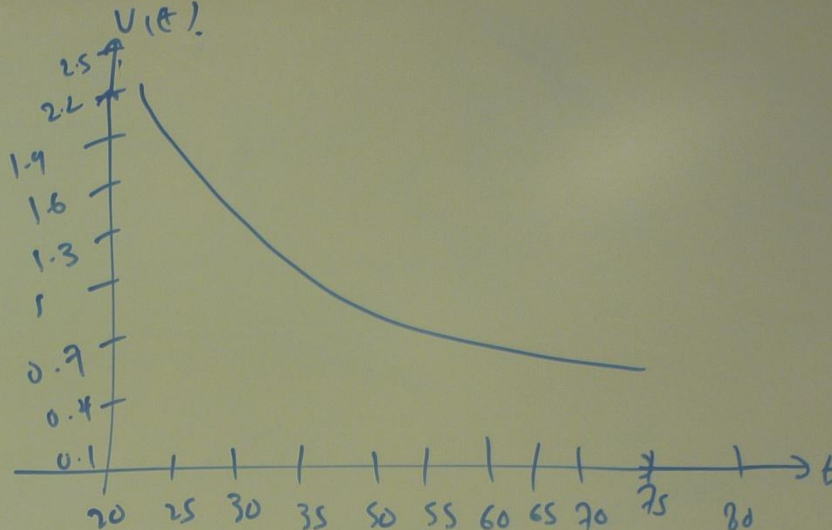
TEMPERATURE (°C)	20	25	30	35	40	45	50	55	60	65	90	75	80
R (KΩ) (R_{NTC})	9.5	8.2	6.8	5.7	4.9	4.3	3.7	3.3	3	2.7	2.5	2.3	2.2
V_{1+}	2.436	2.252	2.02	1.81	1.64	1.5	1.35	1.24	1.15	1.06	1	0.43	0.9

DRAW V_{1+} GRAPH

AV

$$V_{1(+)} = V_{cc} \times \frac{R_{NTC}}{R_1 + R_{NTC}}$$

$$V_{1(-)} = V_{cc} \times \frac{R_3}{R_2 + R_3}$$



IF $R_{NTC} = 9.5\,k\Omega$

$R_1 = 10\,k$

$$V_{1(+)} = \frac{9.5}{10 + 9.5} \times 5 = 2.435$$

IF $R_{NTC} = 8.2\,k\Omega$

$R_1 = 10\,k$

$$V_1(+) = \frac{8.2}{10 + 8.2} \times 5 = 2.252\,\Omega$$

IN ABOVE PROBLEM

(i) CALCULATE INVERTING INPUT VOLTAGE $V_{1(-)}$

(ii) DETERMINE THE TRANSITION TEMPRATURE

(iii) DETERMINE THE VALUE OF R_3 FOR 70°C TRANSITION TEMPERATURE

(iv) SHOW A RELAY INTERFACE CIRCUIT TO THE OUTPUT TERMINAL TO OPERATE A 240V HEATING ELEMENT.

(i

AV

$$V_{1(+)} = V_{cc} \times \frac{R_{NTC}}{R_1 + R_{NTC}}$$

$$V_{1(-)} = V_{cc} \times \frac{R_3}{R_2 + R_3}$$

IF $R_{NTC} = 9.5k\Omega$

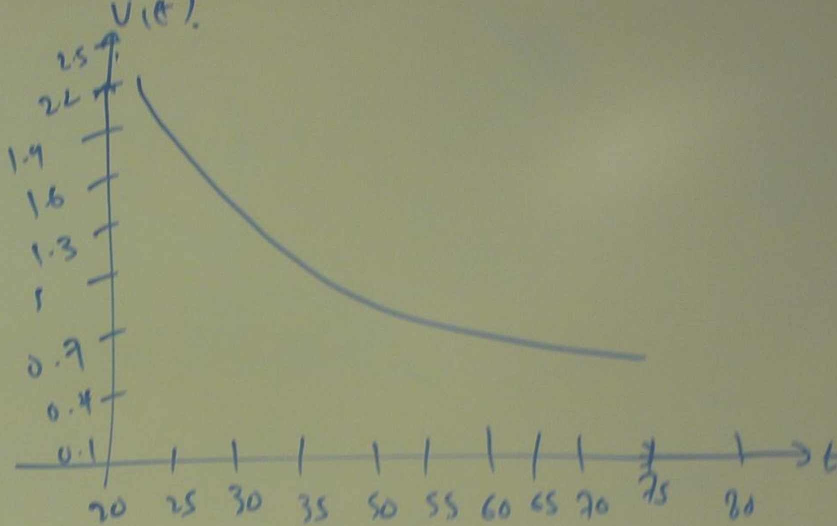
$R_1 = 10\,K$

$$V_{1(+)} = \frac{9.5}{10+9.5} \times 5 = 2.435$$

IF $R_{NTC} = 8.2k\Omega$

$R_1 = 10K$

$$V_1(t) = \frac{8.2}{10+8.2} \times 5 = 2.252\Omega$$



IN ABOVE PROBLEM

(i) CALCULATE INVERTING INPUT VOLTAGE $V_{1(-)}$

(ii) DETERMINE THE TRANSITION TEMPERATURE

(iii) DETERMINE THE VALUE OF R_3 FOR 70°C TRANSITION TEMPERATURE

(iv) SHOW A RELAY INTERFACE CIRCUIT TO THE OUTPUT TERMINAL TO OPERATE A 240V HEATING ELEMENT.

(b) (i) $V_{1(-)} = V_{cc} \times \frac{R_3}{R_3 + R_2}$

$= 5 \times \frac{1.2}{1.2 + 3}$

$= 1.43\ V$

AT 50°C, $V_{1(+)} < V_{1(-)}$

1.35V   1.43V

(ii) 50°C IS TRANSITION TEMPERATURE

(iii) FOR 70°C TEMPERATURE TO BCOME TRANSITION TEMPERATURE

$V_{1(-)}$ MUST BE ATLEAST 1V

$V_{1(-)} = V_{cc} \times \frac{R_3}{R_2 + R_3}$

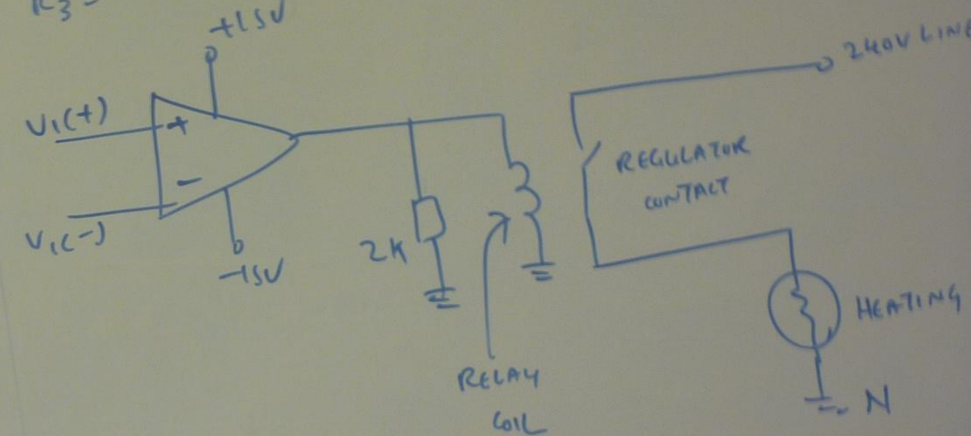
$1 = 5 \times \frac{R_3}{R_3 + 3}$

$1 = \frac{5R_3}{R_3 + 3}$

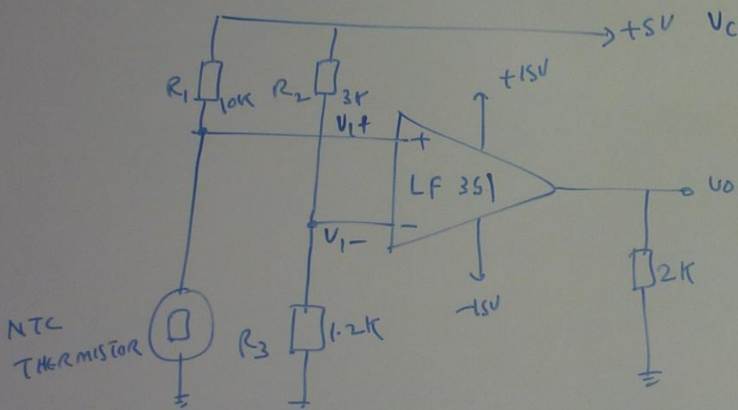
$R_3 + 3 = 5R_3$

$4R_3 = 3$

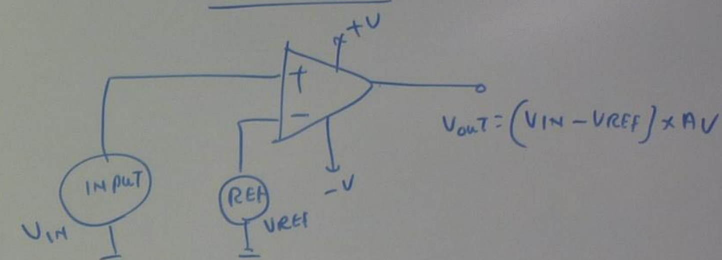
$R_3 = 0.75\ k\Omega$



PB AN NTC (NEGATIVE TEMPERATURE COEFFICIENT) THERMISTOR IS EMPLOYED TO CONTROL THE TEMPERATURE AS SHOWN BELOW



COMPARATOR



$$\boxed{R_t = R_0(1 + \alpha \Delta t)}$$

TEMPERATURE (°C)	20	25	30	35	40	45	50	55	60	65	70	75	80
R (kΩ) (RNTC)	9.5	8.2	6.8	5.7	4.9	4.3	3.7	3.3	3	2.7	2.5	2.3	2.2
V_{1+}	2.436	2.252	2.02	1.81	1.64	1.5	1.35	1.24	1.15	1.06	1	0.93	0.9

DRAW V_1+ GRAPH

VIN − VREF) × AV

$$V_1(+) = V_{cc} \times \frac{R_{NTC}}{R_1 + R_{NTC}}$$

$$V_1(-) = V_{cc} \times \frac{R_3}{R_2 + R_3}$$

IF $R_{NTC} = 9.5k\Omega$

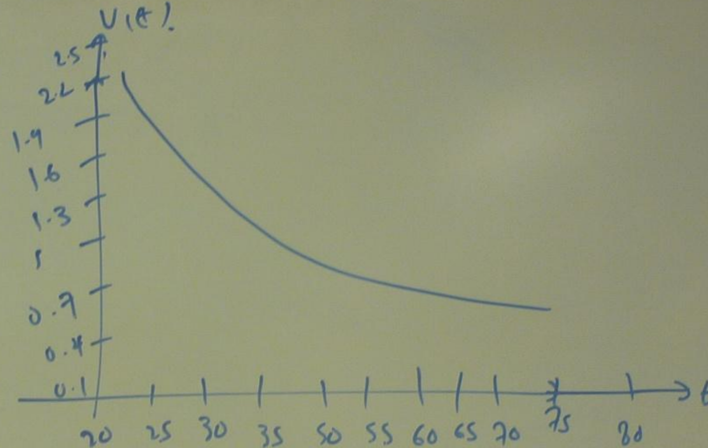
$R_1 = 10K$

$$V_1(+) = \frac{9.5}{10+9.5} \times 5 = 2.435$$

IF $R_{NTC} = 8.2k\Omega$

$R_1 = 10K$

$$V_1(+) = \frac{8.2}{10+8.2} \times 5 = 2.252\Omega$$



IN ABOVE PROBLEM

(i) CALCULATE INVERTING INPUT VOLTAGE $V_1(-)$

(ii) DETERMINE THE TRANSITION TEMPERATURE

(iii) DETERMINE THE VALUE OF R_3 FOR 70°C TRANSITION TEMPERATURE

(iv) SHOW A RELAY INTERFACE CIRCUIT TO THE OUTPUT TERMINAL TO OPERATE A 240V HEATING ELEMENT.

(b) V

(i)

AT 50

(ii) 50 C

(iii)

(b)
(i) $V_{1(-)} = V_{cc} \times \frac{R_3}{R_3+R_2}$

$= 5 \times \frac{1.2}{1.2+3}$

$= 1.43\ V$

AT 50°C, $V_{1(+)} < V_{1(-)}$

$1.35V \quad 1.43V$

(ii) 50°C IS TRANSITION TEMPERATURE

(iii) FOR 70°C TEMPERATURE TO BECOME TRANSITION TEMPERATURE $V_{1(-)}$ MUST BE ATLEAST 1V

$V_{1(-)} = V_{cc} \times \frac{R_3}{R_2+R_3}$

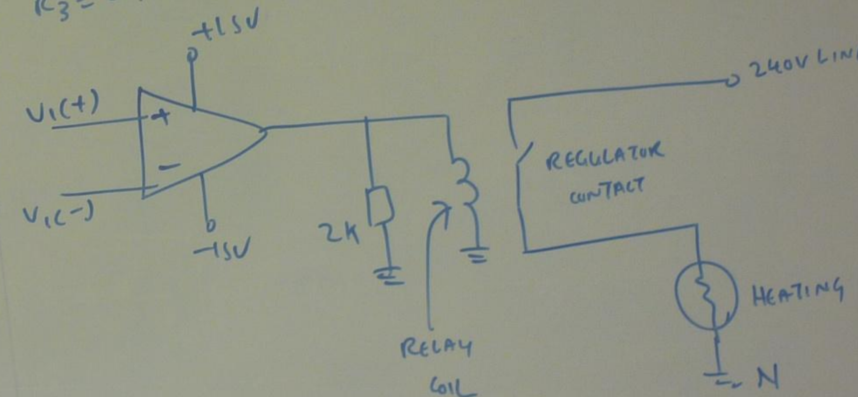
$1 = 5 \times \frac{R_3}{R_3+3}$

$1 = \frac{5R_3}{R_3+3}$

$R_3+3 = 5R_3$

$4R_3 = 3$

$R_3 = 0.75\ k\Omega$



(b)

$V_i = 1$

V_i MA

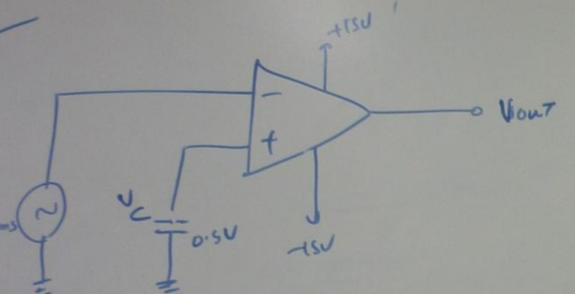
V_i

1.4

V_i 0.5V

V_{ou}

pb

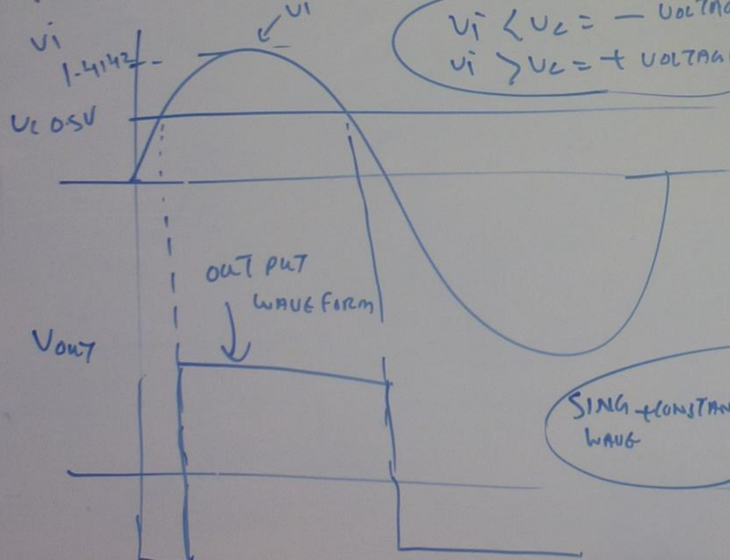


DRAW BOTH INPUT AND OUTPUT WAVE FORMS

$V_{i\,max} = \sqrt{2}\, V_{i\,rms} = 1.4142 \times 1 = 1.4142\,V$

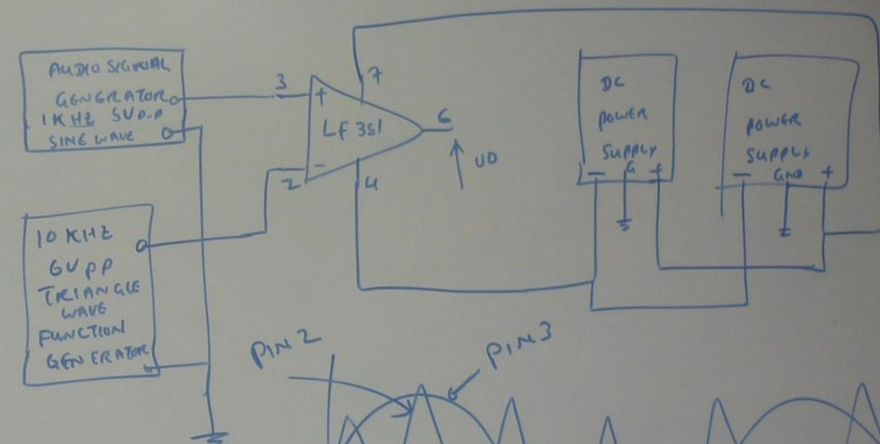
$V_i < V_c = -$ VOLTAGE

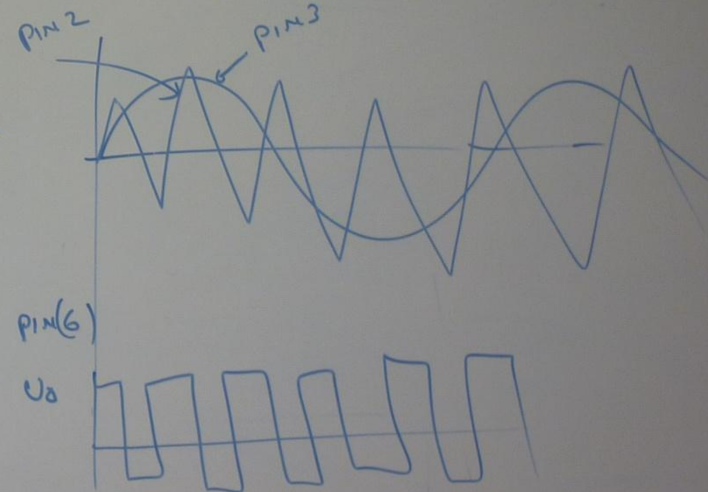
$V_i > V_c = +$ VOLTAGE



SING + CONSTANT $\Rightarrow$ SQUARE WAVE
WAVE

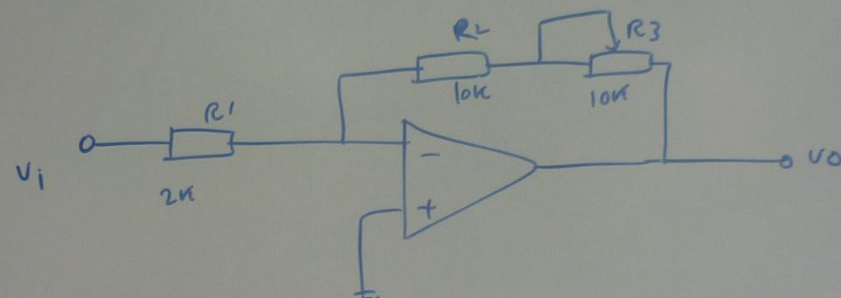
BASIC PWM CIRCUIT





Pb

FOR THE AMPLIFIER CIRCUIT SHOWN BELOW, DETERMINE MINIMUM VOLTAGE GAIN AND MAXIMUM VOLTAGE GAIN.



$$A_V = -\frac{R_f}{R_i} = -\frac{(R_2+R_3)}{R_1}$$

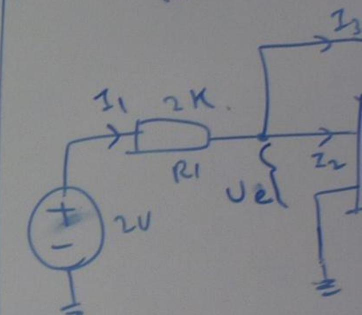
MAX $R_3 = 10K \longrightarrow A_V = -\frac{(10+10)}{2} = -10$

MIN $R_3 = 0 \longrightarrow A_V = -\frac{(10+0)}{2} = -5$

Pb

FOR THE CIR

THE CURRENT



$$\boxed{I_1 = \frac{V_{IN}}{R_1}} = \frac{2}{2}$$

$I_2 = 0$

$\therefore I_1 = I_3 = 1$

$V_{Ref} = I_3$

$= 1$

$=$

BELOW, DETERMINE

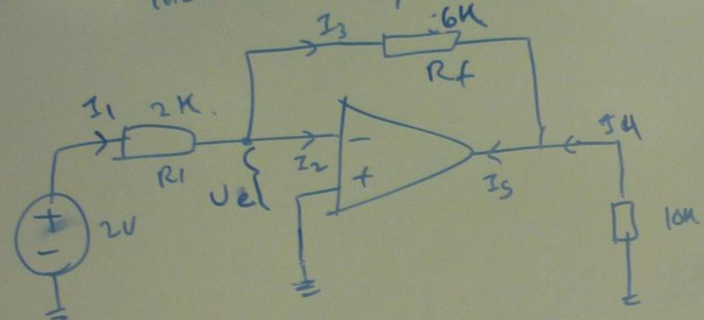
UM VOLTAGE GAIN.

$\frac{+10)}{} = -10$

$\frac{+0)}{2} = -5$

Pn/ FOR THE CIRCUIT SHOWN BELOW FIND

THE CURRENT $I_1 \sim I_5$



$$\boxed{I_1 = \frac{V_{IN}}{R_1}} = \frac{2}{2K} = 1\,mA$$

$I_2 = 0$

$\therefore I_1 = I_3 = 1\,mA$

$$\boxed{V_{Ref} = I_3 \times R_f}$$

$= 1mA \times 6K$

$= 6V$

$$\boxed{V_0 = V_e - V_{Ref}}$$

$= 0 - 6 = -6\ V$

$I_4 = \frac{V_{OUT}}{R_4} = \frac{-6}{10}$

$= -0.6\,mA$

$I_5 = I_3 + I_4$

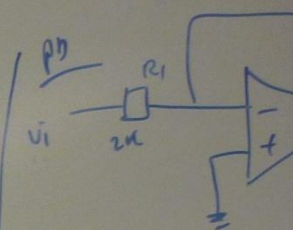
$= 1 + (-0.6)$

$= 0.4\,mA$

$I_1 \sim I_5 = 1 - 0.4$

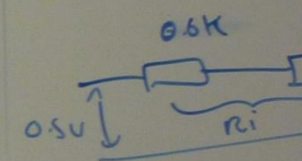
$= 0.6\,mA$

Pn/



DETERMINE IN

AUDIO SIGNAL GENERATOR 1KHz 0.5V_{PP} $R_o = 600\Omega$



$R_i = $

$$\boxed{V_0 = V_c - V_{Ref}}$$

$$= 0 - 6 = -6\,V$$

$$I_4 = \frac{V_{OUT}}{R_4} = \frac{-6}{10}$$

$$= -0.6\,mA$$

$$I_5 = I_3 + I_4$$

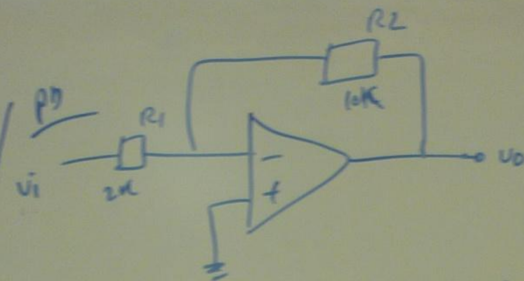
$$= 1 + (-0.6)$$

$$= 0.4\,mA$$

$$I_1 \sim I_5 = 1 - 0.4$$

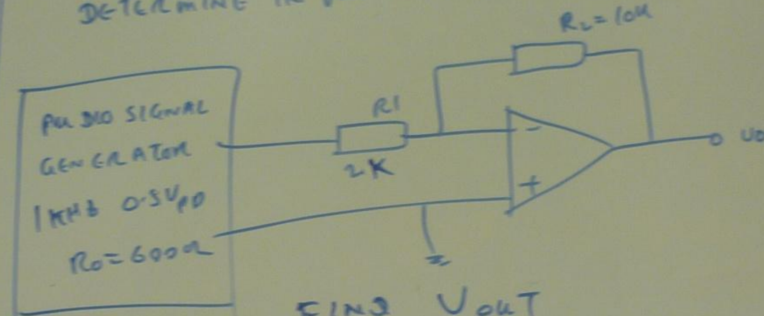
$$= 0.6\,mA$$

PD

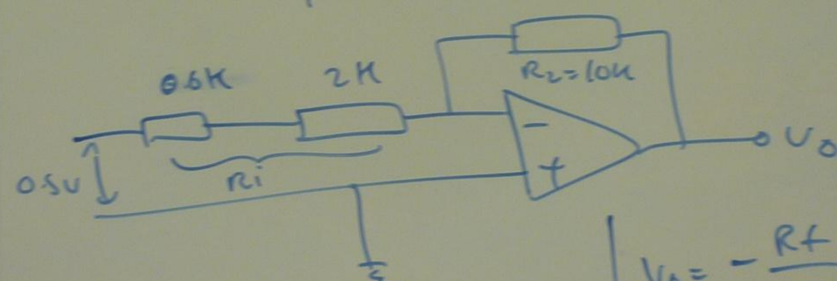


$$R_{IN} = R_1 = 2K$$

DETERMINE INPUT RESISTANCE



FIND V_{OUT}



$$R_i = 0.6 + 2 = 2.6K$$

$$V_0 = -\frac{R_f}{R_i} \times V_{IN}$$

$$= \frac{-10}{2.6} \times 0.5$$

$$= -1.92\,V$$

(a)

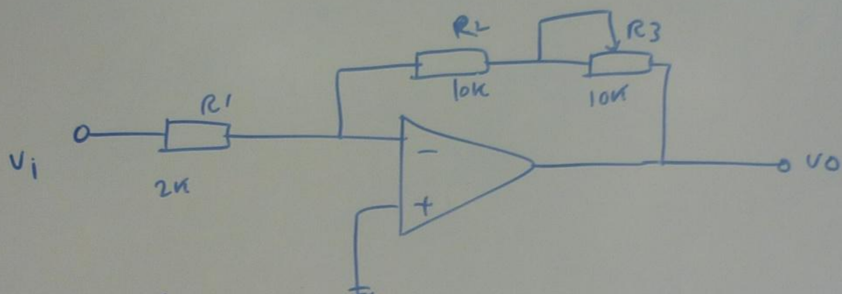
(i)

AT

(ii) So

(iii)

pb FOR THE AMPLIFIER CIRCUIT SHOWN BELOW, DETERMINE MINIMUM VOLTAGE GAIN AND MAXIMUM VOLTAGE GAIN.



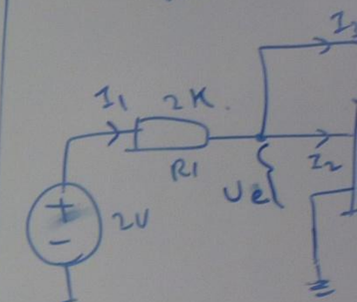
$$A_v = -\frac{R_f}{R_i} = -\frac{(R_2+R_3)}{R_1}$$

MAX $R_3 = 10K \longrightarrow A_v = -\frac{(10+10)}{2} = -10$

MIN $R_3 = 0 \longrightarrow A_v = -\frac{(10+0)}{2} = -5$

pb FOR THE CIR

THE CURRENT



$$\boxed{I_1 = \frac{V_{IN}}{R_1}} = \frac{2}{2}$$

$I_2 = 0$

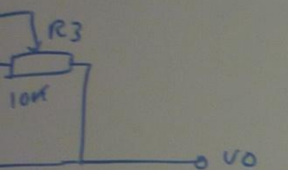
$\therefore I_1 = I_3 = 1$

$V_{Ref} = I_3$

$= 1$

$= 6$

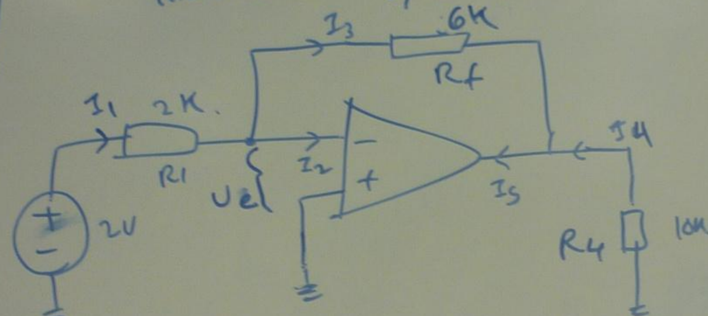
...N BELOW, DETERMINE
...AXIMUM VOLTAGE GAIN.



$\frac{...(10+10)}{2} = -10$

$\frac{...(10+0)}{2} = -5$

P/
FOR THE CIRCUIT SHOWN BELOW FIND
THE CURRENT $I_1 \sim I_5$



$$\boxed{I_1 = \frac{V_{IN}}{R_1}} = \frac{2}{2K} = 1\,mA$$

$I_2 = 0$

$\therefore I_1 = I_3 = 1\,mA$

$$\boxed{V_{Ref} = I_3 \times R_f}$$

$= 1\,mA \times 6K$

$= 6V$

$$\boxed{V_o = V_e - V_{Ref}}$$

$= 0 - 6 = -6\,V$

$$I_4 = \frac{V_{OUT}}{R_4} = \frac{-6}{10}$$

$= -0.6\,mA$

$I_5 = I_3 + I_4$

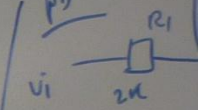
$= 1 + (-0.6)$

$= 0.4\,mA$

$I_1 \sim I_5 = 1 - 0.4$

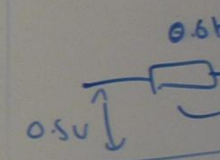
$= 0.6\,mA$

P/



DETERMI...

AUDIO SIGNAL...
GENERATOR
1KHz 0.5Vp...
Ro=600Ω...



$$\boxed{V_0 = V_c - V_{Ref}}$$

$$= 0 - 6 = -6\ V$$

$$I_4 = \frac{V_{out}}{R_4} = \frac{-6}{10}$$

$$= -0.6\ mA$$

$$I_5 = I_3 + I_4$$

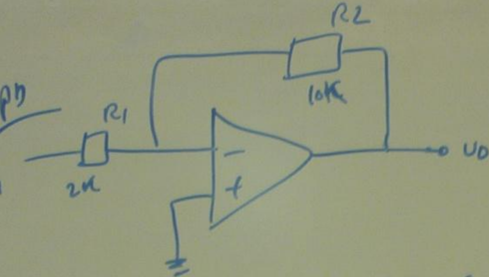
$$= 1 + (-0.6)$$

$$= 0.4\ mA$$

$$I_1 \sim I_5 = 1 - 0.4$$

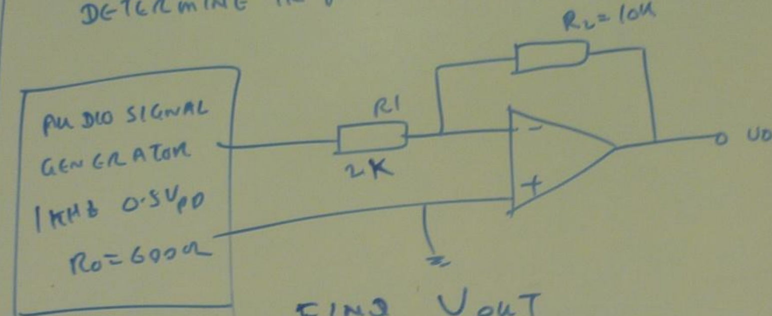
$$= 0.6\ mA$$

pn

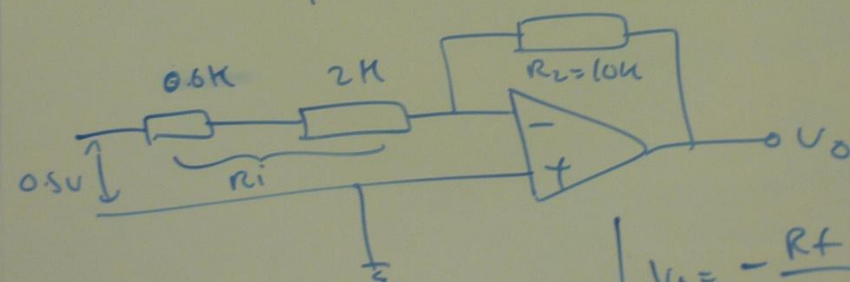


$$R_{IN} = R_1 = 2\ K$$

DETERMING IN PUT RESISTANCE



FIND V_{out}



$$R_i = 0.6 + 2 = 2.6\ K$$

$$V_0 = -\frac{R_f}{R_i} \times V_{IN}$$

$$= \frac{-10}{2.6} \times 0.5$$

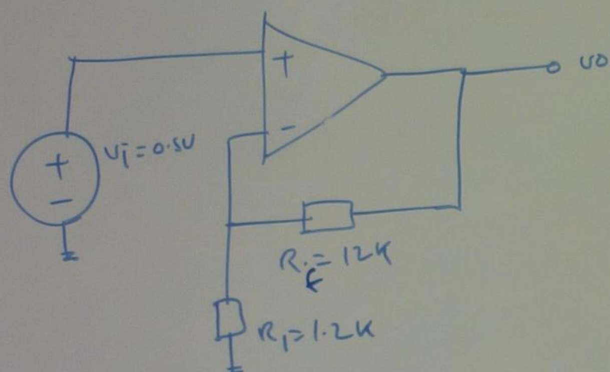
$$= -1.92\ V$$

pn

$V_0 =$

pb

FOR THE GIVEN CIRCUIT, CALCULATE OUTPUT VOLTAGE



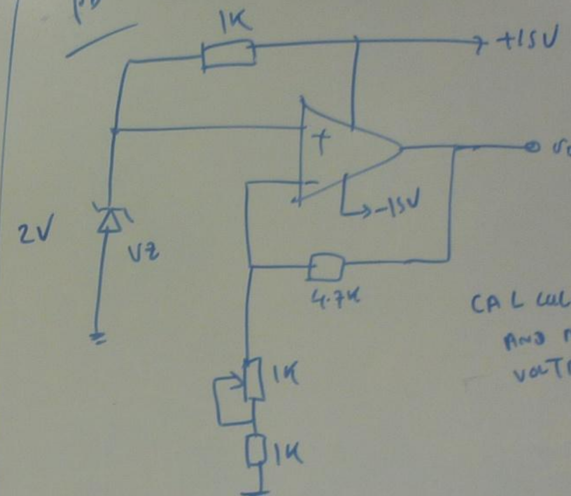
$$V_o = \left[1 + \frac{R_f}{R_1}\right] v_i$$

$$= \left[1 + \frac{12}{1}\right] \times 0.5$$

$$= [13] \times 0.5$$

$$= 6.5V$$

pb



CALCULATE MAXIMUM AND MINIMUM OUTPUT VOLTAGES

$$V_o = (V_{IN} - V_Z)\left(1 + \frac{R_f}{R_i}\right)$$

$R_i = 1K$

$$V_o = (15 - 2)\left(1 + \frac{4.7}{1}\right) = 39V$$

$R_i = 2K$

$$V_o = (15 - 2)\left(1 + \frac{4.7}{2}\right) = 65V$$

pb

$V_i = 1$ rms

OR

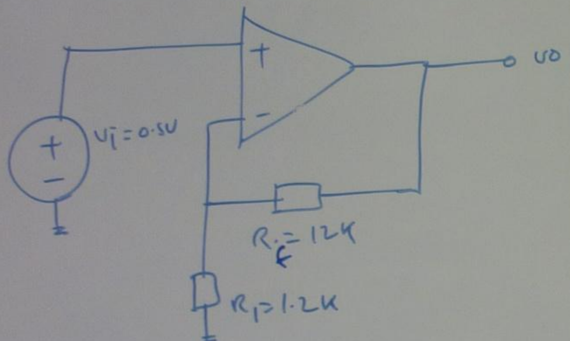
V_i MAX

v_i 1.414

V_i 0.5V

V_{out}

pb FOR THE GIVEN CIRCUIT, CALCULATE OUTPUT VOLTAGE



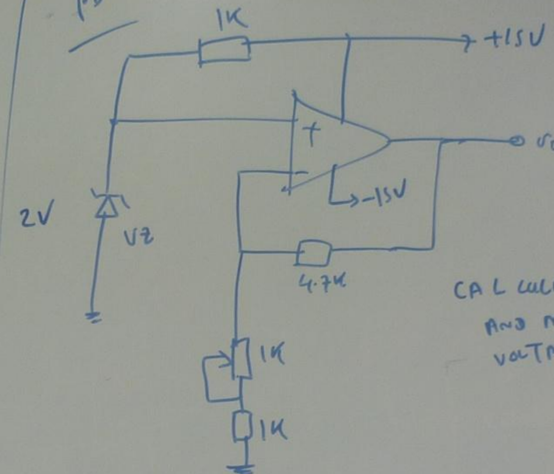
$$V_o = \left[1 + \frac{R_f}{R_1}\right] v_i$$

$$= \left[1 + \frac{12}{1}\right] \times 0.5$$

$$= [13] \times 0.5$$

$$= 6.5V$$

pb



CALCULATE MAXIMUM AND MINIMUM OUTPUT VOLTAGES

$$V_o = (V_{IN} - V_z)\left(1 + \frac{R_f}{R_i}\right)$$

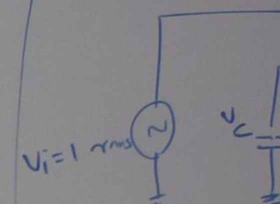
$R_i = 1K$

$$V_o = (15 - 2)\left(1 + \frac{4.7}{1}\right) = 39V$$

$R_i = 2K$

$$V_o = (15 - 2)\left(1 + \frac{4.7}{2}\right) = 65V$$

pb



DRAW BOTH

V_i max $= \sqrt{2}\, V_i$