Op. amps. – outcome 2.

Homework 2.1

a) (i) Open loop gain (A_0) is very high, typical value 200,000 or higher.

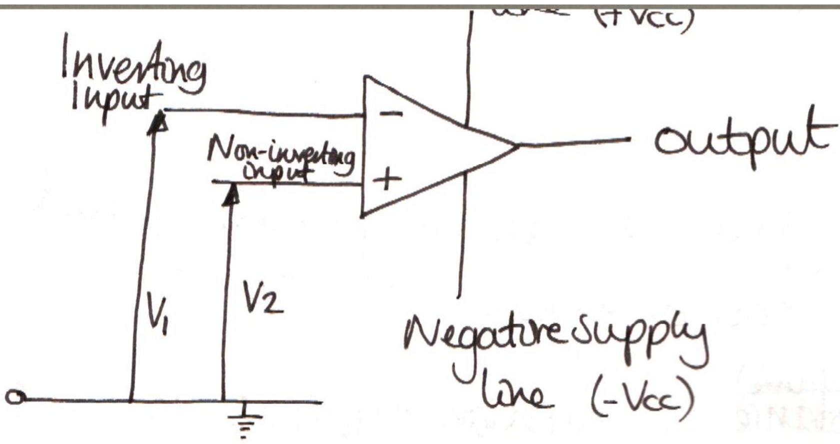
(ii) Input resistance (impedance) is very high, typical value 1MΩ.

(iii) Output impedance is very low, typical value 75Ω.

b) (i) Ideally the output gain would be infinitely high. Obviously an amplifier with an infinite gain would be useless, as the smallest input would result in a full output. A very high or even infinite gain can be controlled by suitable feedback.

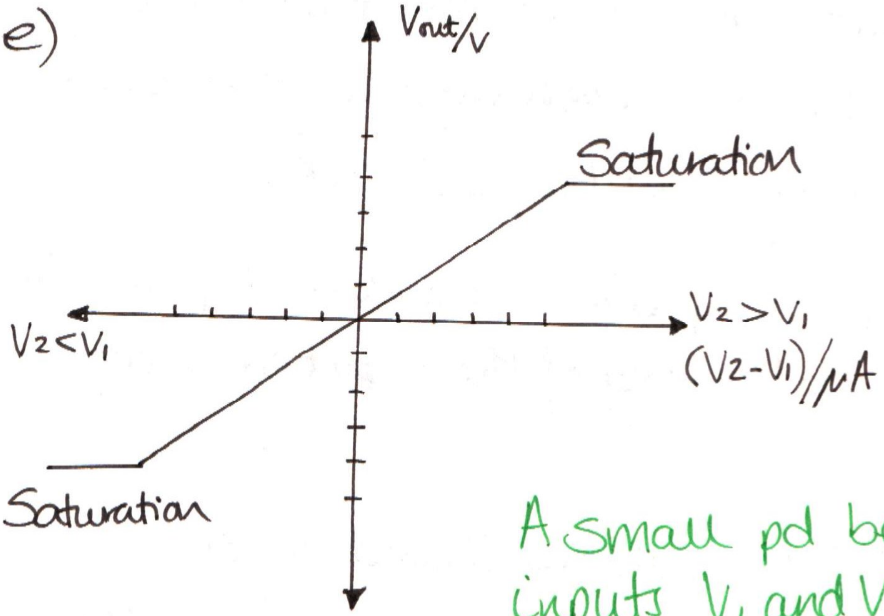
(ii) Ideally the input impedance should be infinite, so that there is no loading of the input source at all.

(iii) Ideally the output impedance should be zero. With a zero output resistance, the amplifier can be connected to a load of any resistance without the output voltage being affected.



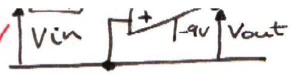
d) Difference amplifier - here both inputs are used. The op. amp. amplifies the difference between the two input signals.

e)



A small pd between the two inputs V_1 and V_2 will cause the amplifier to saturate and produce an output just below the supply voltage. The output will be linear between these two saturation points or difference input.

Homework 2.2.



a) (i) gain = ? Vout = ?

$R_f = 20k$ $R_i = 10k$

$$A_v = -\frac{R_f}{R_i} = -\frac{20}{10} = -2$$

$$V_o = -V_{in} \times \frac{R_f}{R_i}$$

$$V_o = -1 \times \frac{20}{10} = -2V$$

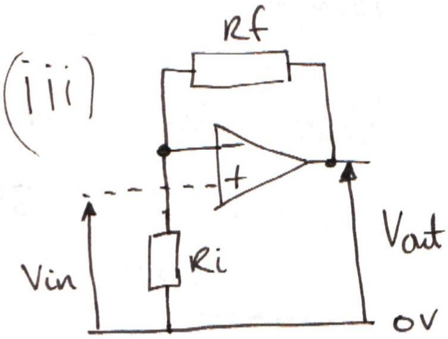
(ii) $R_f = 200k$ $R_i = 10k$

$$A_v = -\frac{R_f}{R_i} = -\frac{200}{10} = -20$$

$$V_o = -V_{in} \times \frac{R_f}{R_i}$$

$$V_o = -1 \times \frac{200}{10} = -20V$$

(iii)



b) (i) gain = ? Vout = ?

$R_f = 20k$ $R_i = 10k$

$$A_v = 1 + \frac{R_f}{R_i}$$

$$A_v = 1 + \frac{20}{10} = 3$$

$$V_o = V_i \times A_v$$

$$V_o = 1 \times 3 = 3V$$

(ii) $R_f = 200k$ $R_i = 10k$

$$A_v = 1 + \frac{R_f}{R_i}$$

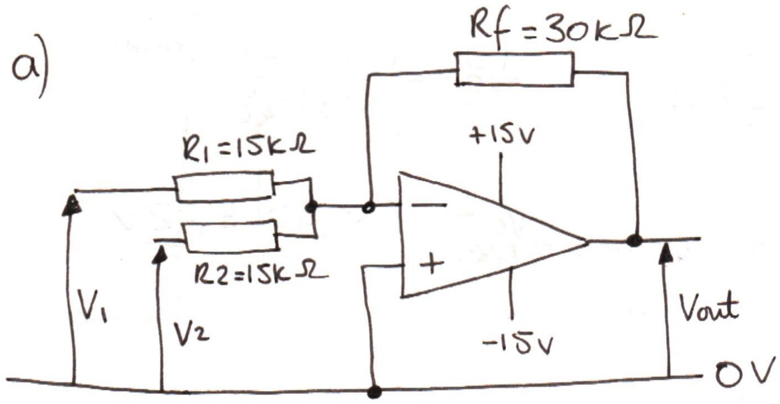
$$A_v = 1 + \frac{200}{10} = 21$$

$$V_o = V_i \times A_v$$

$$V_o = 1 \times 21 = 21V$$

Homework 2.3

a)



b) (i) Vout = ? $V_1 = +1V$ $V_2 = +4V$.

$$V_{out} = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2}\right)$$

$$V_{out} = -30\left(\frac{1}{15} + \frac{4}{15}\right)$$

$$V_{out} = -30\,(0.07 + 0.27)$$

$$V_{out} = -30 \times 0.34$$

$$\underline{V_{out} = -10.2V}$$

(ii) Vout = ? $V_1 = +1V$. $V_2 = -4V$.

$$V_{out} = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2}\right)$$

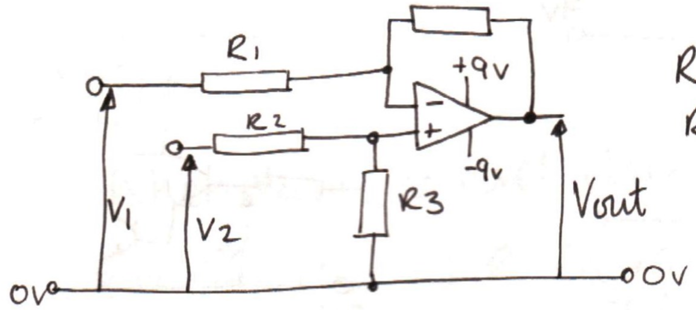
$$V_{out} = -30\left(\frac{1}{15} - \frac{4}{15}\right)$$

$$V_{out} = -30\,(0.07 - 0.27)$$

$$V_{out} = -30 \times -0.2$$

$$V_{out} = \underline{6V}$$

Homewak 2.5.



$R_f = R_3$.
$R_1 = R_2$.

a) Difference amplifier – The output will be determined by the difference between the two input signals which is then amplified by the ratio between Rf and R1. If the inputs are the same then the output will be zero.

b) (i) Vout = ? $R_f = R_i = 1M\Omega$, $V_1 = 2.4v$, $V_2 = -4v$.

$$V_{out} = \frac{R_f}{R_1} \times (V_2 - V_1)$$

$$V_{out} = \frac{1}{1} \times (-4 - 2.4)$$

$$V_{out} = -6.4V$$

(ii) Vout = ? $R_f = 1M$, $R_i = 100k$, $V_1 = 4.5v$, $V_2 = 3.5v$.

$$V_{out} = \frac{R_f}{R_i} \times (V_2 - V_1)$$

$$V_{out} = \frac{1 \times 10^6}{1 \times 10^3} \times (3.5 - 4.5)$$