Homework – 2.1

Operational Amplifiers (Op. Amps) were originally made from discrete components and were designed to solve mathematical equations electronically by performing operations such as addition, etc. in analogue computers. Present day op. amps in integrated circuit form have many uses. One of the main ones being as high gain voltage amplifiers.

(a) Describe the chief properties of practical op. amps refering to;
  (i) open loop gain
  (ii) input impedance
  (iii) output impedance.

(b) Describe these properties as displayed by an 'IDEAL' op. amp.

(c) Sketch the basic diagram for an op. amp. which is supplied from a dual balanced d.c. power supply showing inputs and outputs.

(d) Describe its operation as a **difference amplifier**.

(e) Sketch a typical voltage characteristic graph on the axis shown in *fig. 2.1.1* below and describe the behaviour of the device over a range of inputs using the terms *saturation, linear range, difference input*.

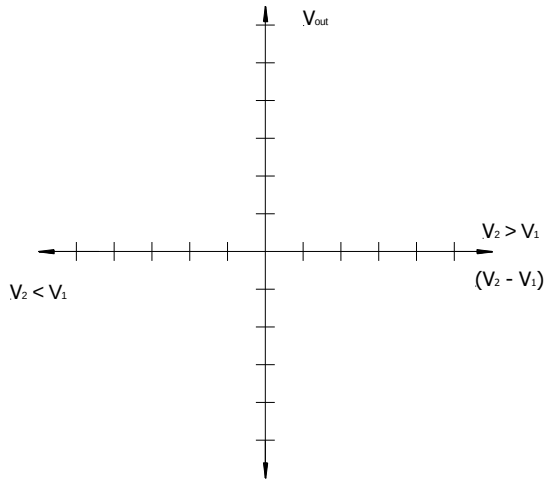


Figure 2.1.1

Homework – 2.2

(a) An inverting amplifier has a power supply of ±9V and the input voltage V_i = +1V. What is the value of the gain and the output voltage V_o when,
  (i) R_f = 20k and R_i = 10k
  (ii) R_f = 200k and R_i = 10k
  (iii) Sketch the circuit for the above examples.

(b) Repeat the above question when the op. amp is arranged as a non-inverting amplifier.

Homework – 2.3

An op. amp summing amplifier has 2 inputs. The power supply is ± 15V, and R_f = 30k the input resistors R_i each being 15k.

(a) Make a diagramatic sketch of circuit diagram for this arrangement.

(b) Calculate the output voltage V_o when
  (i) V_1 = +1V and V_2 = +4V
  (ii) V_1 = +1V and V_2 = -4V

Homework – 2.4

Op. amps are sometimes used in voltage-follower mode.

(a) Sketch this arrangement clearly labelling the diagram.
(b) Describe briefly how it operates.
(c) State a possible use for this configuration.

Homework – 2.5

The *figure 2.5.1* below represents a practical op. amp configuration.

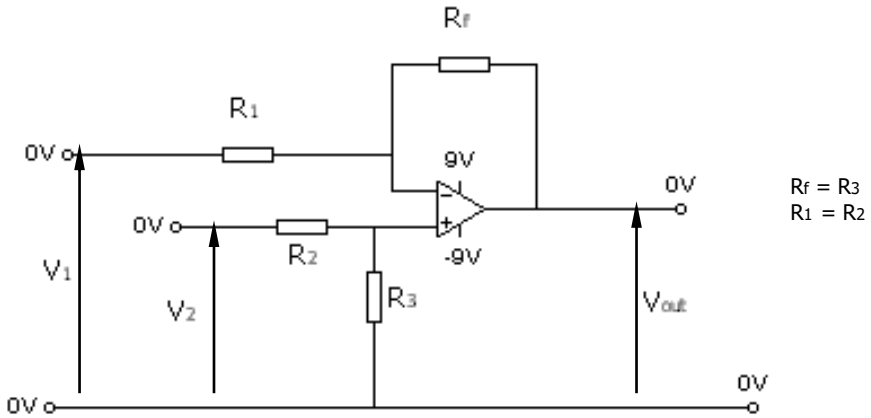


Figure 2.5.1

(a) Name this configuration and describe its operation refering to the inputs and outputs and values of reistors.
(b) Calculate the output voltage in each of the following cases.
  (i) $R_f = R_i = 1M$; $V_1 = 2.4V$; $V_2 = -4V$
  (ii) $R_f = 1M$; $R_i = 100k$; $V_1 = 4.5V$; $V_2 = 3.5V$

Homework – 2.6

An op. amp circuit is shown in the *figure 2.6.1* below.

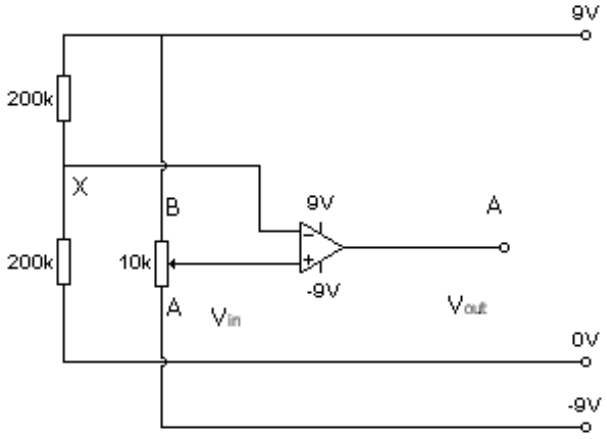


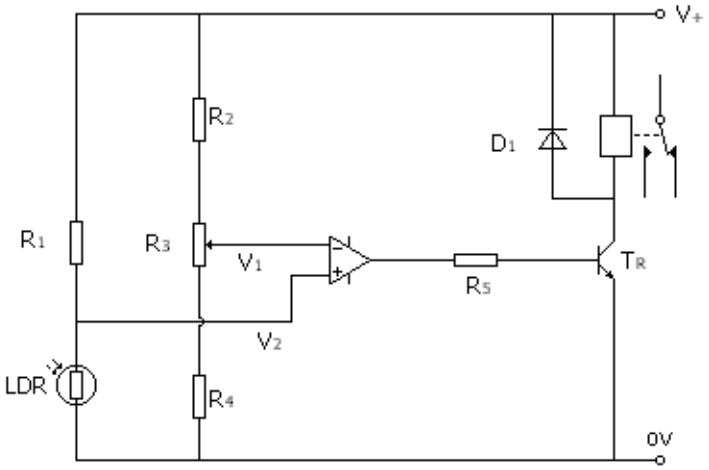
Figure 2.6.1

(a) Name this configuration
(b) State the voltage at point 'x'
(c) Sketch a graph of V_{in} (horizontal) against V_{out} (vertical) to show the relationship of V_{in} and V_{out} as the slider on the variable resistor moves from A to B.

(d) The output is to be used to operate a darlington pair buffer amplifier which will drive a relay. Sketch a suitable arrangement for this circuit.
(e) Replace the darlington pair with a MOSFET buffer and sketch this arrangement.
(f) State two advantages of MOSFET's over bi-polar transistors.

Homework – 2.7

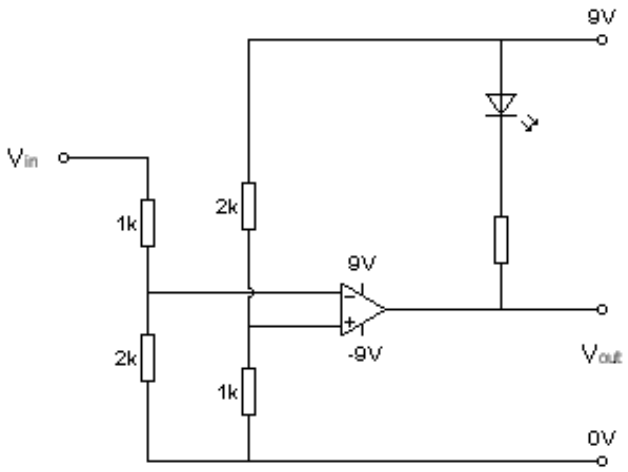
The circuit below shows a light activated switch which operates a relay.



(a) State the op. amp configuration used in this circuit.
(b) If the op. amp output is to be negative in normal daylight describe how the voltage levels V_1 and V_2 compare to give this.
(c) Describe what happens in darkness to ;
  (i) the LDR
  (ii) the relative values of V_1 and V_2.
  (iii) the output from the op. amp
  (iv) the transistor T_r
  (v) the relay
(d) State the function of the diode D1 in the circuit
(e) Show the modified circuit which will reverse the operation of the relay.

Homework – 2.8

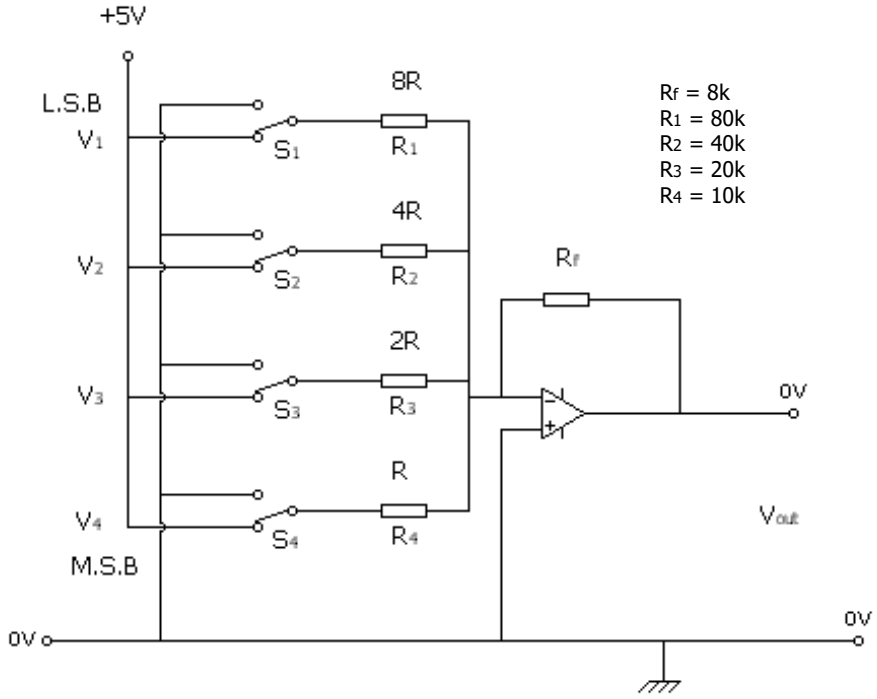
(a) Calculate the voltage at the non-inverting input of the op. amp shown.
(b) Calculate the output voltage when V_{in} = 0.
(c) Describe the operation of the LED as V_{in} varies from 0 to 9V.



Homework – 2.9

The figure below shows a diagramatic sketch of a simple digital to analogue converter. The output V_{out} is governed by the position of the switches S_1 to S_4 which may be set high 1 (5V) or low 0 (0V).

The relative value of resistors R_1 – R_4 are chosen such that each is twice the value of the previous i.e: 8R, 4R, 2R, R. *(MSB – Most Significant Bit, LSB – Least Significant Bit)*



(a) Write down the equation for the output of a summing amplifier having 4 inputs and show that;

$$V_{out} = -(0.1V_1 + 0.2V_2 + 0.4V_3 + 0.8V_4)$$ *Volts for the values of R_1, R_2, R_3 & R_4 and R_f given.*

(b) Calculate the output voltage for the switch positions shown ie. All inputs high and also for all inputs low when R = 10k and R_f = 8k.

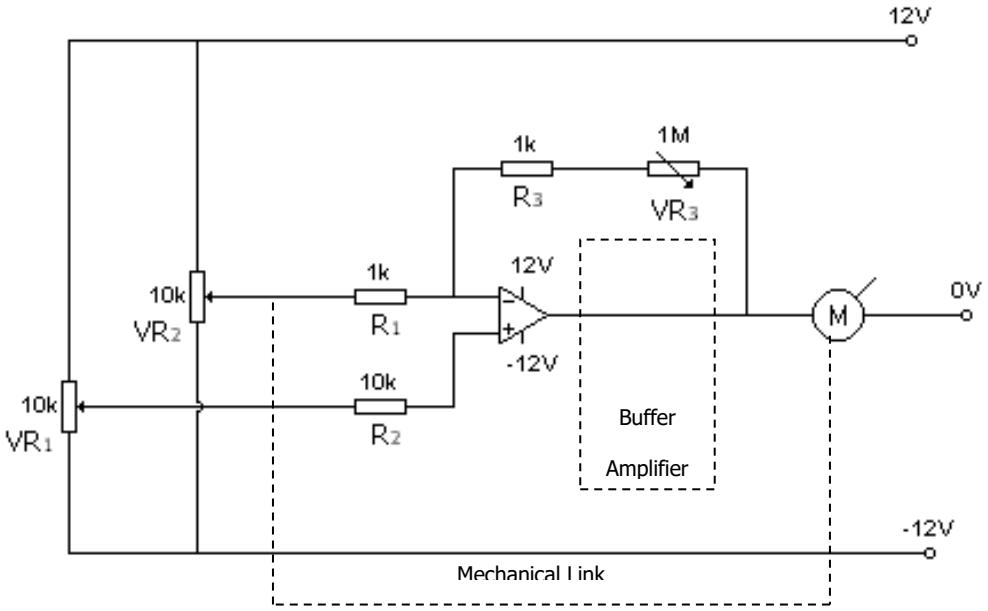
(c) Complete the table below by computing the output for all possible combinations of the 4 switches where V_1, V_2, V_3 & V_4 can be either 0V or 5V.

S_4	S_3	S_2	S_1	V_{out}
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

(d) Show how the above system may be modified by adding an additional op. amp device which will give a positive output equal to 2 x $V_{out.}$

Homework – 2.10

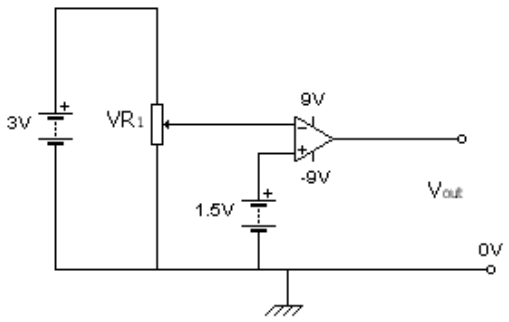
The system below is used to position an aerial remotely by adjusting V_{r1} to the required set position causing the aerial to move correspondingly.



(a) Sketch a suitable buffer amplifier which will meet the requirements of this system.
(b) Identify the amplifier configuration and describe how this system operates.

Homework – 2.11

An op. Amp is connected as shown below.



(a) Name the op. Amp configuration.
(b) Explain what happens to V_o as R_1 is adjusted from 0 - R_1.
(c) Show on a sketched graph how the value of V_{out} varies as R_1 is adjusted.