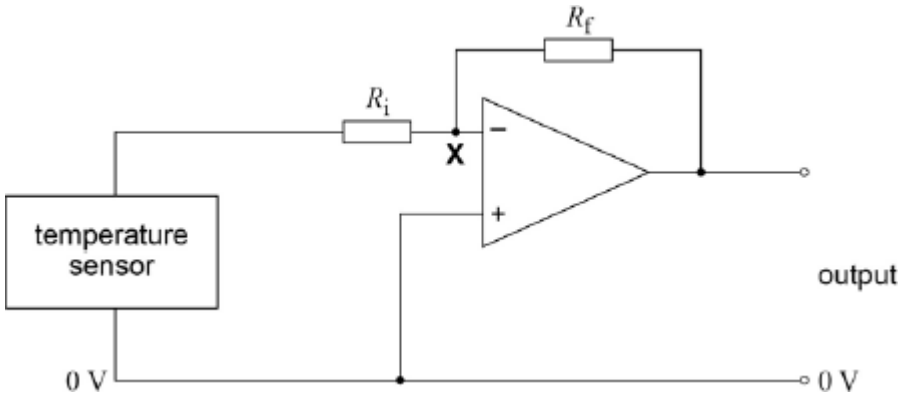
Q1.Figure 1 shows a circuit that includes an ideal operational amplifier. A student uses this circuit to amplify the signal from the sensor before further processing by the system.

Figure 1



(a) Point X in **Figure 1** is said to be a virtual earth.

Explain the meaning of the term virtual earth in this type of circuit.

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(2)

(b) The temperature sensor produces a signal that changes by 10 mV for every degree Celsius change in temperature. The signal is 0 mV when the temperature of the sensor is 0 °C

The value of R_i is 22 kΩ and the value of R_f is 270 kΩ.

Calculate the output voltage V_{OUT} of the circuit in **Figure 1** when the sensor is at a temperature of 50 °C.

V_{OUT} = ... V

(2)

(c) The circuit is powered by a -15 V - 0 - +15 V supply. Explain why this circuit will not detect temperatures above 122 °C.

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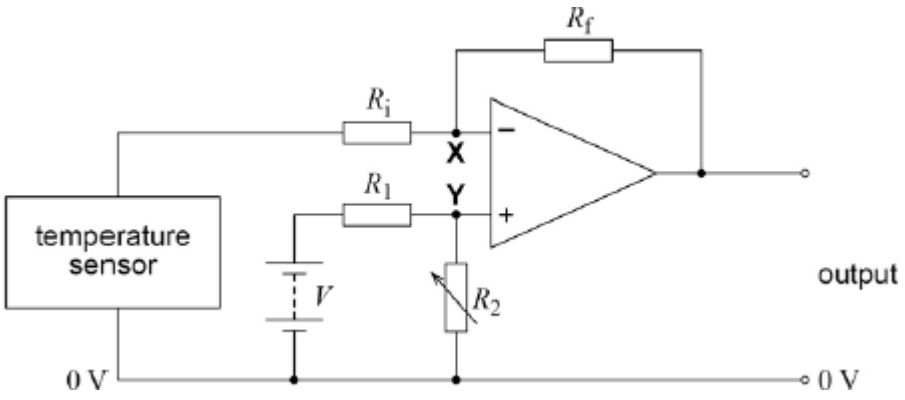
(2)

(d) A student suggests a modification to the circuit in **Figure 1** to form a difference amplifier circuit for a thermostat. The modified circuit is shown in **Figure 2**.

Figure 2



The output controls a circuit that switches the heater off when the output is positive.

Explain how this circuit operates so that the heater switches off when the temperature reaches a pre-determined level.

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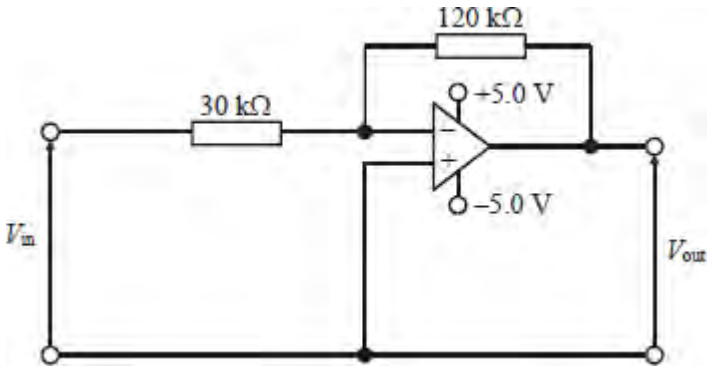
(3)
(Total 9 marks)

Q2. The diagram below shows an op-amp used in an amplifier circuit.



(a) Name the type of amplifier circuit shown. .....

(1)

(b) Calculate the output voltage V_{out} when the input voltage V_{in} = 0.50 V.

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(2)

(c) The input is now connected to a sinusoidal source of rms output 2.0 V and frequency 50 Hz.

(i) Calculate the peak input voltage.

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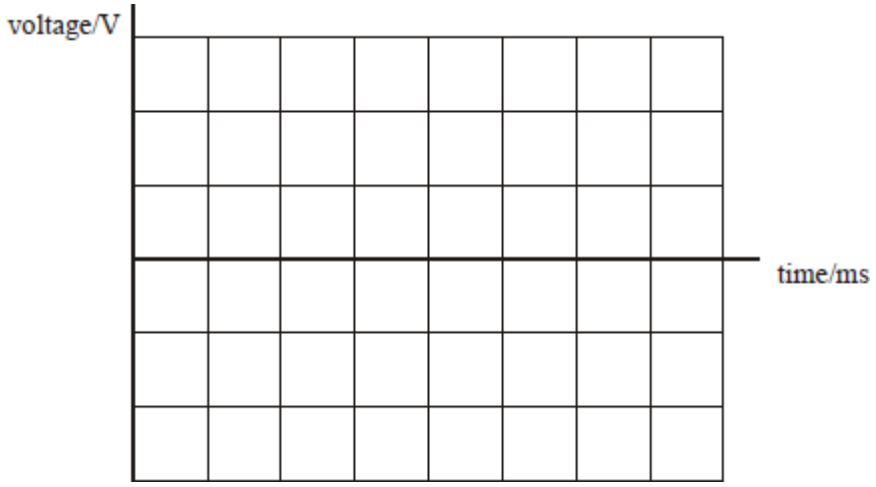
(ii) On the axes below draw a trace showing **two** cycles of the input signal and label it **A**.

On the same axes, draw the **two** corresponding cycles of the output signal and label it **B**.

Add suitable scales to the axes.



(6)
(Total 9 marks)