

Q1. The circuit shown in **Figure 1** uses an ideal op-amp as a voltage comparator. It is used in a frost warning device in which the LED lights when the temperature falls to 0°C. **Figure 2** shows the variation of resistance with temperature of the thermistor.

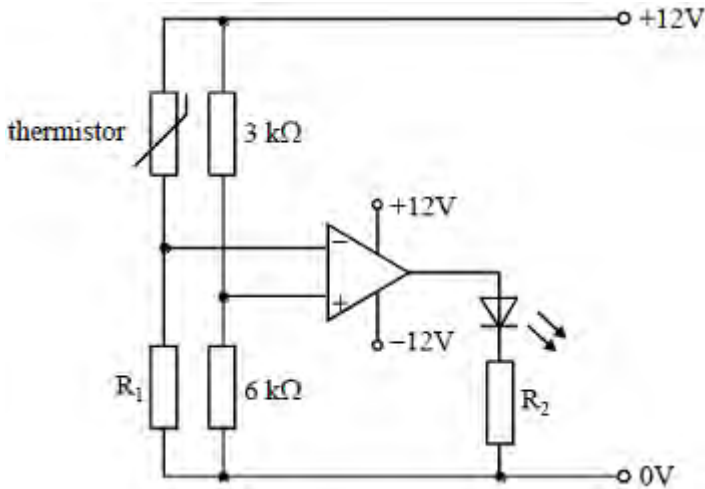


Figure 1

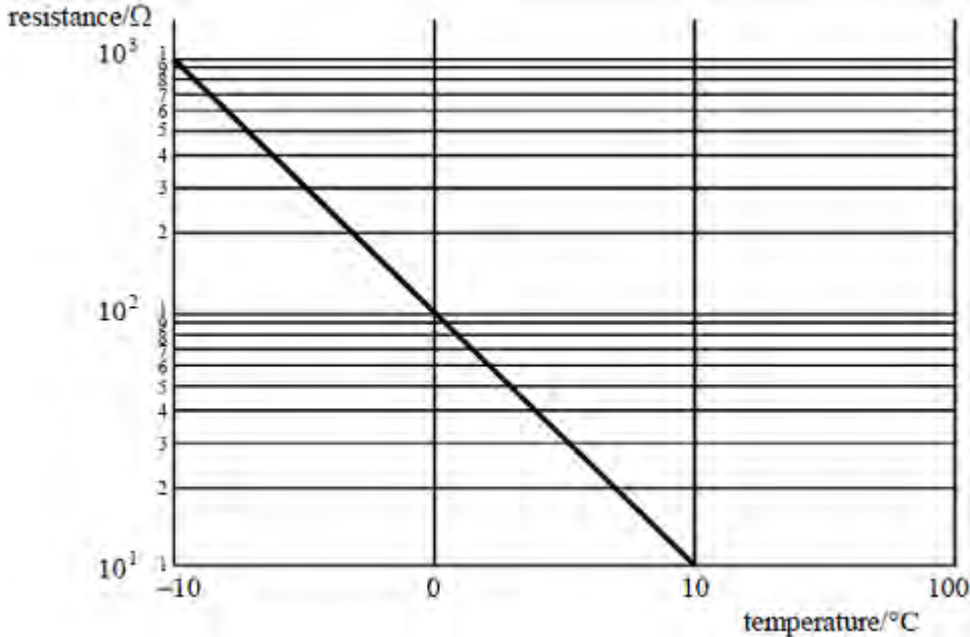


Figure 2

(a) Calculate the voltage at the non-inverting input of the op-amp.

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(1)

(b) Calculate the resistance of R_1 to allow the output to switch at 0°C .

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(2)

(c) When the LED is on, the current through it is 20 mA and the p.d. across it is 2.0 V.

Calculate

(i) the resistance of resistor R_2 ,

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(ii) the power dissipated in this resistor.

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(4)

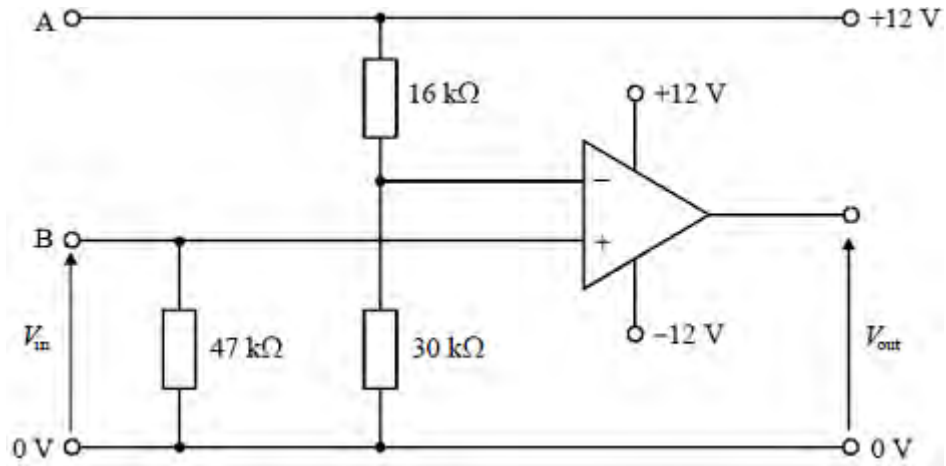
(d) In practice, what value of resistor from the E24 series should be used for R_2 ?

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(1)

(Total 8 marks)

Q2. In the circuit shown, an ideal operational amplifier is used as a voltage comparator.



- (a) The voltage V_{in} is steadily increased from 0 V. Calculate V_{in} when the sign of V_{out} changes from negative to positive.

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(2)

- (b) (i) The op-amp is required to operate an LED. Add to the circuit an LED and its limiting resistor so that the LED lights when V_{in} is less than the value calculated in part (a).

- (ii) Explain why the LED functions in the position you have drawn it.

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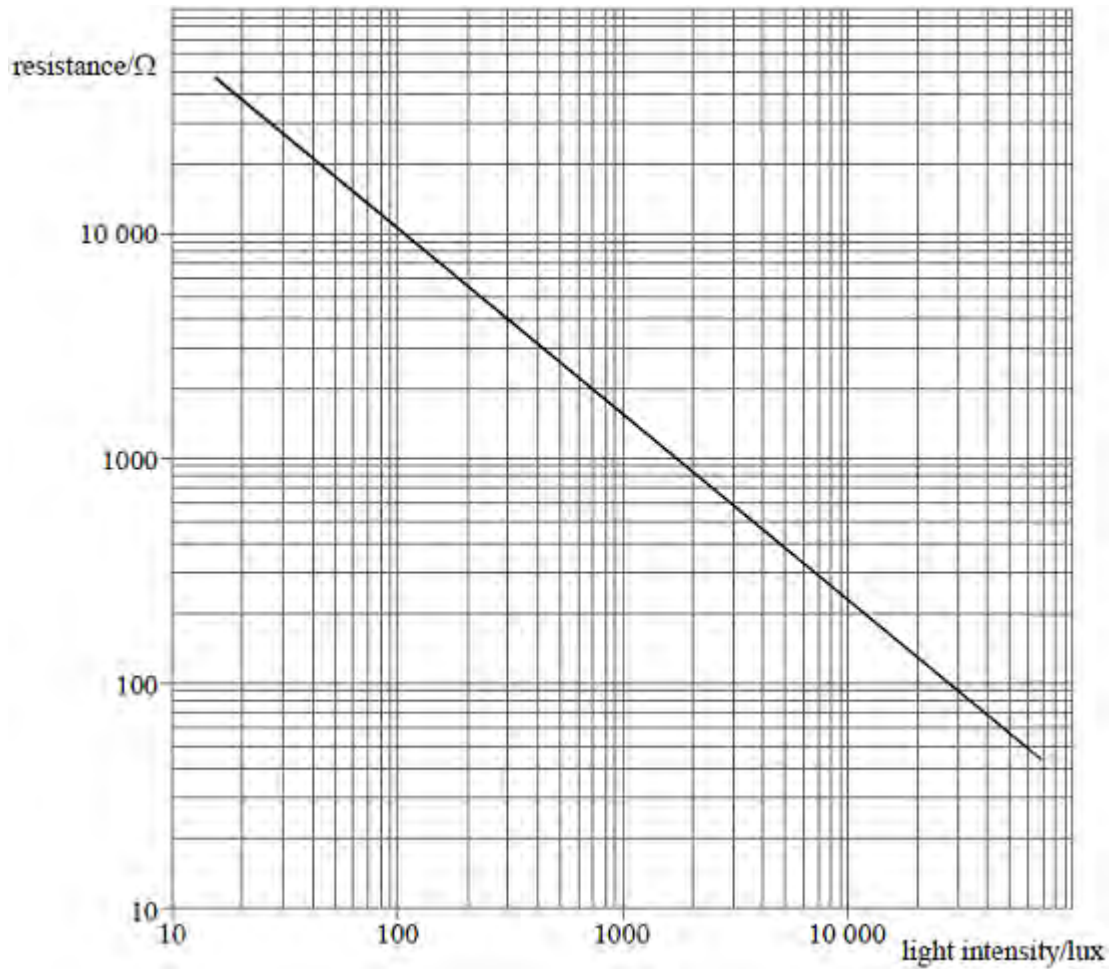
- (iii) Calculate the minimum value for the limiting resistor with the LED. Assume that the LED has a voltage drop of 2.0 V across it when emitting and a maximum current of 25 mA through it.

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(5)

- (c) An LDR is now connected between the points A and B in the circuit. The characteristic of the LDR is shown below.



Determine the light intensity at which the LED switches.

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(3)

Q3.(a) State **two** characteristics of an operational amplifier.

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(2)

(b) (i) Draw a circuit diagram showing an operational amplifier used as an inverting voltage amplifier.

(ii) Give suitable values for the components you have used in the circuit for a voltage amplification of magnitude 150.

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(4)

(c) When *negative feedback* is used with an amplifier the bandwidth increases.

(i) Explain what is meant by negative feedback as applied to the circuit drawn in part (b).

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(ii) Give **one** other advantage of using negative feedback in this application.

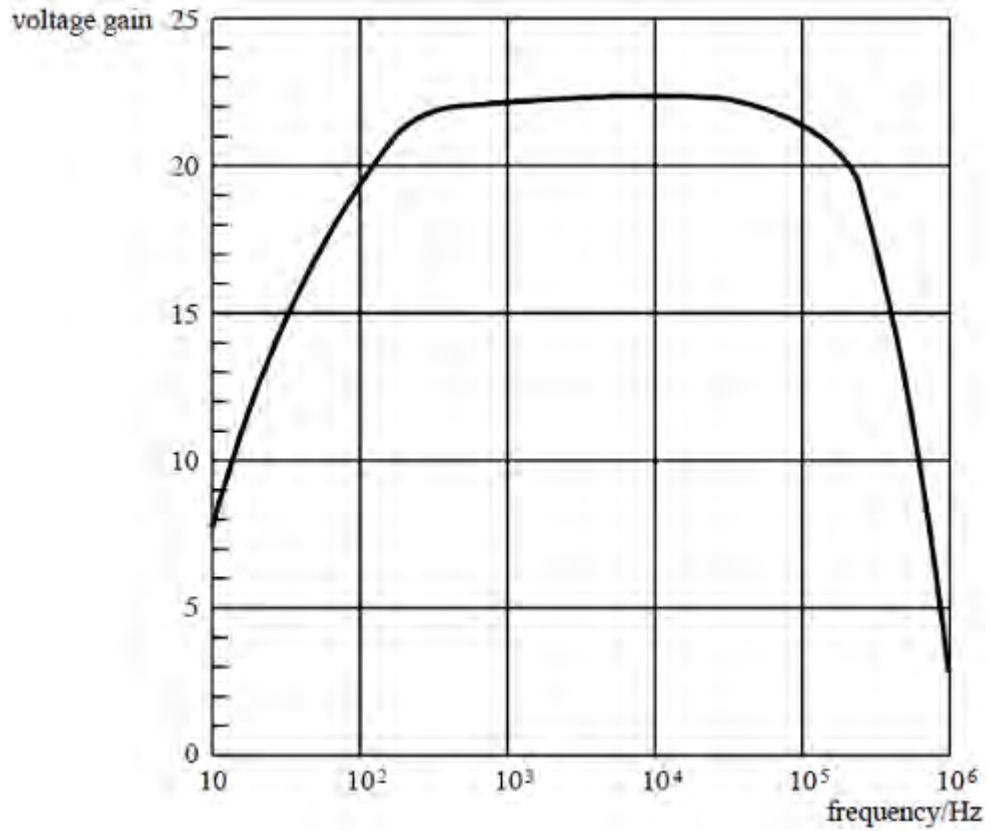
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(iii) State what is meant by the bandwidth of an amplifier.

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(iv) Indicate on the graph below, by means of a horizontal line, the bandwidth of the amplifier whose characteristic is shown.

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(5)
(Total 11 marks)