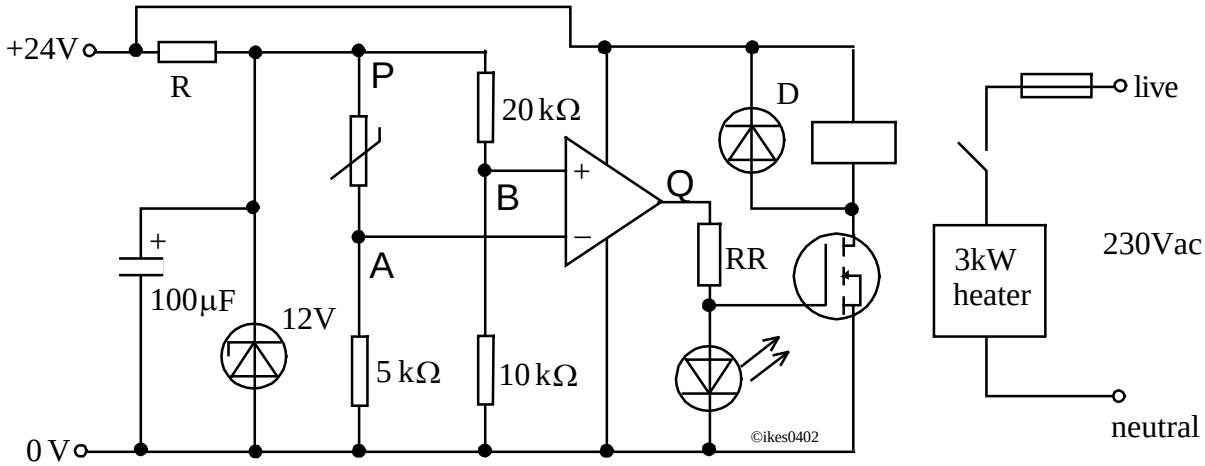
Sensor, Op-amp comparator, and output revision.

1). For growing tropical plants it is necessary to ensure that the greenhouses are maintained at a minimum temperature at all times. An electronic systems is used to achieve this. The circuit diagram of the system used is shown below.



(a) Mark onto the circuit diagram above the following sub-systems:

(i) a voltage regulator sub-system,
(ii) an input sub-system,
(iii) a voltage divider sub system,
(iv) an output sub-system
(v) a comparator sub-system.

(5)

(b) (i) Explain why the voltage at point P is 12V.

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(1)

(ii) The 12V zener diode has a maximum power rating of 400mW. Calculate the maximum current that can pass through this diode.

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(2)

(iii) Calculate the minimum value for resistor R.

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(2)

(iv) Explain what value resistor you would choose from the E24 series.

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(2)

(v) Calculate a suitable power rating for this resistor.

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(2)

(c) Using the graph of the characteristic of the thermistor, state the resistance of the thermistor at the following temperatures:

(i) 10ºC .....

(ii) 20ºC .....

(iii) 25ºC .....

(iv) 40ºC .....

(v) 50ºC .....

(5)

(d) (i) Calculate the voltage at point B.

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(2)

(ii) State, with a reason, the voltage at point A that will make the output of the op-amp change state.

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(2)

(iii) State, with a reason, the resistance of the thermistor that will make the output of the op-amp change state.

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(2)

(iv) State, with a reason, the temperature of the thermistor that will make the output of the op-amp change state.

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(2)

(v) State and explain two reasons why an op-amp makes such an effective comparator.

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(2)

(e) (i) State, with a reason, the voltage at Q when the thermistor is at a temperature of 22ºC.

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(2)

(ii) The LED emits blue light when the voltage at Q is 24V. Estimate the voltage at the gate of the MOSFET when the LED is lit.

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(1)

(iii) The maximum current that can pass safely through the LED is 30mA. Calculate a suitable value for the resistor RR.

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(2)

(f) (i) Label the relay in the circuit diagram with the word *relay*.

(1)

(ii) State and explain *three* reasons why a relay is used in this system.

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(3)

(iii) Explain why the relay cannot be connected directly to the output of the op-amp

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(1)

(iv) State and explain *three* reasons why a MOSFET makes an ideal output buffer.

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(3)

(v) Explain the purpose of the diode labelled D.

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(2)

(g) (i) Calculate the current that relay contacts must switch.

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(2)

(ii) Explain whether the relay contacts should be NO or NC types.

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(2)

(iii) State a suitable value for the fuse.

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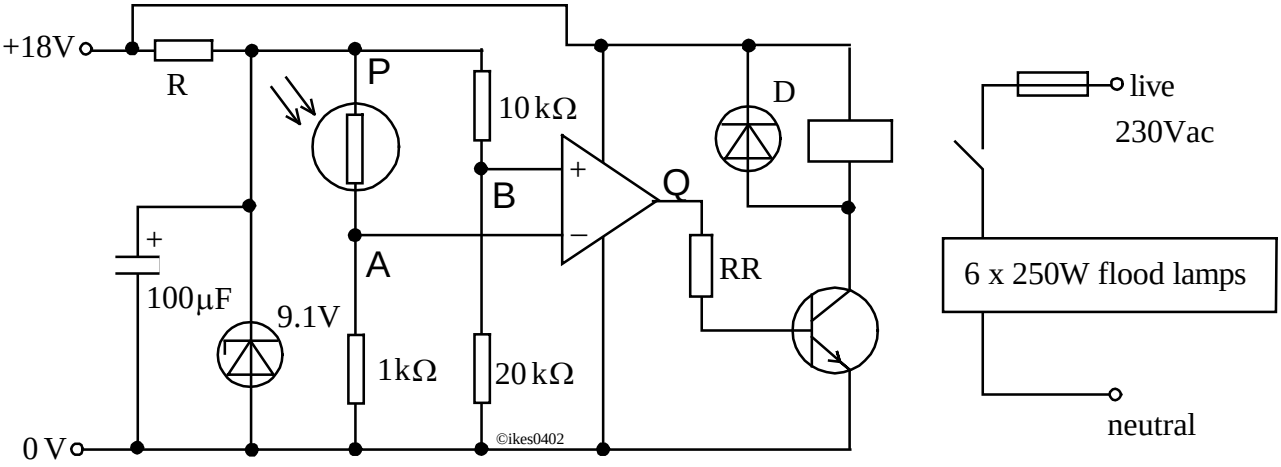
(1)

2). In order to reduce the amount of vandalism occurring a local council decides to install an automatic lighting system which will turn on the street lights around a shopping precinct whenever the daylight falls below a certain level. The circuit diagram of the electronic control system used is shown below.



(a) Mark onto the circuit diagram above the following sub-systems:
(i) a voltage regulator sub-system,
(ii) an input sub-system,
(iii) a voltage divider sub system,
(iv) an output sub-system
(v) a comparator sub-system.

(5)

(b) (i) What is the voltage at point P.

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(1)

(ii) The 9.1V zener diode has a maximum power rating of 400mW. Calculate the maximum current that can pass through this diode.

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(2)

(iii) Calculate the minimum value for resistor R.

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(2)

(iv) Explain what value resistor you would choose from the E24 series.

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(2)

(v) Calculate a suitable power rating for this resistor.

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(2)

(c) Using the graph of the characteristic of the LDR, state the resistance of the LDR at the following light levels:

(i) 10 lux .....

(ii) 70 lux .....

(iii) 200 lux .....

(iv) 1000 lux .....

(v) 4000 lux .....

(5)

(d) (i) Calculate the voltage at point B.

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(2)

(ii) State, with a reason, the voltage at point A that will make the output of the op-amp change state.

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(2)

(iii) State, with a reason, the resistance of the LDR that will make the output of the op-amp change state.

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(2)

(iv) State, with a reason, the light level that will make the output of the op-amp change state.

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(2)

(v) State and explain two reasons why an op-amp makes such an effective comparator.

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(2)

(e) (i) State, with a reason, the voltage at Q when the light level falling onto the LDR is 2000 lux.

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(2)

(ii) What is the approximate base emitter voltage of a transistor that is conducting.

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(1)

(iii) The base current needed by the transistor is 2mA. Calculate a suitable value for the resistor RR.

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(2)

(f) (i) Label the relay in the circuit diagram with the word *relay*.

(1)

(ii) State and explain *three* reasons why a relay is used in this system.

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(3)

(iii) Explain why the relay cannot be connected directly to the output of the op-amp

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(1)

(iv) State and explain *three* reasons why a MOSFET makes a better output buffer than a transistor.

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(3)

(v) Explain the purpose of the diode labelled D.

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(2)

(g) (i) Calculate the current that relay contacts must switch.

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(2)

(ii) Explain whether the relay contacts should be NO or NC types.

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(2)

(iii) State a suitable value for the fuse.

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(1)