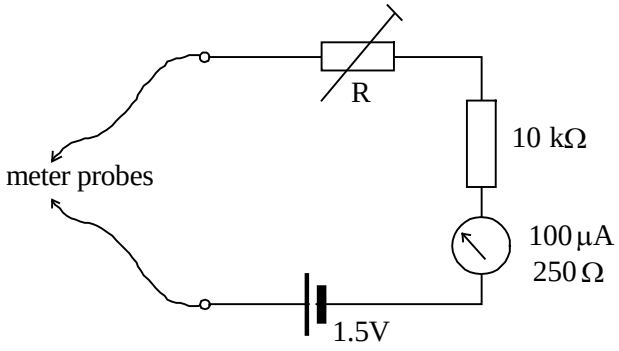
Foundation Module type questions from previous syllabi

1). The circuit diagram of a simple resistance (ohm) meter is shown below.



(a) When the meter leads are connected together the meter is adjusted to read full scale deflection which corresponds to a resistance of 0 ohms.
Calculate the value of R.

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(4)

(b) Calculate the value of the resistor that must now be placed between the meter probes to give a reading on the meter of 50μA.

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(2)

(c) Comment on the linearity of the resistance scale that could be applied to the meter.

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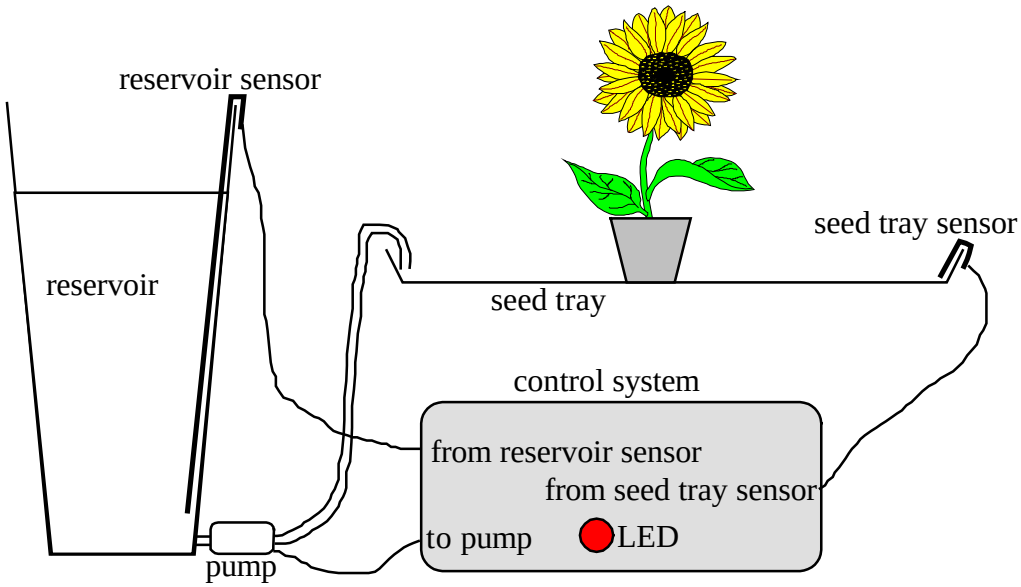
(3)

(9)

2). An automatic watering system for a green house is shown below.



If the seed tray sensor is dry (logic 1) then the pump must be turned on (logic 1) until the seed tray sensor is wet (logic 0). If the reservoir sensor is dry (logic 1) because the reservoir is empty, then the warning LED must be illuminated (logic 1) but the pump must not be turned on even if the seed tray is dry.

Summarise the information given above in the truth table below.

(a)

tray sensor	reservoir sensor	pump	LED
wet	wet		
wet	dry		
dry	wet		
dry	dry		

(2)

(b) Using NAND gates only draw a labelled circuit diagram for this system in the space below.

(4)

(c) A MOSFET is to be used to interface the logic circuit to the pump. What characteristics of a MOSFET make it suitable for this application?

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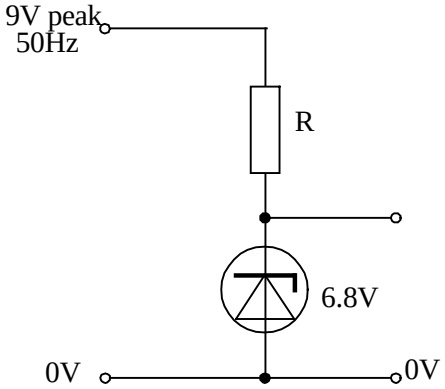
(2)

(8)

3). A 6.8V, 300mW zener diode is connected to an alternating voltage supply of amplitude 9V as shown below.



(a) Calculate a suitable value for R.

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(2)

(b) By considering the characteristic of a zener diode, calculate the peak power dissipated in R in the above circuit.

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(2)

(c) Show that the time period of the supply is 20ms.

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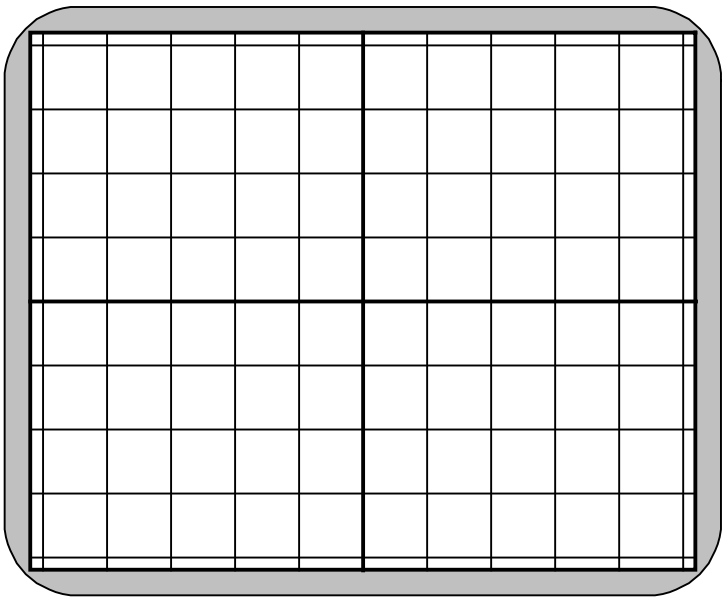
(1)

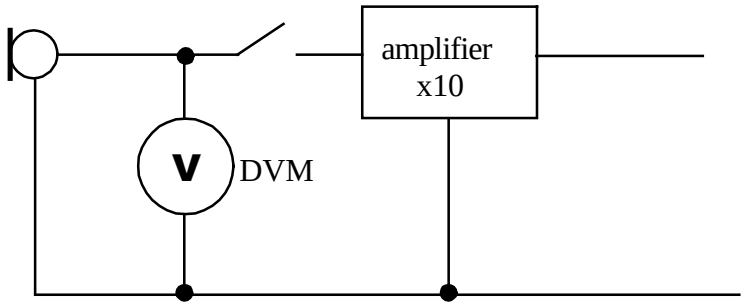
(d) An oscilloscope is connected across the zener diode. The timebase is set to 5ms/div and the y-sensitivity is set to 5V/div Draw on the diagram of the screen below the waveform that you would expect to see



(2)

(7)

4). A microphone has an output resistance of 100kΩ. It is connected as shown in the diagram below. When the switch is open the Digital Voltmeter (DVM) reads 0.5V. When the switch is closed the DVM reads 0.1V.



(a) Calculate the input resistance of the amplifier.

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(4)

(b) Calculate the output voltage from the amplifier.

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(2)

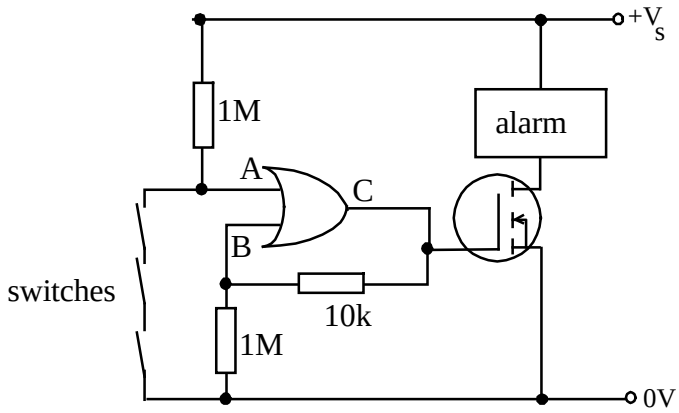
(6)

5). (a) Complete the truth table for a two input OR gate.

A	B	OUT
0	0	
0	1	
1	0	
1	1	

(1)

(b) Such an OR gate is used in the circuit diagram below for an intruder alarm. The *normally closed* (NC) switches are attached to the windows.



Describe what will happen when a window is opened and then closed.

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(5)

(c) Mark onto the diagram a suitable place for a RESET switch.

(1)

(d) Explain why a MOSFET is better suited to this application than a transistor.

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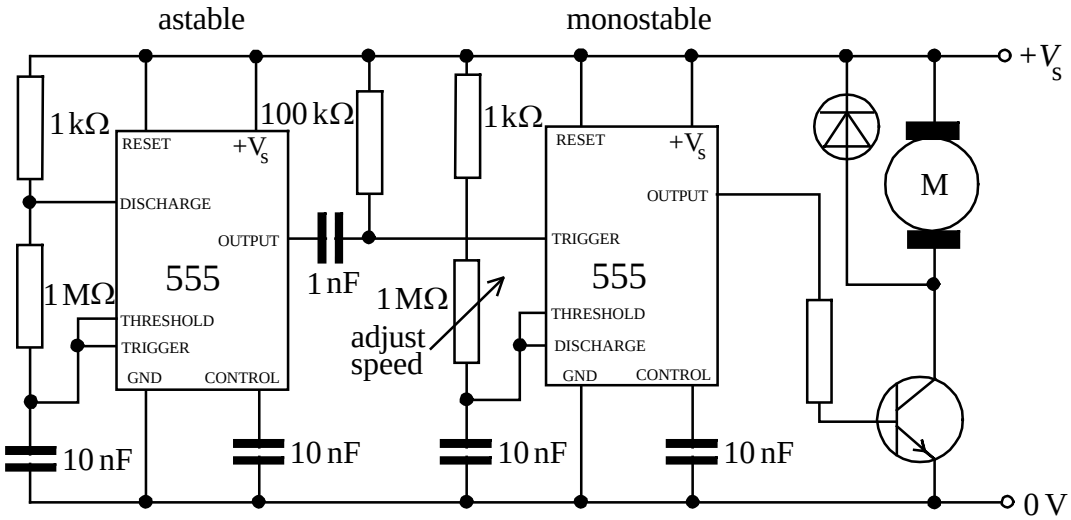
(1)

(8)

6). The circuit shows a motor speed controller consisting of an astable followed by a monostable. The speed of the motor is varied by altering the mark to space ratio of the signal that controls the output transistor.



a) i) Explain what is meant by mark to space ratio.

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(1)

ii) What is the mark to space ratio of the Astable?

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(1)

iii) Calculate the frequency of the astable.

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(2)

b). What is the duration of the longest pulse from the monostable?

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(3)

c). State and explain **one** advantage of this type of motor speed controller compared with a controller which varies the voltage of the power supply to the motor.

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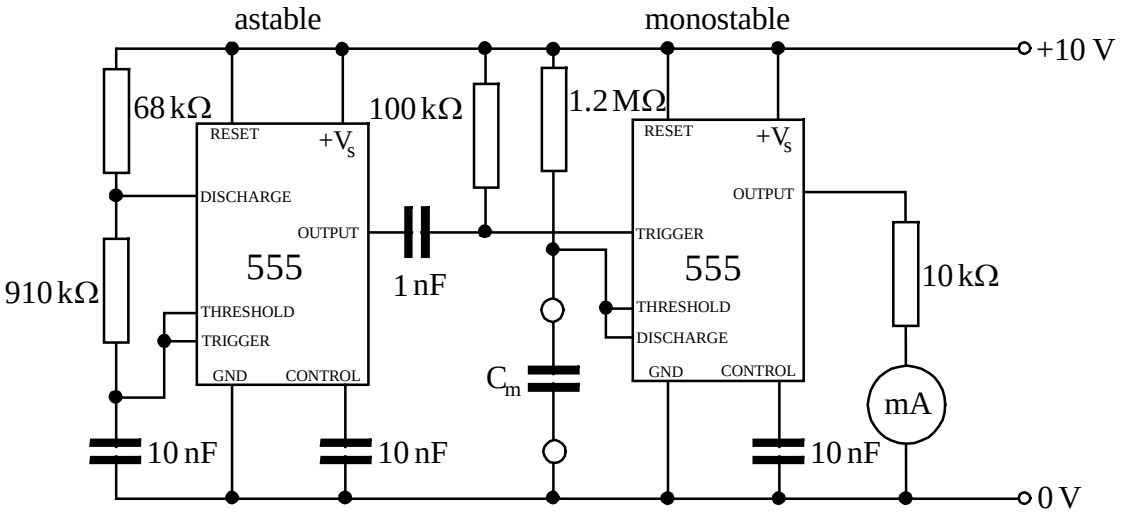
(2)

(9)

7). The circuit diagram is for an instrument to measure capacitance. The capacitor to be measured, C_m, is used as the timing capacitor for the monostable.



a). Calculate the period of oscillation of the astable.

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(2)

b). If the capacitor being measured has a value of 5 nF, what will be the duration of the pulse from the monostable?

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(2)

c). The pulses from the monostable are connected to a 1 mA meter in series with a 10 kΩ resistor. A 100 µF capacitor is connected across the meter.

i). Explain the effect these pulses from the monostable will have on the meter.

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(3)

ii) Estimate the reading obtained on the meter.

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(2)

d). What is the maximum value of capacitor that can be measured on this instrument?

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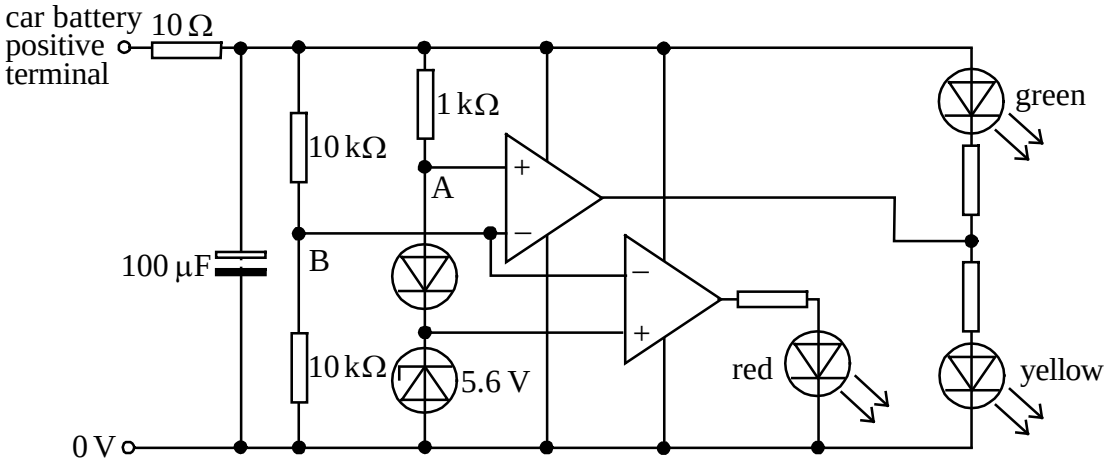
(1)

(10)

8). The circuit shown is for a battery indicator for a car. The state of the battery is indicated by LEDs.
Assume that the voltage across a conducting diode is 0.6V.



a). Explain the function of the 10 Ω resistor and the 100 μF capacitor.

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(2)

b). What is the voltage at point A?

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(1)

c). If the car battery voltage is 10 V, what is the voltage at B?
Explain your answer and state which LEDs are illuminated.

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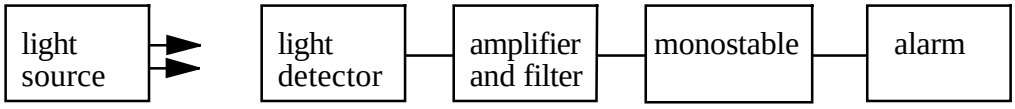
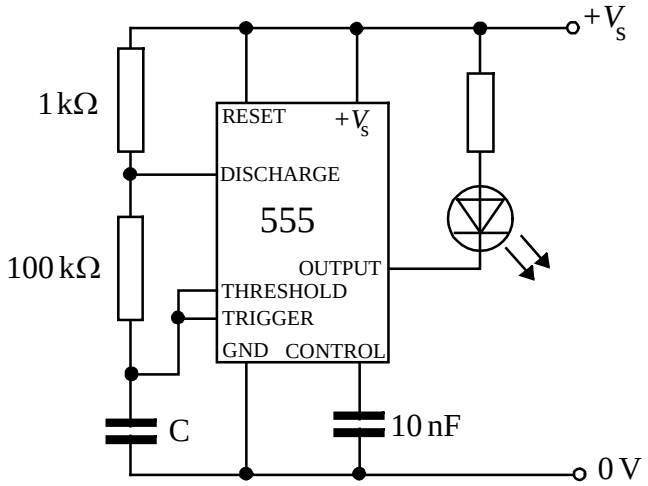
(4)

(7)

9). An intruder alarm uses a narrow beam of light. When the beam of light is interrupted the alarm sounds for 20 s and then resets. The block diagram for the alarm is shown below.



The light source is an ultra bright LED which is switched on and off at a frequency of 1 kHz by a 555 timer IC. The circuit diagram of the light source is shown below.



(a) Calculate the value of C needed to give a frequency of 1 kHz.

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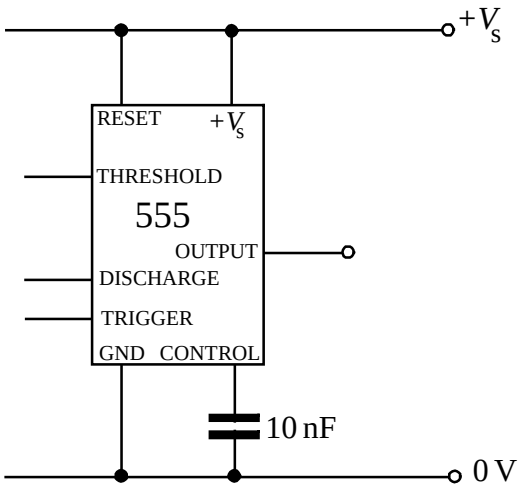
(2)

(b) A 555 is also used as the 20 s monostable. Complete the circuit diagram below by inserting the timing components and show where the input would be connected.



(4)

(c) Give suitable values for the timing components, showing your reasoning.

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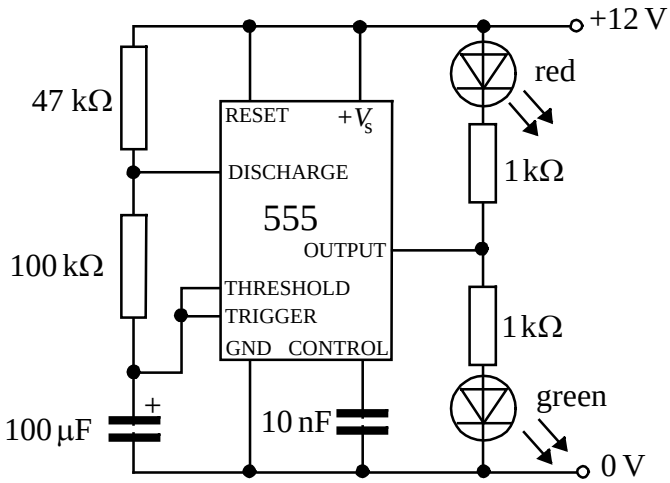
(3)

(9)

10). In the circuit shown, two LEDs are switched on and off alternately. The circuit operates from a 12V supply. The 555 IC alone has a current consumption of 5mA.



(a) Calculate the ON time for the red LED.

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(2)

(b) Calculate the ON time for the green LED.

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(2)

(c) What is the mark-to-space ratio for the red LED?

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(2)

(d) Estimate the maximum current consumption of the circuit.

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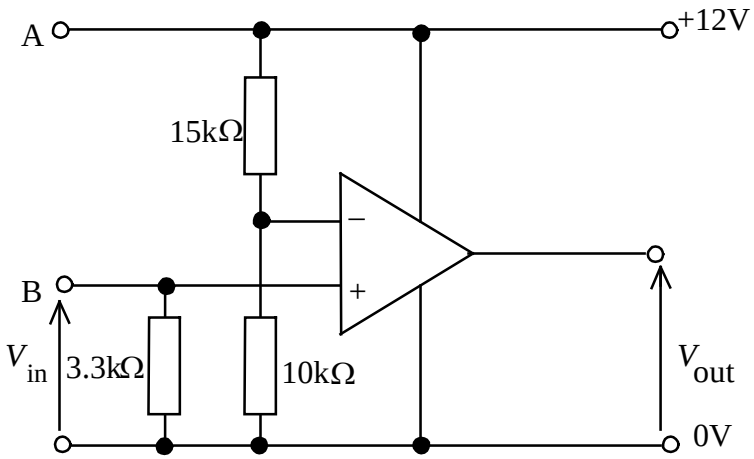
(3)

(9)

11). The diagram below shows the circuit diagram of a comparator using an ideal op-amp.



(a) Calculate the switching level of the comparator.

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(2)

(b) The op-amp is required to operate an LED which can have a maximum current of 30mA at a voltage of 2V.

(i) Draw onto the diagram above the LED and its associated resistor,so that when V_{in} is 6V, the LED is illuminated.

(2)

(ii) Calculate the minimum value for the series resistor for the LED.

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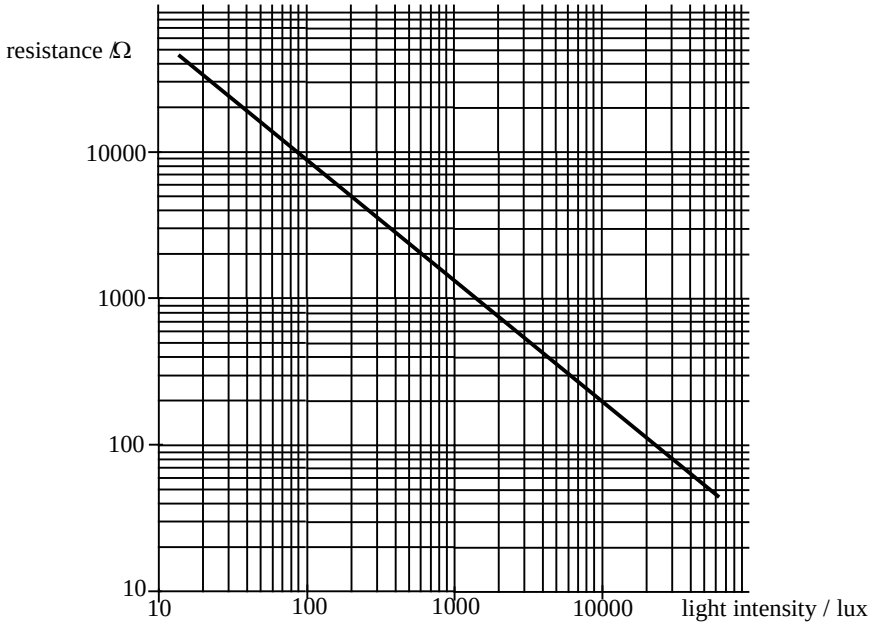
(2)



(d) An LDR, with a characteristic curve as shown in the graph, is now connected between points A and B. What will be the light level at which the LED switches?

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(2)

(8)

12). A burglar alarm for a house allows entry by the front door and does not sound the alarm so long as a correct code is typed onto a keypad within 20s of the front door being opened.

a) Name the type of circuit that can be used to generate a delay.

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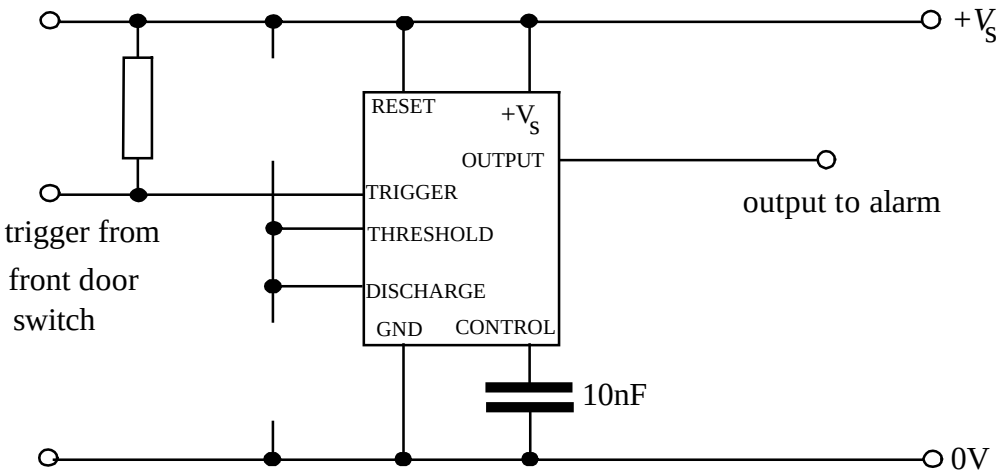
(1)

(b) The delay circuit is to be constructed using a 555 timer ic. A partly drawn delay circuit is shown in the diagram below.
Complete the circuit diagram by correctly adding a 1MΩ resistor and a capacitor.



(2)

(c) Calculate a suitable value for the capacitor that you have added to give this delay.

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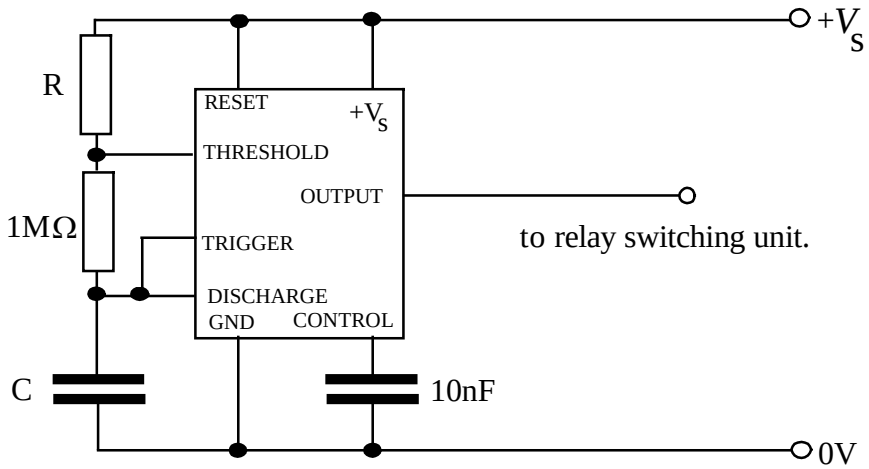
(2)

(5)

13). To reduce the power consumption of a humidity sensor used in a greenhouse it is decided that the humidity sensor will only be switched on for 10 seconds in every minute. A 555 timer IC and relay switching unit are to be used to switch the humidity sensor on and off. The circuit diagram is shown below.



(a). Calculate the require value of C.

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(3)

(b) Calculate the required value of R.

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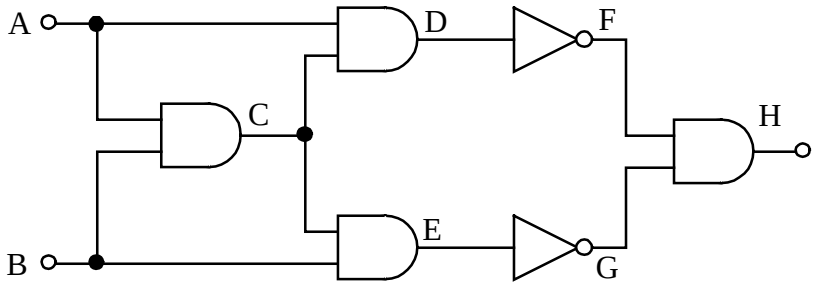
(2)

(c) Draw the circuit diagram of a suitable relay switching unit using a MOSFET, relay and any other components that you need.

(4)

(9)

14). As part of a project a student needs to construct the logic circuit shown below.



(a) Complete the truth table for the circuit shown below.

A	B	C	D	E	F	G	H
0	**0**						
0	**1**						
1	**0**						
1	**1**						

(4)

(b) The student's supervisor feels that this circuit could be simplified and asks the student to redraw the circuit using the least number of gates possible.
Draw in the space below the simplified circuit using the least number of gates.

(1)

(5)