Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced Subsidiary/Advanced

WJEC CBAC

CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Addysg Gyffredinol
Uwch Gyfrannol/Uwch

382/01

ELECTRONICS

ET2

P.M. TUESDAY, 23 May 2006

(1½ hours)

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

For Examiner's use only.	
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

Your attention is drawn to the Information for the use of candidates on page 2 of this paper.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

INFORMATION FOR THE USE OF CANDIDATES

Preferred Values for resistors
The figures shown below and their decade multiples and sub-multiples are the E24 series of preferred values.

10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

RC networks	$V_C = V_O (1 - e^{-t/RC})$	for a charging capacitor
	$V_C = V_O e^{-t/RC}$	for a discharging capacitor
	$t = -RC\ 1n\left(1 - \frac{V_c}{V_o}\right)$	For a charging capacitor
	$t = -RC\ 1n\left(\frac{V_c}{V_o}\right)$	For a discharging capacitor
Alternating Voltages	$V_o = V_{rms}\sqrt{2}$	
Silicon Diode	$V_F \approx 0{\cdot}7V$	
Bipolar Transistor	$h_{FE} = \frac{I_C}{I_B}$	Current gain
	$V_{BE} \approx 0{\cdot}7V$	in the on state
MOSFETs	$I_D = g_M V_{GS}$	
Operational amplifier	$G = -\frac{R_F}{R_{IN}}$	Inverting amplifier
	$G = 1 + \frac{R_F}{R_1}$	Non-inverting amplifier
	$V_{OUT} = -R_F\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$	Summing amplifier
	$\text{Slew Rate} = \frac{\Delta V_{OUT}}{\Delta t}$	Slew rate
555 Monostable	$T = 1{\cdot}1\ RC$	
555 Astable	$t_H = 0{\cdot}7\ (R_A + R_B)C$	
	$t_L = 0{\cdot}7\ R_B C$	
	$f = \frac{1{\cdot}44}{(R_A + 2R_B)C}$	
Schmitt Astable	$f \approx \frac{1}{RC}$	

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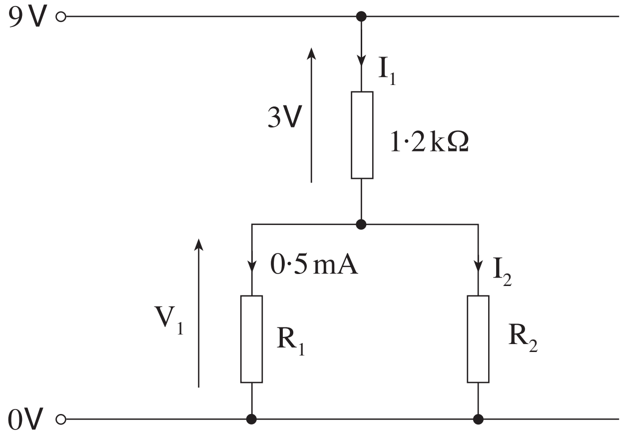
1. Determine the values of I_1, V_1, R_1, I_2 and R_2 in the following circuit.



(a) I_1 ....

....

(b) V_1 ....

....

(c) R_1 ....

....

(d) I_2 ....

....

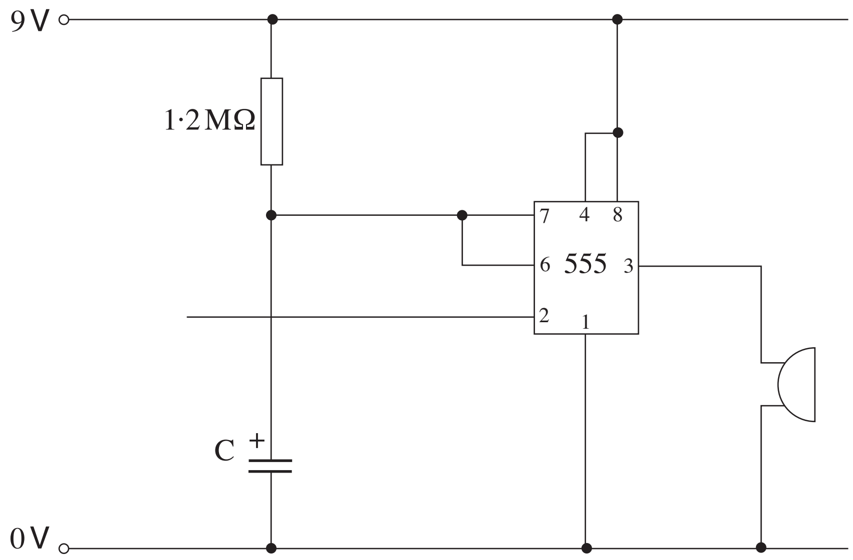
(e) R_2 ....

....

[6]

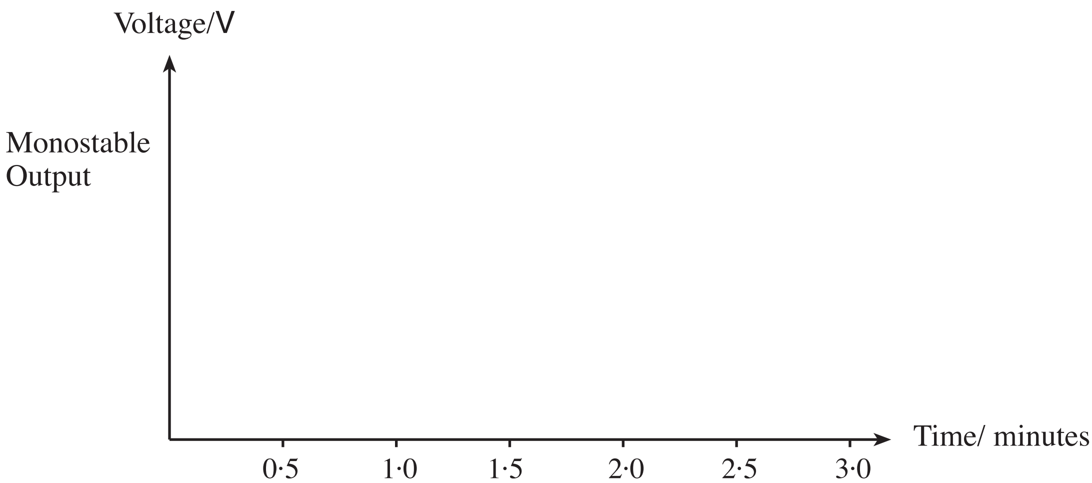
2. A 555 monostable is used in an alarm system. When a push switch is momentarily closed a buzzer sounds for two minutes.

(a) Add a switch and any other necessary component to the diagram below to complete the trigger section of the monostable.



[2]

(b) Draw a sketch to illustrate the shape of the waveform produced at the output of the monostable after the push switch is momentarily pressed. The switch is pressed at time = 1 minute.



[2]

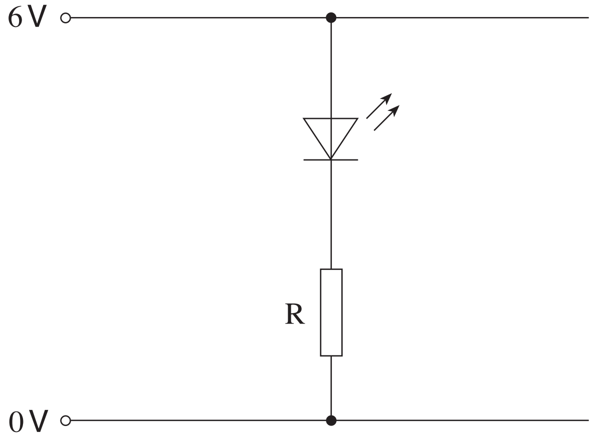
(c) Calculate suitable values for capacitor C to allow the buzzer to come on for two minutes after the push switch is momentarily pressed.

....

....

[2]

3. A ***power on*** indicator for a DC circuit is shown below.



(a) The forward voltage drop across the LED is 2 V.

Calculate the value of resistance required to limit the current through the LED to maximum of 20 mA.

....

....

[2]

(b) The 6 V DC supply is replaced with a 6 V rms AC supply. The new arrangement provides a *power on* indicator for an AC circuit.

(i) **Add a single component** to the circuit diagram allowing the LED to light while protecting it.

(ii) Estimate the new value for resistor R required to provide approximately the same level of illumination as the DC *power on* indicator.

....

[3]

Turn over.

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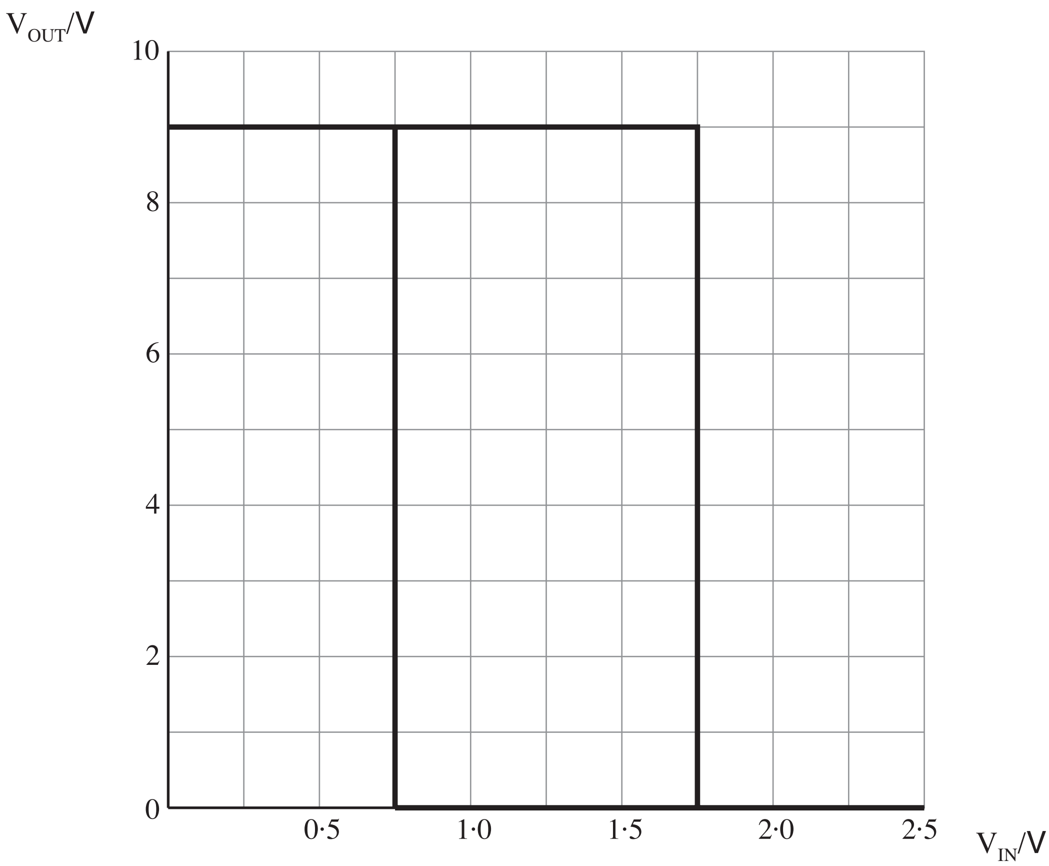
4. *(a)* The graph below shows the switching characteristic of a Schmitt inverter as the input voltage is gradually increased from 0 V to 2·5 V and then decreased back to 0 V.

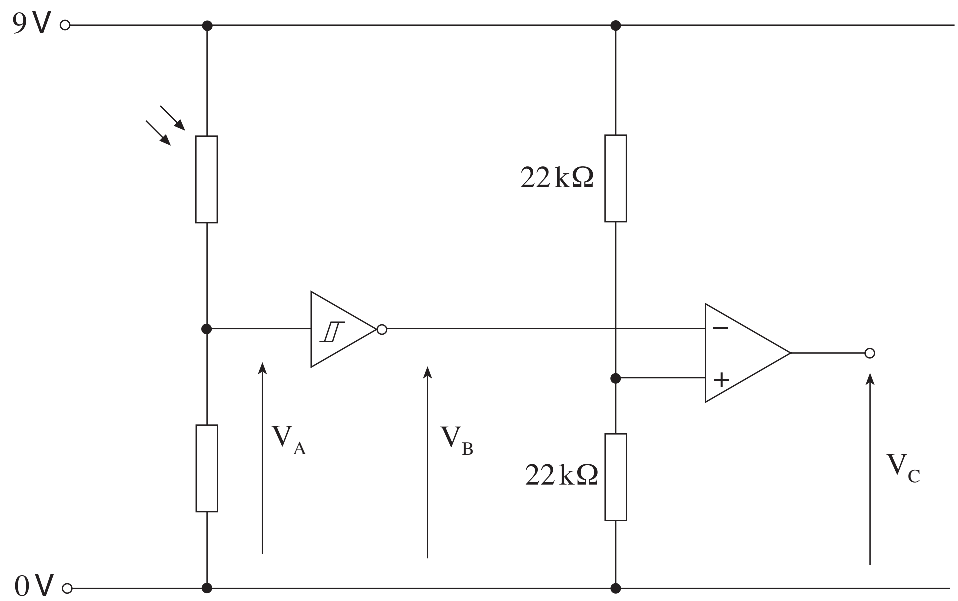


Determine the input switching threshold for

(i) An increasing input voltage ....

(ii) A decreasing input voltage .... [2]

(b) The Schmitt inverter and a comparator are used to interface a light sensor to a logic system. The comparator output saturates at 9 V and 0 V.



(i) The voltage V_A is increased from 0·3 V to 2·2 V. What are the corresponding values of voltages V_B and V_C?

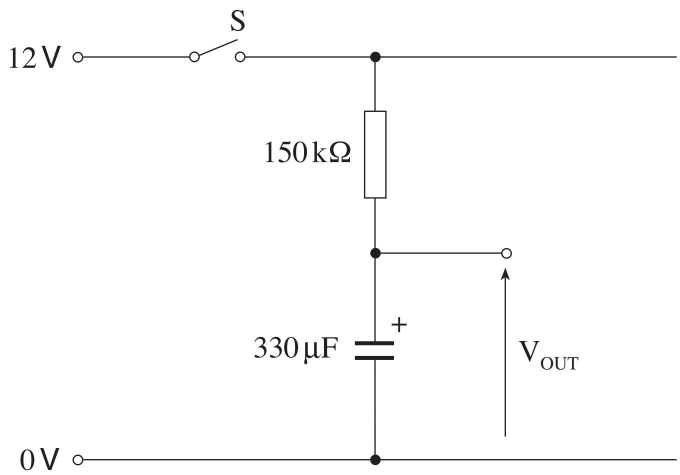
....

(ii) The voltage V_A is now decreased from 2·2 V to 1·2 V. What are the corresponding values of voltages V_B and V_C?

....

[3]

5. The capacitor shown in the following circuit is initially discharged.



(a) Calculate the time constant of the circuit.

....

....
[2]

(b) Switch S is closed at time t = 0.

(i) Determine the time taken for V_{OUT} to reach 6 V.

....

....
[2]

(ii) Calculate the value of V_{OUT} at time t = 10 s.

....

....

....
[2]

(iii) Estimate V_{OUT} 300 seconds after switch S is closed.

....
[1]

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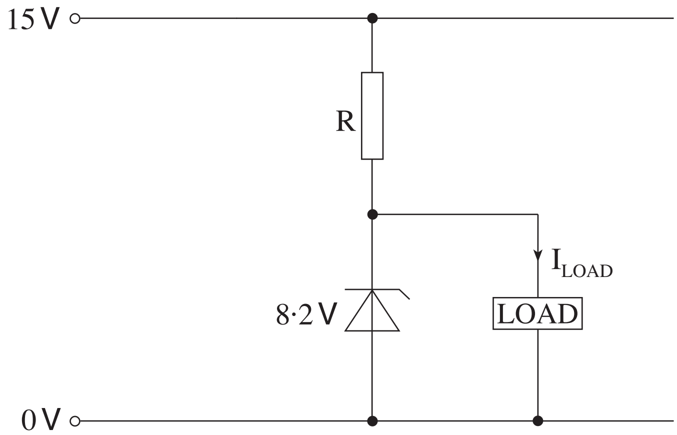
6. The following diagram shows a simple stabilised power supply. The 8·2 V zener diode requires a current of at least 10 mA to maintain the zener voltage.



The power supply **must** be able to supply a load current, I_{LOAD}, of 60 mA.

(a) Calculate the maximum **ideal** value of resistor R to allow a load current of 60 mA.

....

....

....

[2]

(b) The current through the load is 60 mA. Suddenly, the load is disconnected from the power supply.

(i) What is the new value of the current through the zener diode?

....

(ii) Calculate the power dissipated in the zener diode after the load is disconnected.

....

....

[3]

(c) Select the preferred value of resistor that you would use for R from the E24 series. Give a reason for your choice.

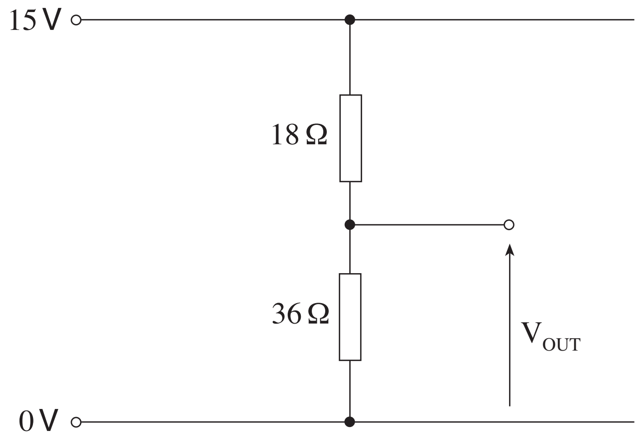
....

....

[1]

Turn over.

7. The following circuit is used as a voltage source.



(a) Thevenin's theorem is used to produce an equivalent circuit.

(i) Calculate the open circuit voltage V_{OC}.

....

....

(ii) Calculate the short circuit current I_{SC}.

....

....

(iii) Calculate the equivalent resistance R_O.

....

....

[3]

(b) (i) Draw the equivalent circuit with a load resistance of 48 Ω connected across the output terminals.

[1]

(ii) Use the equivalent circuit to calculate the voltage drop across the output terminals.

....

....

....
[2]

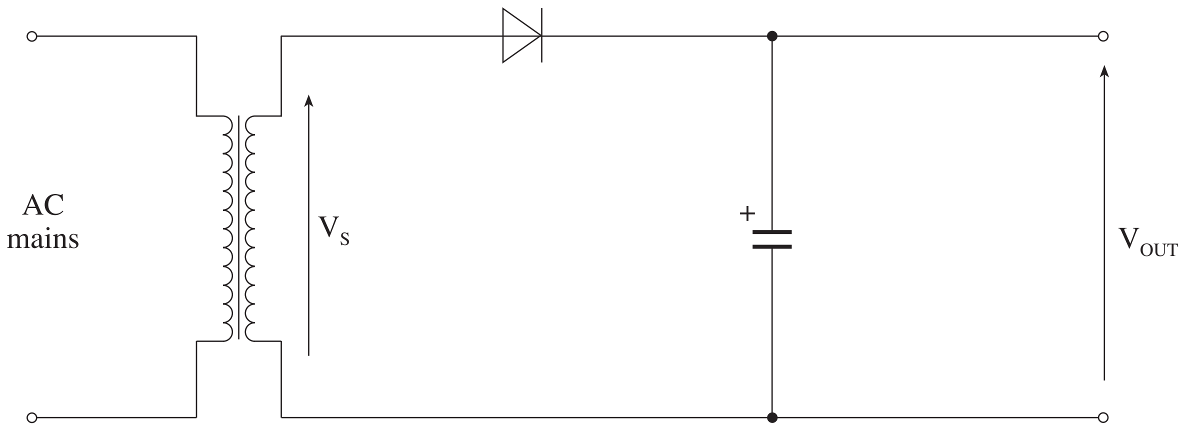
(c) A second 48 Ω resistance is connected in parallel with the original 48 Ω load resistance. Calculate the new voltage drop across the output terminals.

....

....

....
[2]

8. The following diagram shows a smoothed half-wave-rectified power supply.



(a) The rms value of the secondary voltage, V_S , is 9 V. Calculate the **peak value** of:

(i) the secondary voltage,

....

....
[1]

(ii) the voltage V_{OUT}.

....
[1]

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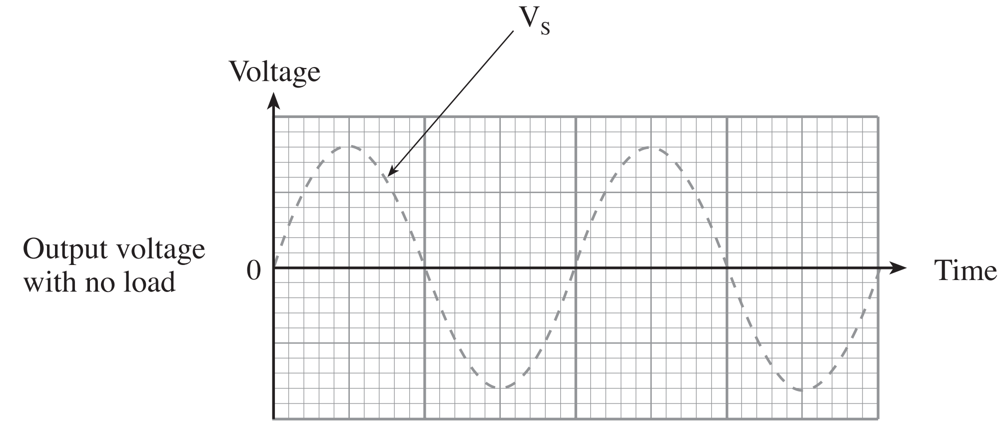
(b) On the axes provided below, sketch a graph to show the voltage V_{OUT} when

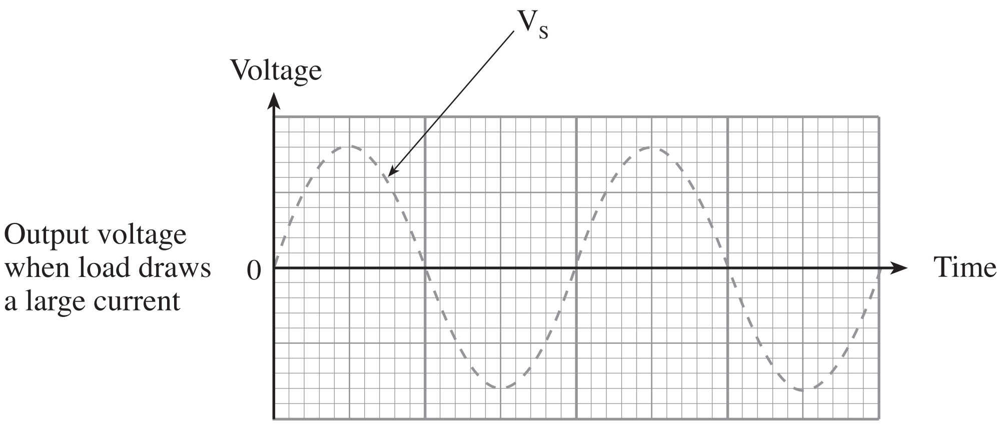
(i) there is no load connected

(ii) a load that draws a large current is connected to the output.

Label the axes with any relevant voltages.

The voltage across the secondary windings of the transformer is shown as a dotted waveform.





[3]

(c) The half-wave rectifier is replaced with a full-wave rectifier.

The mains frequency is 50 Hz. What is the frequency of the ripple voltage produced?

.... [1]

Turn over.

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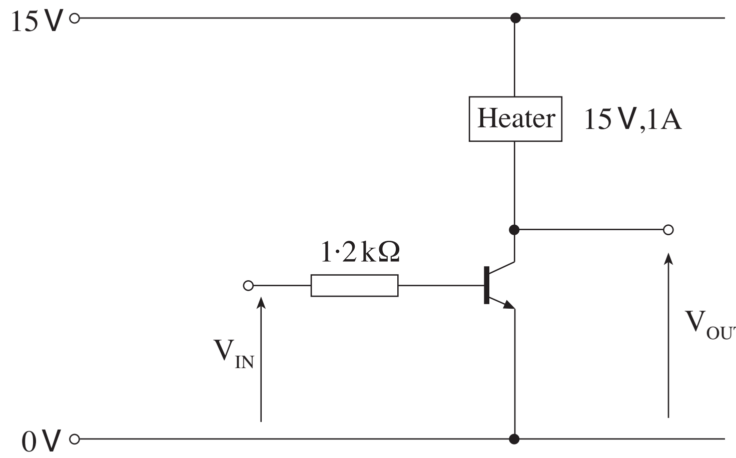
9. The transistor shown in the following switching circuit has a current gain, $h_{FE} = 250$.



(a) The switching circuit is used to operate the heater when the temperature in an aquarium decreases below a predetermined value.

Add the required input sensing sub-system to the circuit diagram.

[2]

(b) The value of V_{IN} is sufficient **just** to saturate the transistor. Calculate:

(i) the base current,

....

....

[2]

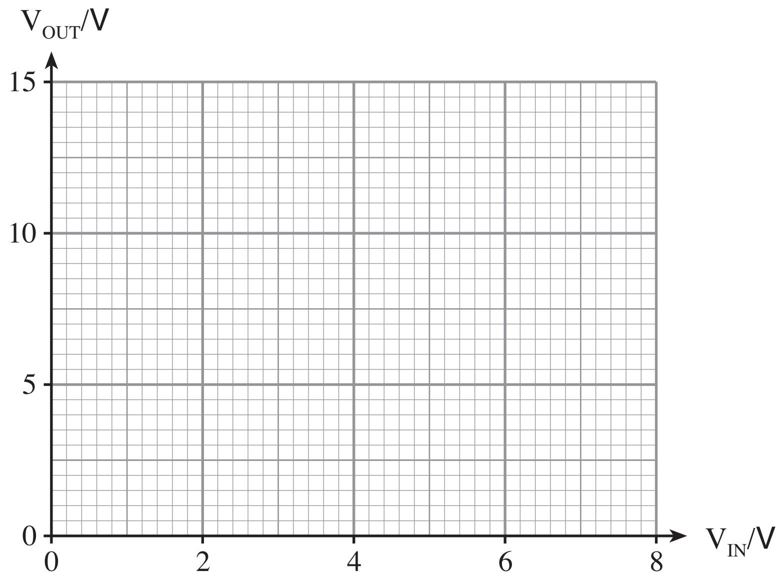
(ii) the value of V_{IN}.

....

....

[2]

(c) Draw a graph to show how V_{OUT} changes as V_{IN} is increased from 0 to 8 V.



[3]

(d) (i) Explain why in some conditions the transistor would overheat.

....

....
[1]

(ii) Why can this problem be overcome if the transistor is replaced with a MOSFET?

....

....
[1]