Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A Level – LEGACY

S18-1142-01

1142/01

ELECTRONICS – ET2

THURSDAY, 24 MAY 2018 – AFTERNOON

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**6**	
2.	**6**	
3.	**9**	
4.	**7**	
5.	**9**	
6.	**8**	
7.	**8**	
8.	**7**	
Total	**60**	

1142
010001

ADDITIONAL MATERIALS

A calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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 total number of marks available for this paper is 60.

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.

You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

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.

Standard Multipliers

Prefix	Multiplier
T	$\times 10^{12}$
G	$\times 10^{9}$
M	$\times 10^{6}$
k	$\times 10^{3}$

Prefix	Multiplier
m	$\times 10^{-3}$
μ	$\times 10^{-6}$
n	$\times 10^{-9}$
p	$\times 10^{-12}$

Charging Capacitor

$$V_C = V_0(1 - e^{-t/RC})$$

$$t = -RC\ln\left(1 - \frac{V_C}{V_0}\right)$$

Discharging Capacitor

$$V_C = V_0\ e^{-t/RC}$$

$$t = -RC\ln\left(\frac{V_C}{V_0}\right)$$

Alternating Voltages

$$V_0 = V_{rms}\sqrt{2}$$

Silicon Diode

$$V_F \approx 0.7\text{ V}$$

Bipolar Transistor

$$h_{FE} = \frac{I_C}{I_B}$$

$$V_{BE} \approx 0.7\text{ V}$$

MOSFETs

$$I_D = g_M V_{GS}$$

555 Monostable

$$T = 1.1\ RC$$

555 Astable

$$t_H = 0.7(R_A + R_B)C$$

$$t_L = 0.7R_BC$$

$$f = \frac{1.44}{(R_A + 2R_B)C}$$

Schmitt Astable

$$f \approx \frac{1}{RC}$$

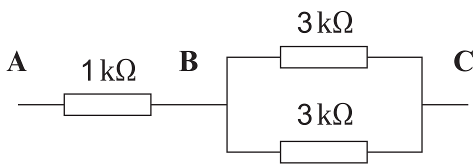
Examiner only

Answer **all** *questions.*

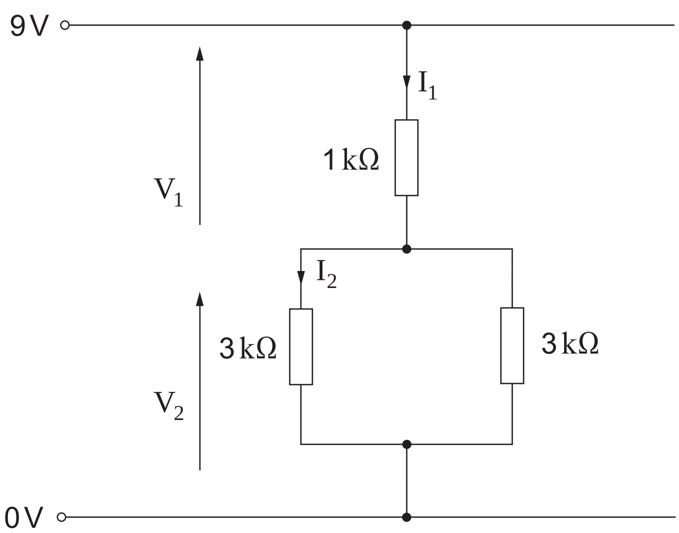
1. *(a)* For the resistor network below calculate the combined resistance between:

Points **B** and **C** ....

Points **A** and **C** .... [2]



(b) The resistor network is used in the following circuit



Determine the value of:

I_1 .... [1]

....

I_2 .... [1]

....

V_1 .... [1]

....

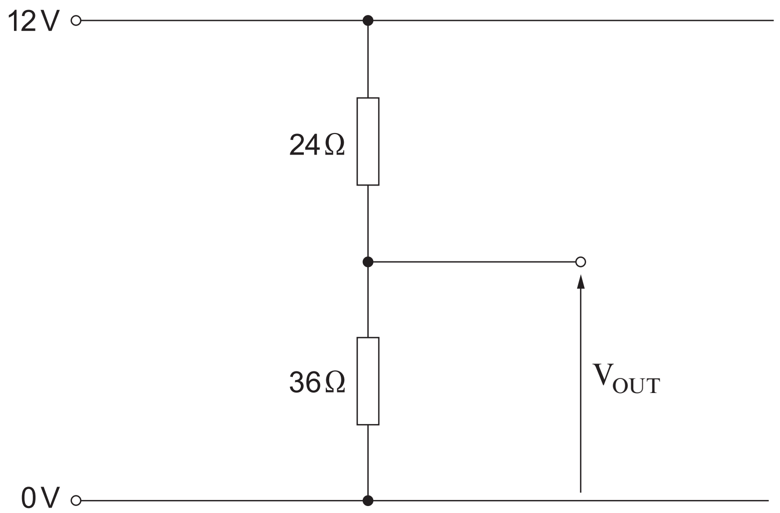
V_2 .... [1]

....

1142
010003

Examiner only

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



(a) Thevenin's theorem is used to produce an equivalent circuit for the voltage source.

(i) Calculate the open circuit voltage V_{OC}. [1]

....

....

(ii) Calculate the short circuit current I_{SC}. [1]

....

....

(iii) Calculate the equivalent resistance R_O. [1]

....

....

Examiner only

(b) (i) Draw the equivalent circuit with a load resistance connected across the output terminals. [1]

(ii) Use the equivalent circuit to calculate the voltage across the output terminals when the load current is 100 mA. [2]

....

....

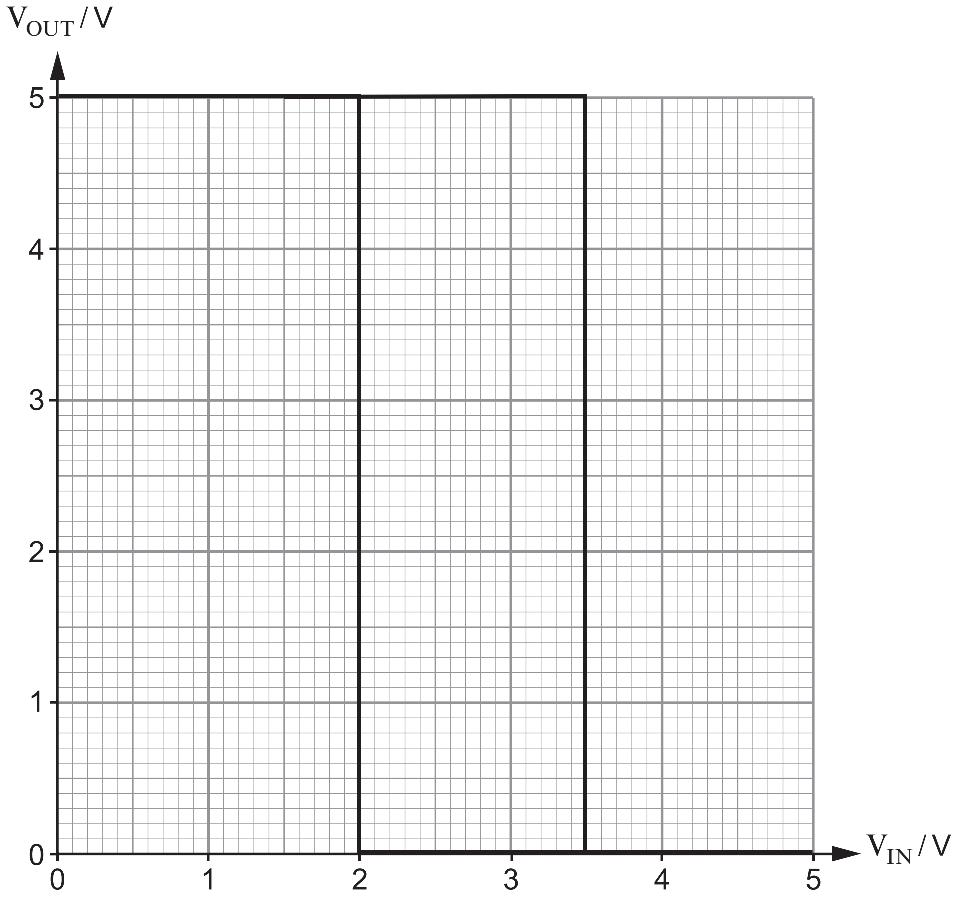
....

....

1142 010005

Examiner only

3. A Schmitt inverter has the following characteristics.



The Schmitt inverter is used to condition the signal produced by a sensing unit.

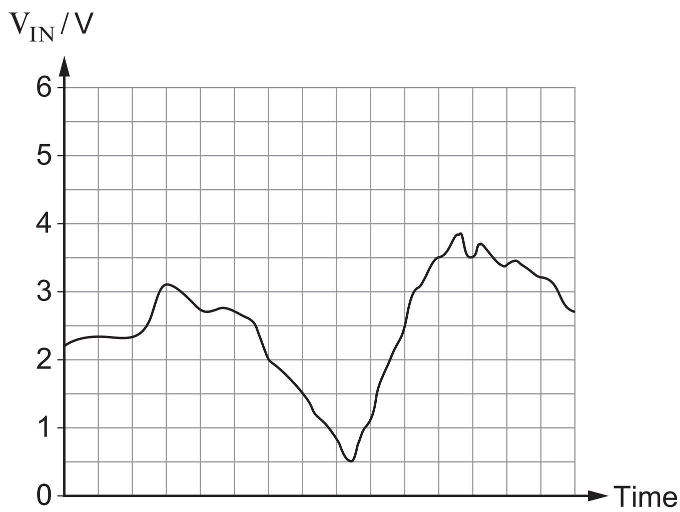
(a) Determine the input switching threshold for:

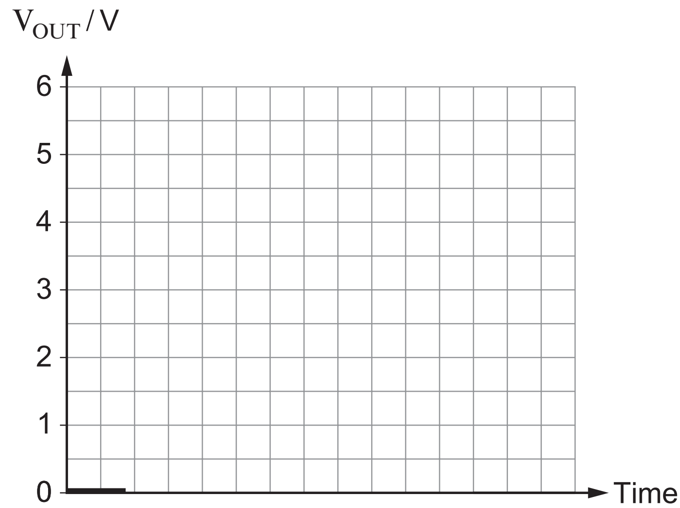
(i) an increasing input voltage .... [1]

(ii) a decreasing input voltage .... [1]

Examiner only

(b) The signal V_{IN} produced by a sensing unit changes over a period of time. Complete the graph to show the signal V_{OUT} obtained at the output of the Schmitt inverter. [3]



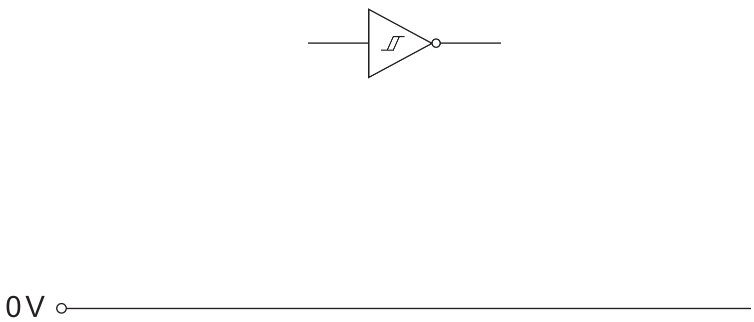


1142 010007

Examiner only

(c) Another Schmitt inverter is used as part of an astable circuit.

(i) Complete the circuit diagram for the astable circuit. [2]



(ii) Calculate the values of all components required to produce a frequency of 500 Hz. [2]

....

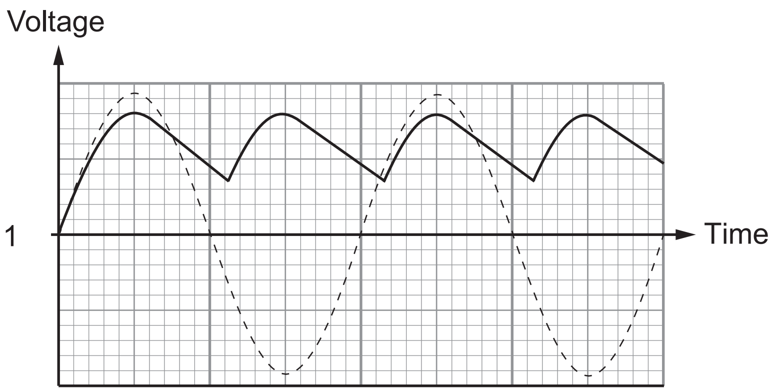
....

1142
010009

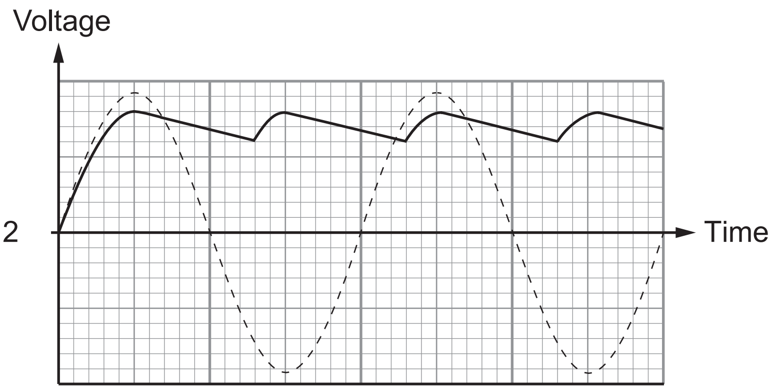
BLANK PAGE

4. *(a)* Here are four waveforms produced by various diode rectifiers. All graphs use identical voltage scales and identical time scales. The AC voltage supplied to the diode rectifier is shown as a dotted waveform.

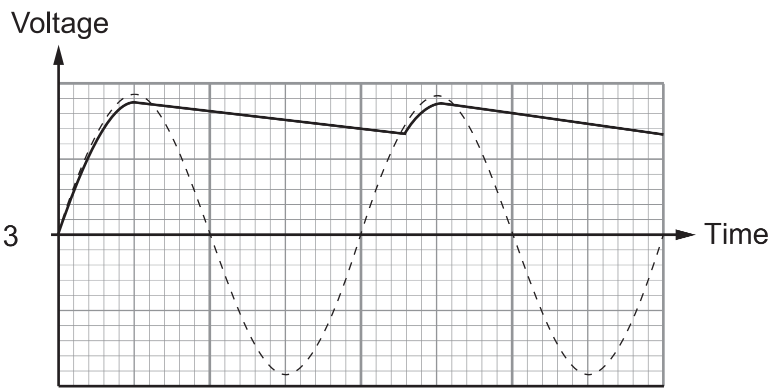
Graph 1



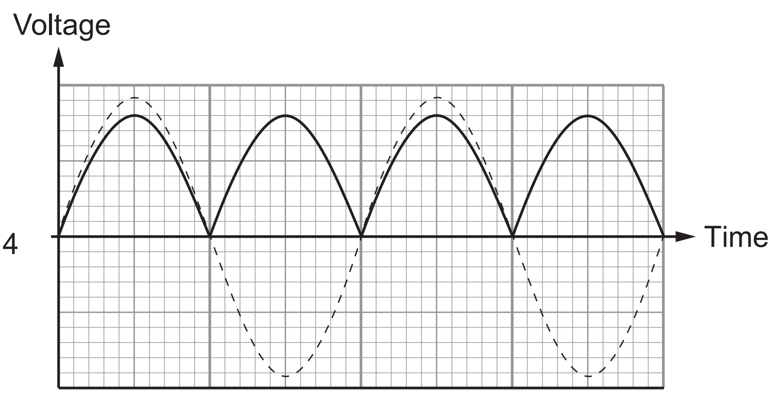
Graph 2



Graph 3



Graph 4



Examiner only

Which graph shows:

(i) The unsmoothed output of a full wave rectifier. .... [1]

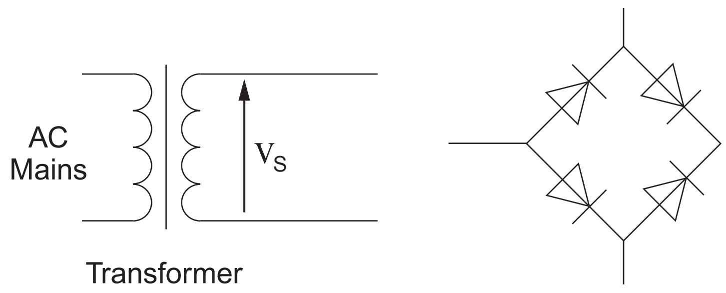
(ii) The smoothed output of a half-wave rectifier with a small ripple voltage. [1]

....

(iii) The smoothed output of a full-wave rectifier with a large ripple voltage. [1]

....

(b) The following diagram shows an incomplete circuit for a full-wave rectified power supply.



(i) Complete the circuit by adding: [3]

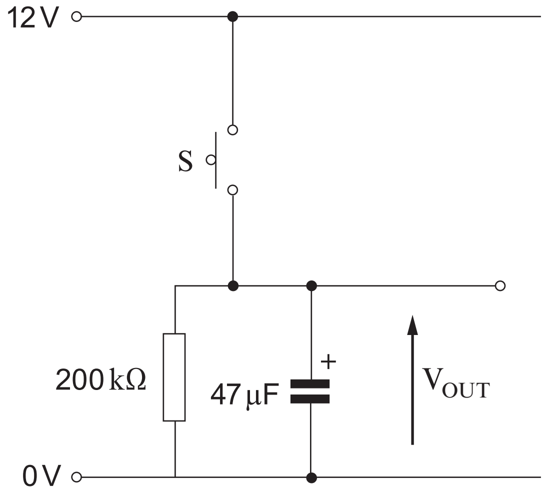
- a smoothing capacitor
- a load resistor
- any missing connections

(ii) The **peak** value of the secondary voltage of the transformer (V_S) is 15 V. Calculate the **peak** value of the full-wave rectified voltage. [1]

....

Examiner only

5. *(a)* The following diagram shows a timing sub-system used in a monostable circuit.



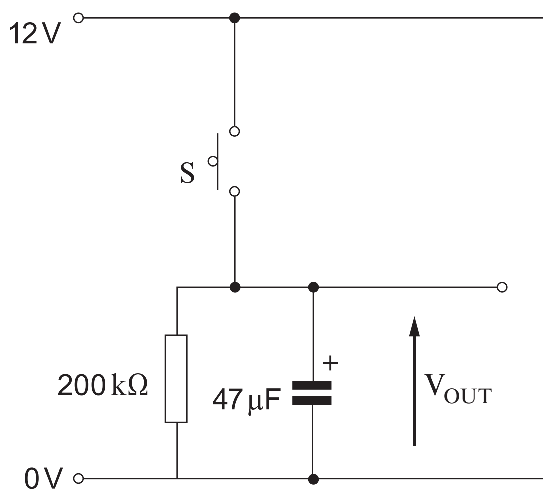
(i) Switch S is closed and then released at time t = 0. Calculate the value of V_{OUT} at time t = 4 s. [2]

....

....

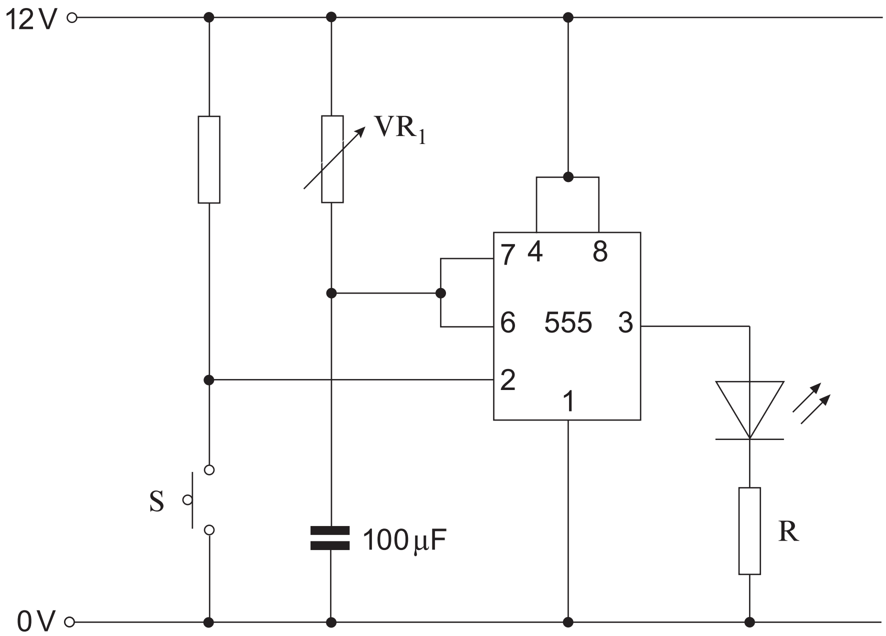
....

(ii) Add a NOT gate and buzzer to the following circuit diagram so that the buzzer comes on for a period of time when switch S is momentarily pressed. [2]



Examiner only

(b) The following diagram shows another type of monostable circuit based on a 555 timer.



The timing sub-system consists of a 100 μF capacitor and a variable resistor VR_1. Calculate the resistance of VR_1 so that a blue LED stays on for one minute after the switch S is momentarily pressed. [2]

....

....

(c) When the monostable is activated, the output voltage is 12 V. The forward voltage drop across the blue LED is 3.6 V.

(i) Calculate the value of resistor R that limits the current through the LED to a maximum of 30 mA. [2]

....

....

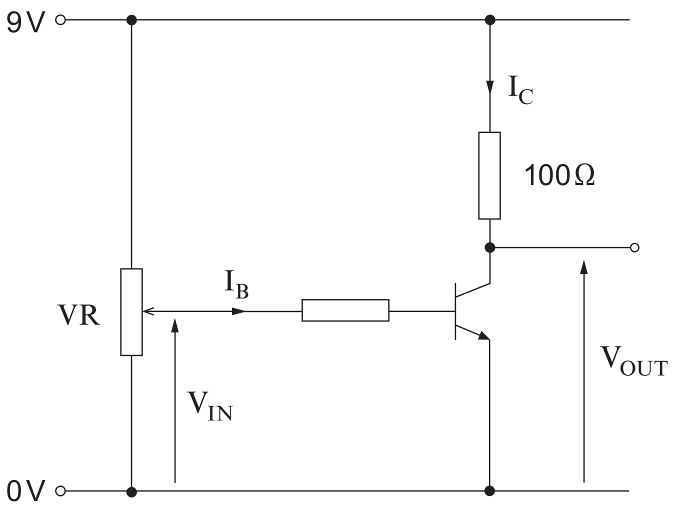
(ii) Determine a suitable preferred value for R. [1]

....

Turn over.

Examiner only

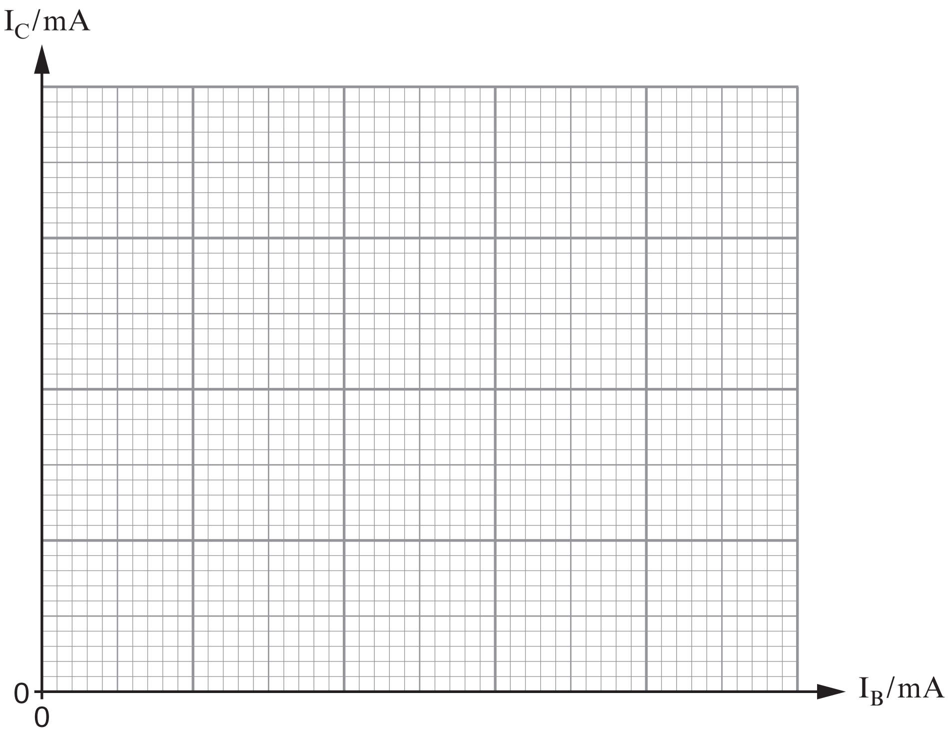
6. The following circuit is set up to investigate a transistor switching circuit.



The output of the potentiometer VR is varied and readings of I_B, I_C, V_{IN} and V_{OUT} are taken.

(a) As the base current is increased from 0.1 to 0.4 mA the collector current increases from 14 to 68 mA and the transistor does not saturate.

(i) Complete the graph below to show how I_C changes as I_B is increased from 0 to 0.45 mA. Label both axes with a suitable scale. [2]



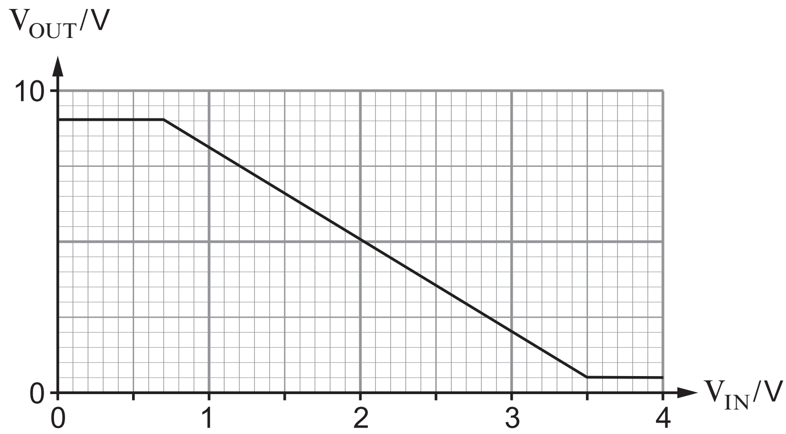
(ii) Determine the current gain (h_{FE}) of the transistor. [1]

....

....

Examiner only

(b) A second graph shows how V_{OUT} changes as V_{IN} is increased from 0 to 4 V.



Use the graph to determine:

(i) The minimum value of V_{IN} required to saturate the transistor. [1]

....

(ii) The value of V_{OUT} , when V_{IN} = 1.5 V and the load resistor is 100 Ω. [1]

....

(c) V_{IN} = 1.5 V and the load resistor is 100 Ω.

Calculate the collector current **and** the power dissipated in the transistor. [3]

....

....

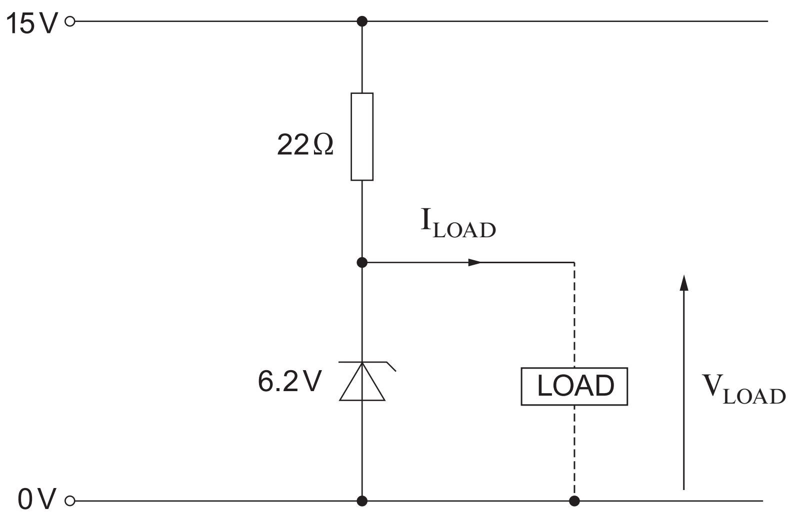
....

....

....

Examiner only

7. The diagram below shows a simple regulated power supply providing an output voltage V_{LOAD}. The zener diode requires a **minimum** current of 10 mA to maintain the zener voltage.



(a) Calculate the current through the 22 Ω resistor when there is no load connected. [2]

....

....

....

(b) What is the maximum load current that the power supply can provide whilst still maintaining the zener voltage? [1]

....

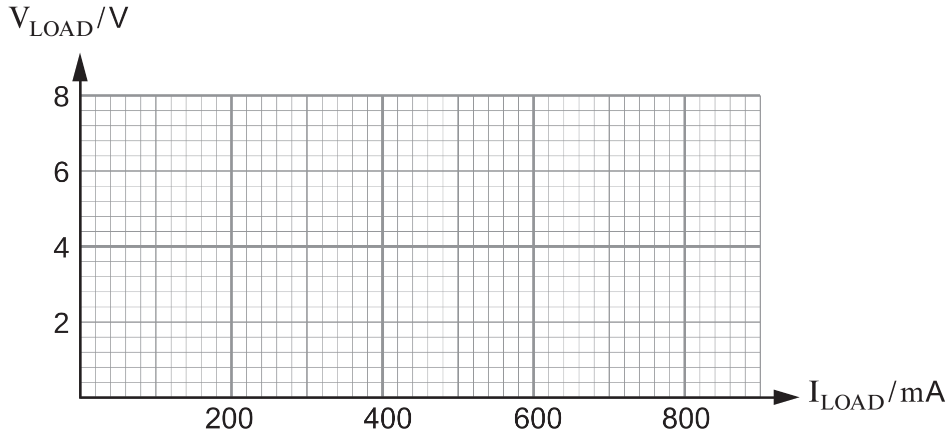
(c) A low resistance load is connected to the power supply. The zener diode ceases to conduct and the load current increases to 500 mA. Calculate the new value of V_{LOAD}. [2]

....

....

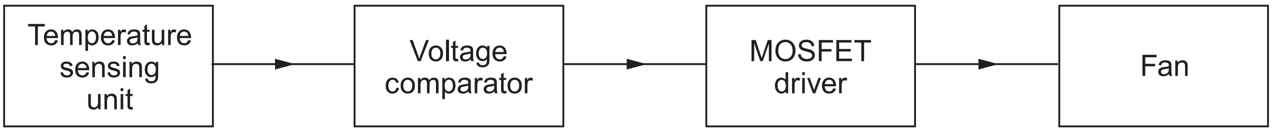
Examiner only

(d) Sketch a graph to show how V_{LOAD} changes as I_{LOAD} is increased gradually from 0 to approximately 700 mA. [3]



Examiner only

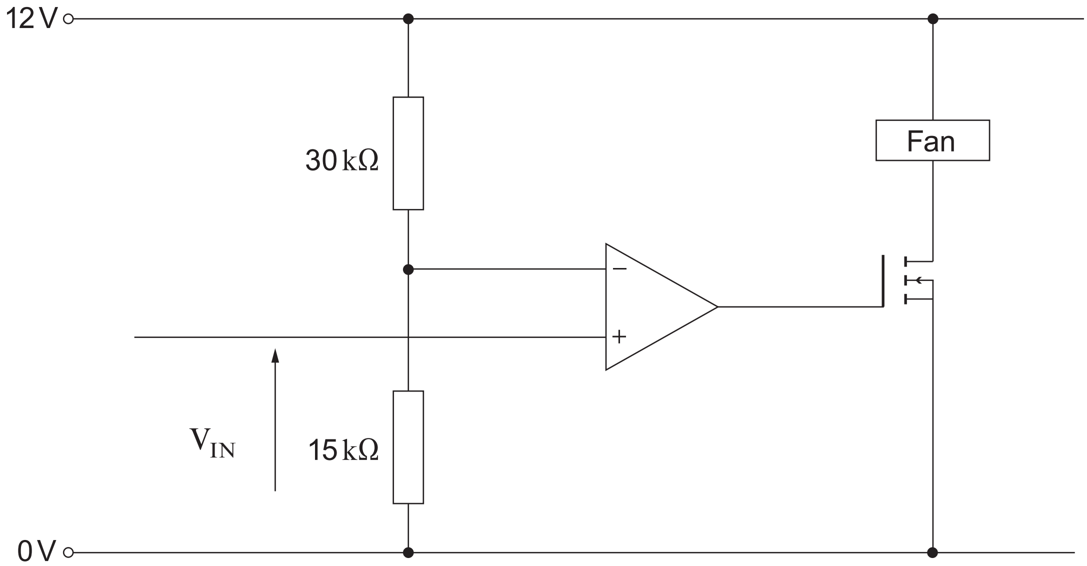
8. The block diagram shows a design for a fan cooling system for a desktop PC.



The fan which is rated at 12 V, 72 W should operate when the air temperature in the PC housing is more than 30 °C.

(a) Complete the circuit diagram for the system by adding:

- the temperate sensing sub-system
- a component to protect the MOSFET when the fan switches off [3]



Examiner only

(b) Calculate the minimum value of V_{IN} at which the fan will operate. [1]

....

(c) The MOSFET has the following parameters:

- maximum power dissipation = 60 W
- r_{DSon} = 0.25 Ω

Calculate the power dissipated in the MOSFET when the fan is operating at its rated current. [3]

....

....

....

END OF PAPER