Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1142/01

ELECTRONICS – ET2

P.M. TUESDAY, 21 May 2013

1¼ hours

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

1142
010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need 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 IN ET2

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

$$V_c = V_o(1 - e^{-t/RC})$$

$$t = -RC\ln\left(1 - \frac{V_c}{V_o}\right)$$

Discharging Capacitor

$$V_c = V_o\ e^{-t/RC}$$

$$t = -RC\ln\left(\frac{V_c}{V_o}\right)$$

Alternating Voltages

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

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

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

$$t_L = 0.7R_BC$$

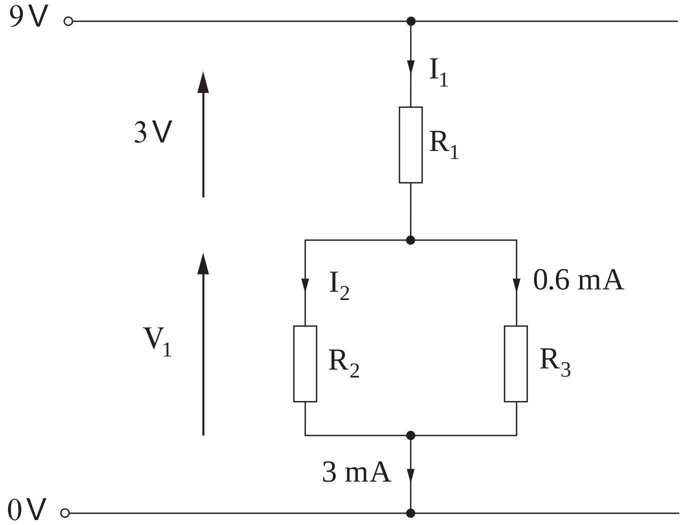
$$f = \frac{1.44}{(R_A + 2R_B)C}$$

Schmitt Astable

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

Examiner only

1. *(a)* Use the information given in the circuit diagram to determine the values of the quantities listed below. [3]

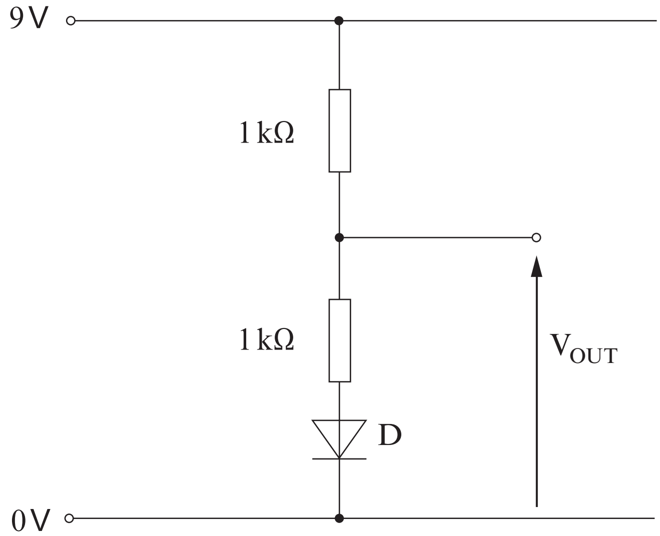


(i) V_1 ....

(ii) I_1 ....

(iii) I_2 ....

(b) In the following circuit, D is a silicon diode.



Calculate the voltage V_{OUT}. [3]

....

....

....

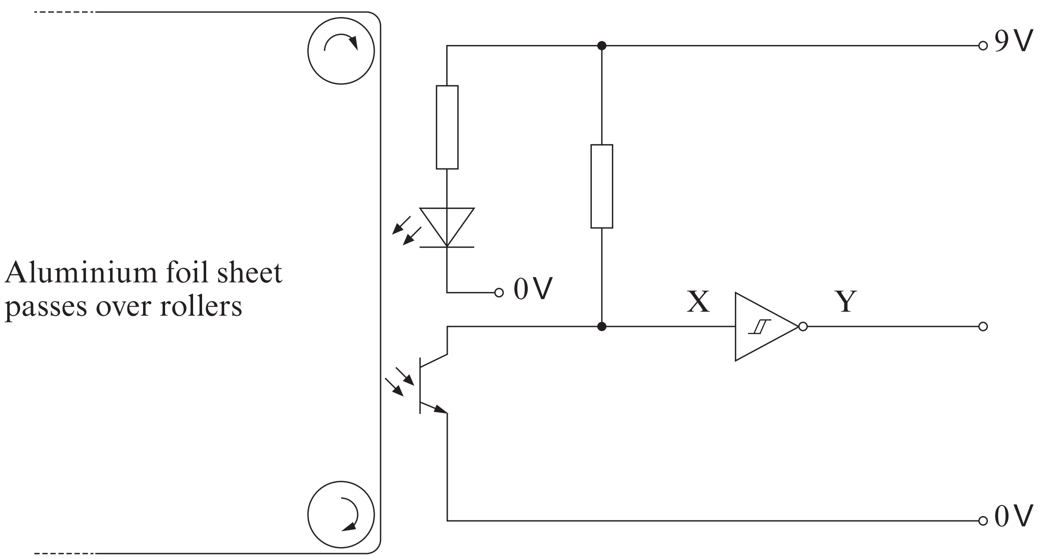
....

1142 010003

Turn over.

Examiner only

2. A packaging machine for aluminium foil uses a LED and phototransistor to check for the presence of the aluminium foil.



(a) State whether the logic levels at X and Y are **high** or **low** when:

(i) the aluminium foil sheet is present

X = ... Y = ...

(ii) the aluminium foil sheet is absent

X = ... Y = ...

[2]

(b) The output of the Schmitt trigger is capable of driving a low-powered buzzer.

Complete the circuit diagram by adding a buzzer that should sound when the system runs out of aluminium foil. [1]

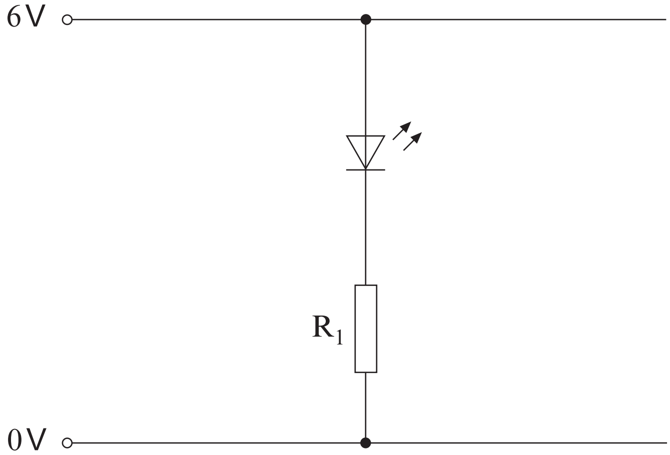
(c) Explain why it is desirable to include a **Schmitt** inverter rather than use a NOT gate in this circuit. [1]

....

....

Examiner only

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



(a) (i) The forward voltage drop across the LED is 2V.
Calculate the value of R_1 required to limit the current through the LED to a maximum of 15 mA.

....

....

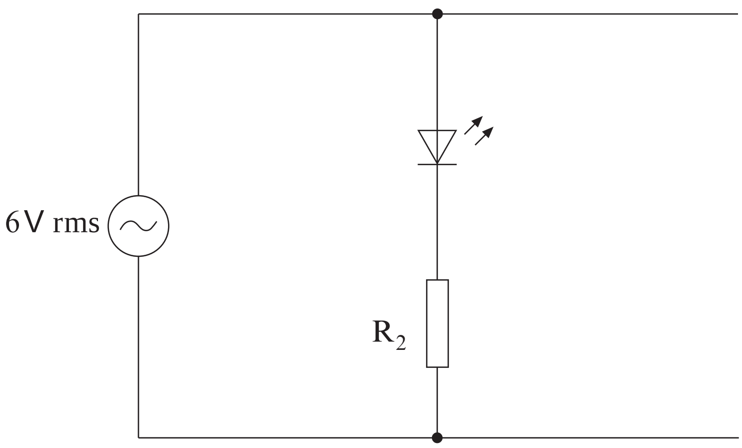
(ii) Select the preferred value for R_1 from the E24 series.

....

[3]

(b) A *power on* indicator is needed for a 6V rms AC circuit.

(i) Complete the circuit diagram by adding a component to protect the LED from the reverse polarity of the supply.



(ii) What resistance of R_2 is required to provide approximately the same level of illumination as the DC *power on* indicator?

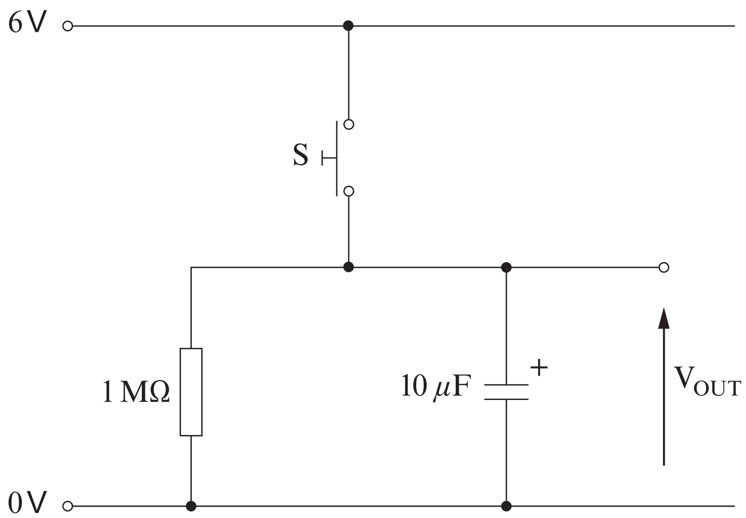
....

[3]

1142
010005

Examiner only

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



(a) Calculate the time constant of the circuit. [1]

....

....

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

(i) Determine the time taken for V_{OUT} to fall to 3V. [2]

....

....

(ii) Calculate the value of V_{OUT} at time t = 20 s. [2]

....

....

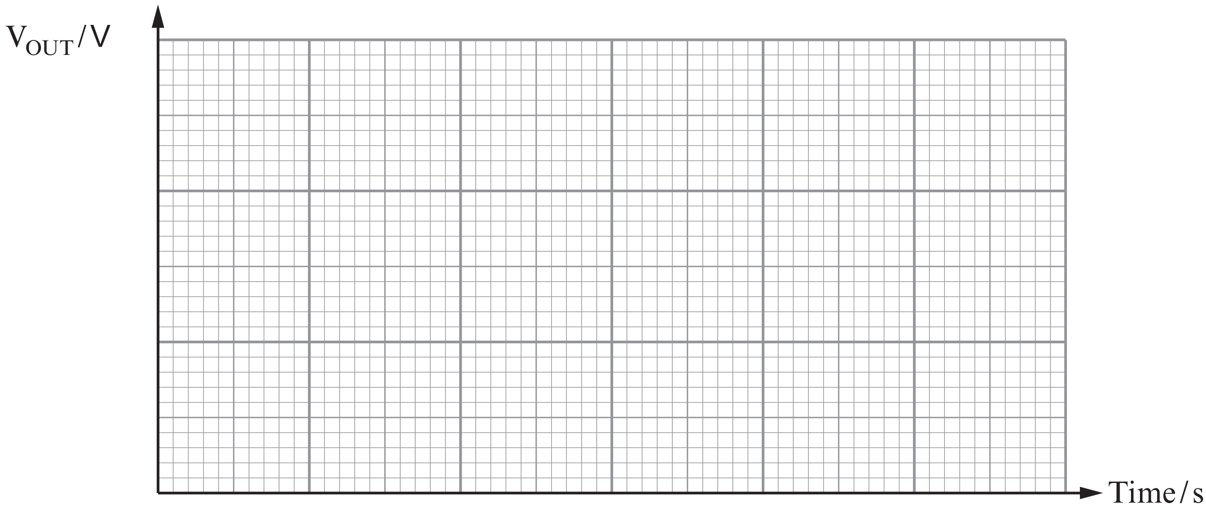
....

(iii) Estimate the time taken for V_{OUT} to reach 0V. [1]

....

Examiner only

(c) (i) Use your answers to part *(b)* to complete the graph of V_{OUT} against time on the axes below. Label both axes with your chosen scale.



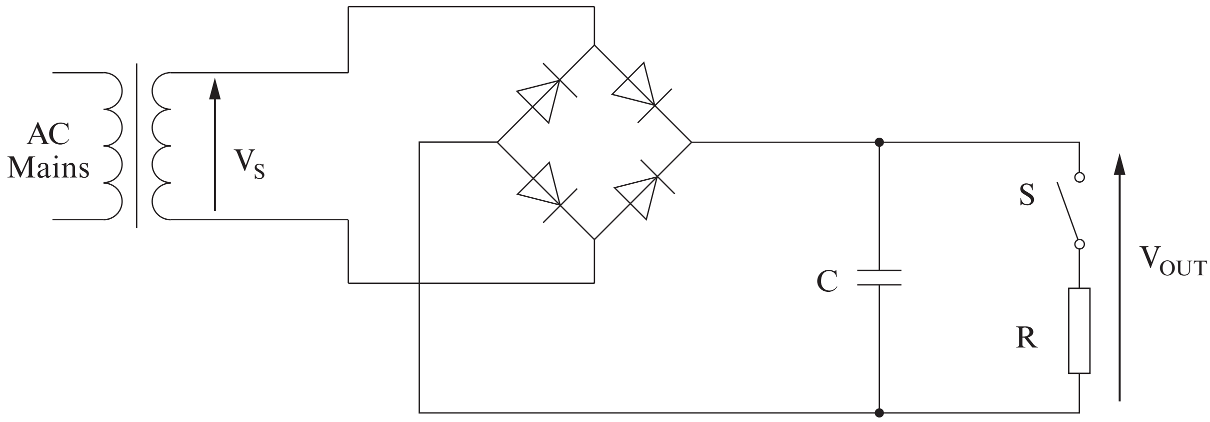
(ii) Use the graph to estimate the time taken for V_{OUT} to discharge to 2V.

....

[3]

1142 010007

5. The following diagram shows part of the circuit of a full-wave rectified power supply connected to the 240 V, 50 Hz, AC mains.



(a) The **peak** value of the secondary voltage of the transformer is 6 V.

Calculate:

(i) the **rms** value of the secondary voltage;

....

(ii) the **peak** value of the voltage V_{OUT}.

....

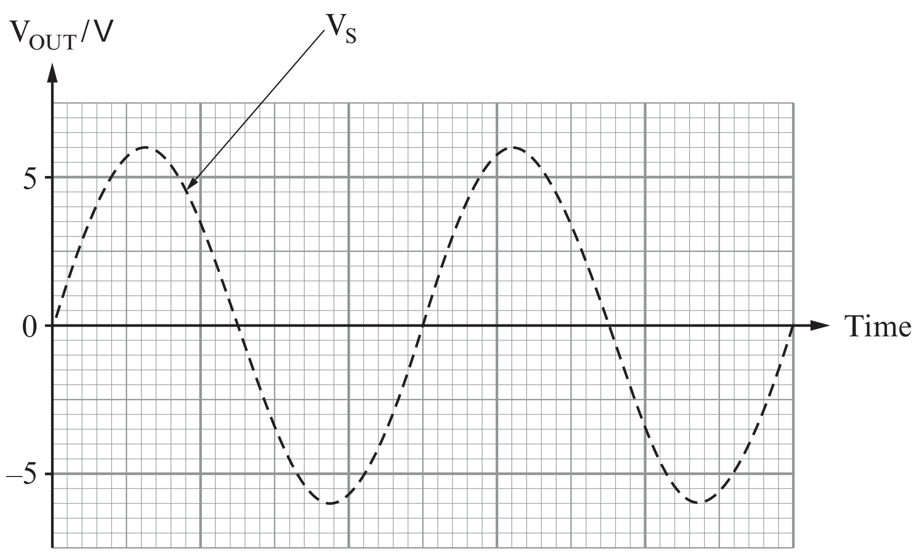
[2]

(b) In the graph below, the voltage across the secondary windings of the transformer (V_S) is shown as a dotted waveform and has a peak voltage of 6 V.

On the axes provided below:

(i) sketch the graph to show the output voltage V_{OUT} when switch S is open;

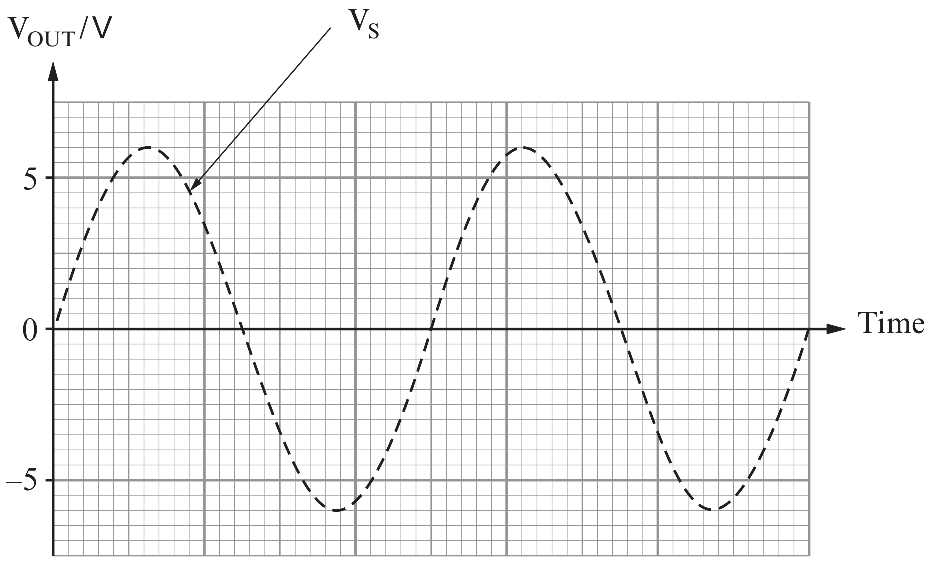
(ii) label any relevant voltages on the graph.



[2]

Examiner only

(c) Switch S is now closed and a large current flows through the load resistor, R. Use the next set of axes to sketch the voltage V_{OUT}.



[2]

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

(i) What happens to the amplitude of the ripple voltage?

....

(ii) What is the frequency of the ripple voltage?

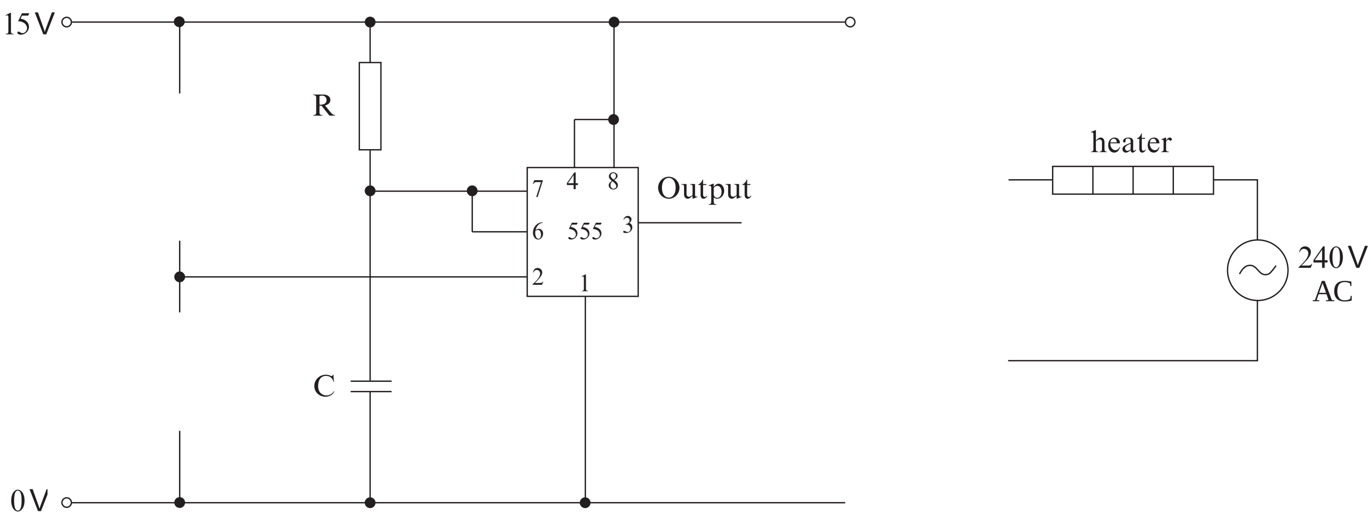
....

[2]

Examiner only

6. The waiting room in a doctor's surgery is kept warm by a 240 V AC mains heater. The heater comes on for a predetermined time when a switch is pressed.

The following diagram shows an incomplete circuit for a 555 monostable timer used to control the heater.



(a) **Add** a switch and any other necessary component to the diagram to complete the trigger section of the monostable. The 555 is negative-edge triggered. [2]

(b) **Add** a relay and any connections to the circuit diagram to show how the 555 timer monostable output is interfaced to the mains heater. [2]

(c) The circuit is triggered for a preset time by pressing the switch.
C is a 220 μF capacitor. Calculate the ideal value of resistor R, so that the heater will come on for 5 minutes when the trigger switch is momentarily pressed. [3]

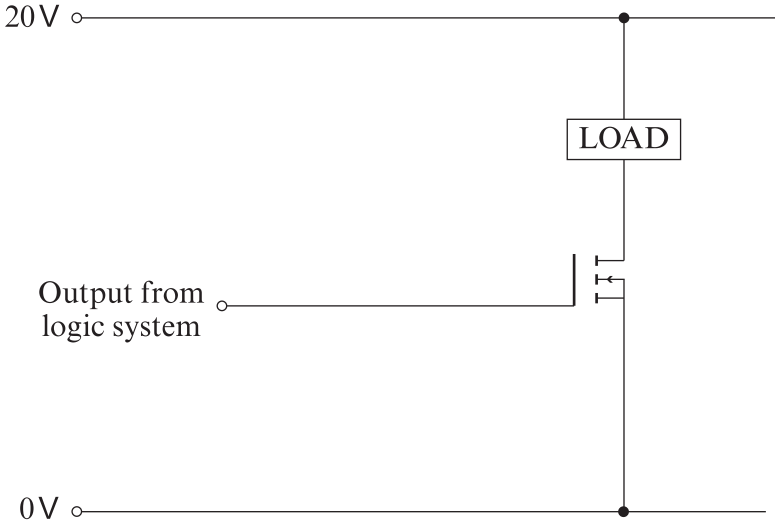
....

....

....

Examiner only

7. The circuit below shows a MOSFET being used to interface a logic system to a load.



(a) The logic 1 output from the logic system is 8 V. Calculate the minimum value of g_M required to allow a load current of 15 A. [2]

....

....

(b) Estimate the value of the gate current when the load current is 15 A. [1]

....

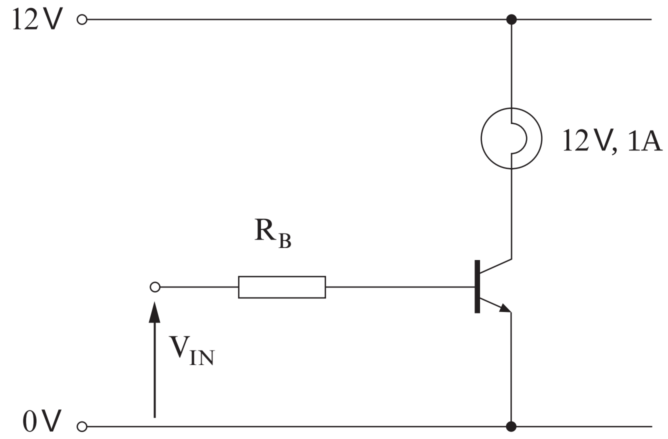
(c) Why is it important for the MOSFET to have a small value of r_{DSon}? [1]

....

....

Examiner only

8. Here is a transistor switch used to control a lamp rated at 12 V, 1 A.



(a) The transistor has a current gain (h_{FE}) of 250.
The input voltage V_{IN} is 4.7 V and the transistor is **just** saturated.

Determine:

(i) the collector current; [1]

....

(ii) the base current; [1]

....

(iii) the value of the base resistor R_B. [2]

....

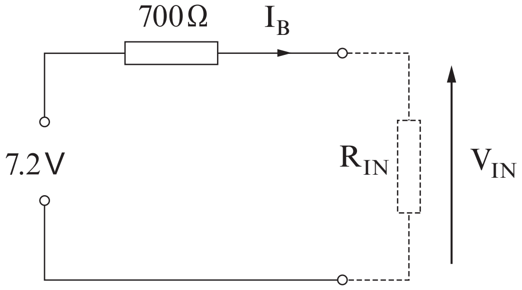
....

(b) The switching circuit is used to control the temperature in an egg incubator.
When the temperature drops to 37 °C, the lamp comes on to warm up the incubator.
Add the temperature sensing sub-system to the circuit diagram. It must be possible to adjust the switch-on temperature. [2]

Examiner only

(c) It is possible that the circuit will not function correctly due to the transistor input *loading* the temperature sensing sub-system.

The Thevenin **equivalent circuit** for the temperature sensing sub-system at 37 °C is shown connected to the transistor input R_{IN}.



Use the equivalent circuit to show by calculation whether the transistor is saturated at 37°C.

[Hint: You will need to consider whether the new voltage V_{IN} is sufficient to saturate the transistor when providing the base current calculated in part *(a)*(ii).] [3]

....

....

....

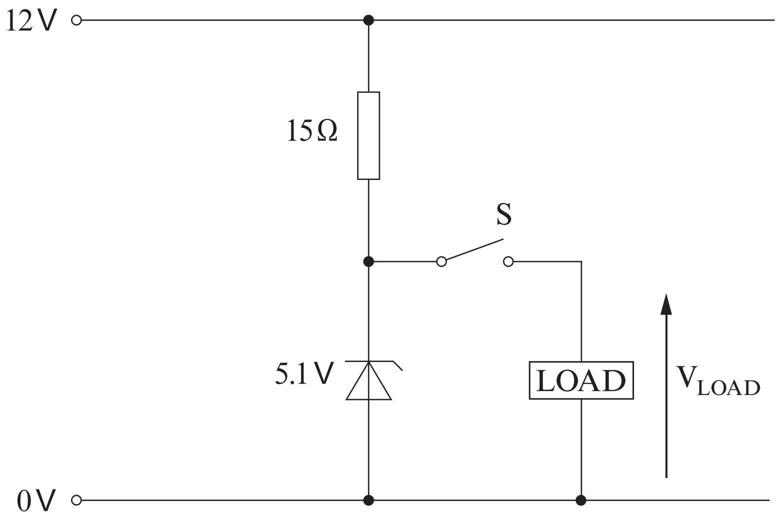
....

....

....

Examiner only

9. The following diagram shows a simple regulated power supply designed to work from a car battery.



The zener diode requires a **minimum** current of 10 mA to maintain the zener voltage.

(a) Switch S is initially open.

(i) Calculate the current through the 15 Ω resistor. [2]

....

....

....

(ii) Calculate the power dissipated in the zener diode. [2]

....

....

(b) Switch S is now closed.

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

....

(c) When fully charged the output of the car battery increases to 14.3 V and the current through the zener diode is greater than 10 mA.

At a battery voltage of 14.3 V determine the voltage across:

(i) the 15 Ω resistor; ....

(ii) the load. ....

[2]

END OF PAPER