X025/201

NATIONAL QUALIFICATIONS 2007

MONDAY, 4 JUNE 9.00 AM – 11.30 AM

ELECTRONIC AND ELECTRICAL FUNDAMENTALS
INTERMEDIATE 2

100 marks are allocated to this paper.

Answer **all** questions in Section A (50 marks).

Answer **two** questions from Section B (25 marks each).

A Datasheet is provided for questions 5 and 8.

In all your answers to questions requiring calculations, all working **must** be shown.

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Section A

Attempt all the questions in this section (50 marks)

1. Convert the following numbers.

(*a*) Binary to decimal 11001011_2 **2**

(*b*) Decimal to hexadecimal 96_{10} **2**

(*c*) Hexadecimal to binary $E5_{16}$ **2**

(6)

2. The diagrams in Figure Q2 show input and output waveforms to and from electronic circuits labelled **X** and **Y**.

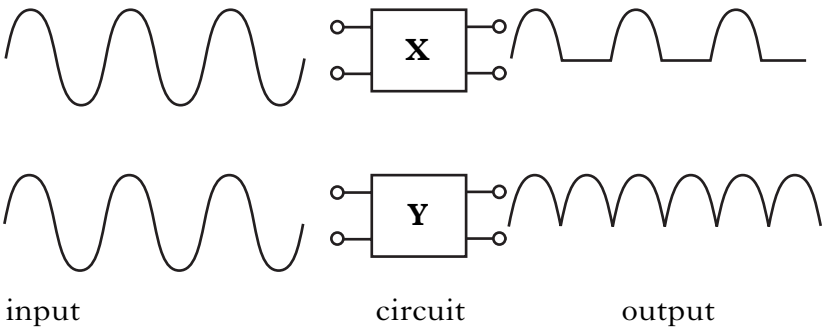

Figure Q2

State the full name for each type of circuit for:

(*a*) circuit **X**; **2**

(*b*) circuit **Y**. **2**

(4)

3. With reference to Figures Q3 (*a*) and (*b*), identify the following circuit symbols.

(*a*)

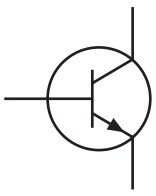

Figure Q3(*a*) **1**

(*b*)

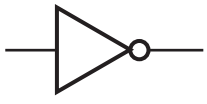

Figure Q3(*b*) **1**

(2)

Marks

4.

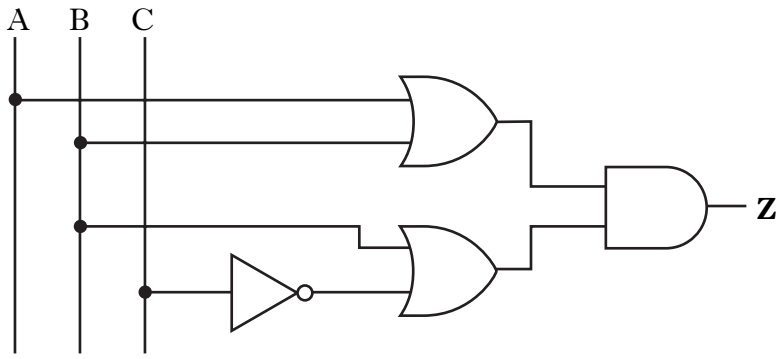

Figure Q4

For the circuit shown in Figure Q4:

(*a*) determine the Boolean expression for output **Z**; **2**

(*b*) draw the truth table for the circuit; **4**

(*c*) determine the circuit output **Z** when a fault condition causes input B to be permanently high. **2**

(8)

5. Referring to Figure Q5 and using the supplied datasheet:

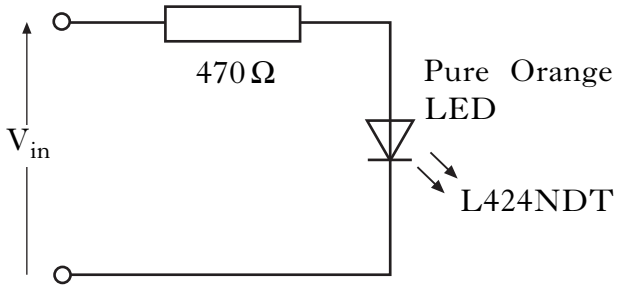

Figure Q5

(*a*) determine the maximum current the diode can handle; **1**

(*b*) determine the typical forward voltage drop; **1**

(*c*) calculate the maximum value of input voltage that can be applied. **3**

(5)

[Turn over

6. The coil B shown in Figure Q6 moves at a constant speed of $5\,m\,s^{-1}$ through a magnetic field with a flux density of 0·8 T. The maximum induced voltage is 6·8 volts.

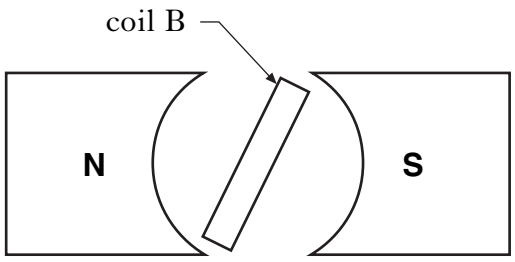

Figure Q6

(*a*) Calculate the effective length of the coil. **2**

(*b*) State the **two** angles relative to the magnetic field where the maximum instantaneous voltage will occur. **2**

(4)

7.

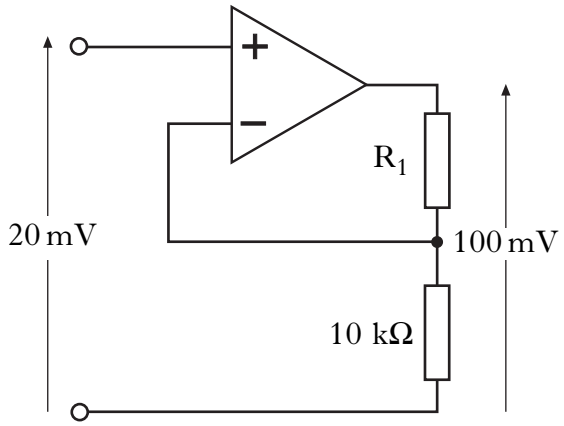

Figure Q7

With reference to the circuit shown in Figure Q7:

(*a*) identify the circuit configuration; **1**

(*b*) calculate the circuit gain; **1**

(*c*) determine the value of resistor R_1; **2**

(*d*) if the input voltage increases to 25 mV, determine the value of a resistor to replace R_1, to maintain the same value of output voltage. **2**

(6)

Marks

8.

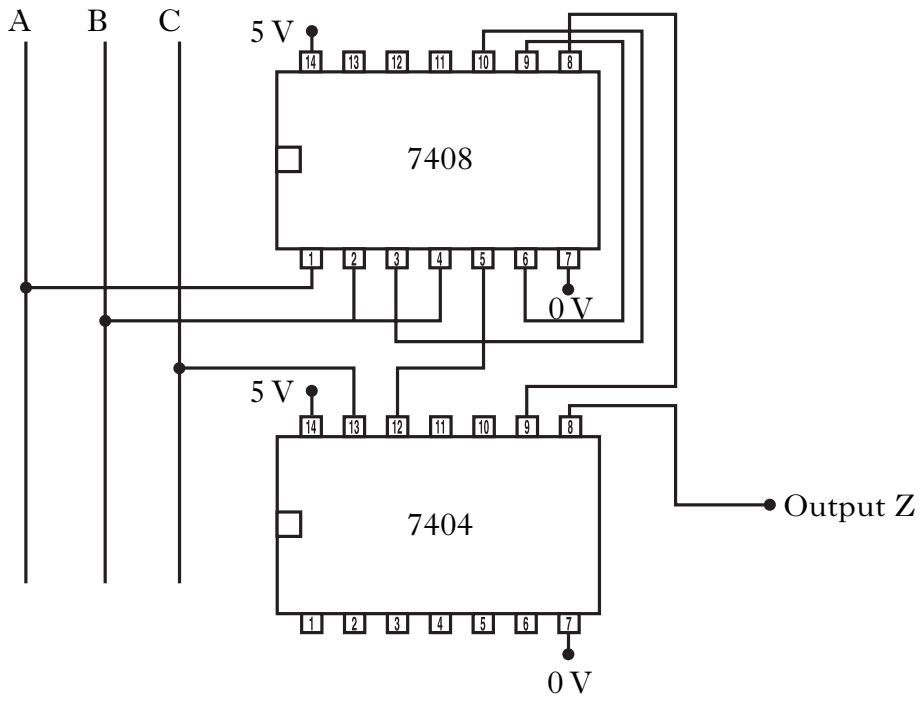

Figure Q8

Figure Q8 shows a logic circuit. With reference to the data sheet:

(*a*) draw the logic diagram; **3**

(*b*) draw the truth table for the circuit; **4**

(*c*) a fault condition causes input 9 on the 7408 to be permanently low. State the effect on the circuit output Z and **justify** your answer. **2**

(9)

9.

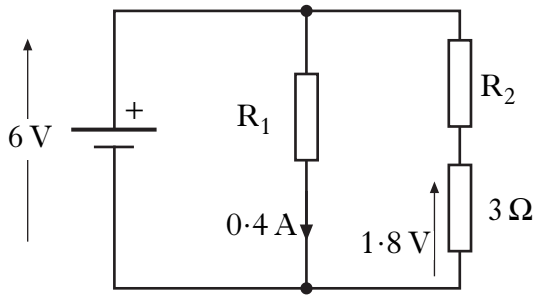

Figure Q9

For the circuit shown in Figure Q9, determine:

(*a*) the resistance of the resistor R_1; **1**

(*b*) the current through the 3 Ω resistor; **1**

(*c*) the resistance of the resistor R_2; **2**

(*d*) the total circuit resistance. **2**

(6)

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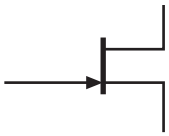
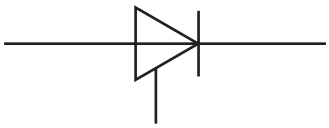
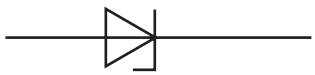
Section B

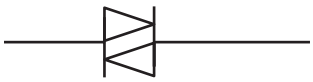
Attempt any TWO questions in this section (50 marks).
Each question is worth 25 marks.

10. (*a*) Identify the following circuit symbols:

(i)  **1**

(ii)  **1**

(iii)  **1**

(iv)  **1**

(*b*) Under test conditions a diode was found to exhibit the following characteristics.

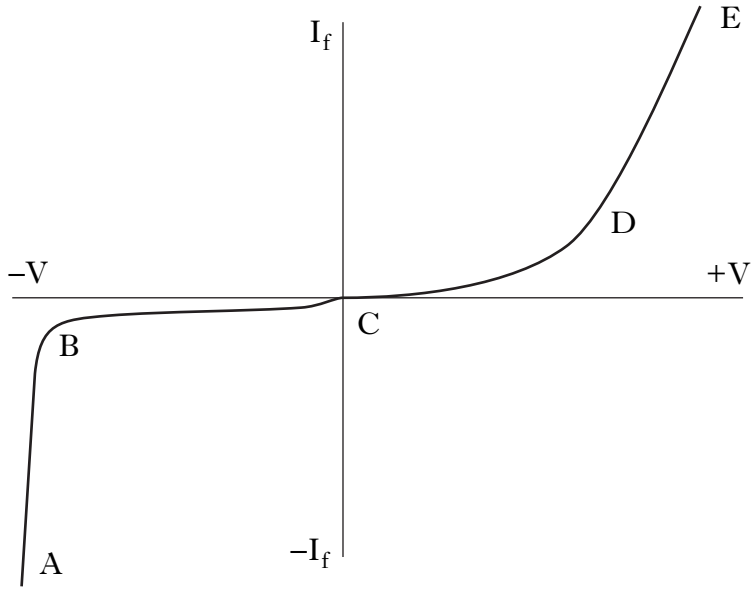


Figure Q10(*b*)

Identify with the use of the letters A to E on the characteristic Figure Q10(*b*) where the following begins:

(i) reverse breakdown; **1**

(ii) forward conduction. **1**

10. (continued)

(*c*) Identify the type of semiconductor device that would most likely produce the characteristic shown in Figure Q10(*c*) under test conditions. **2**

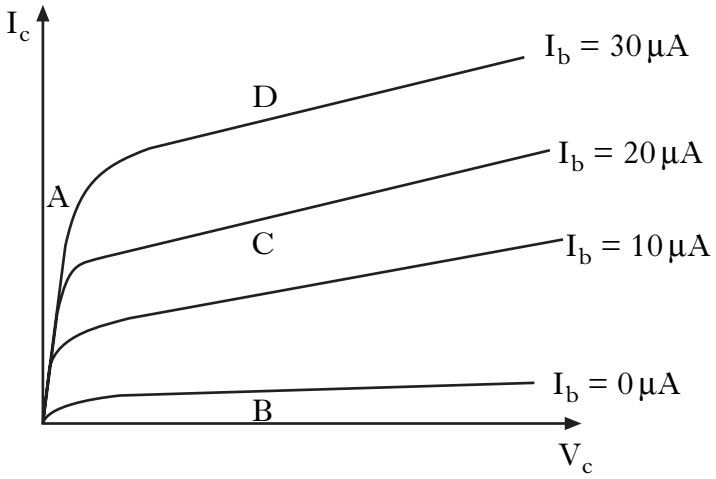


Figure Q10(*c*)

(*d*) For the characteristics shown in Figure Q10(*c*) identify the areas where the device is acting as:

(i) a switch in the OFF position; **1**

(ii) a current control device; **1**

(iii) a switch in the ON position. **1**

(*e*) Identify the circuit shown in Figure Q10(*e*)(i) and identify the terminals labelled 1, 2 and 3. **2,3**

(i)

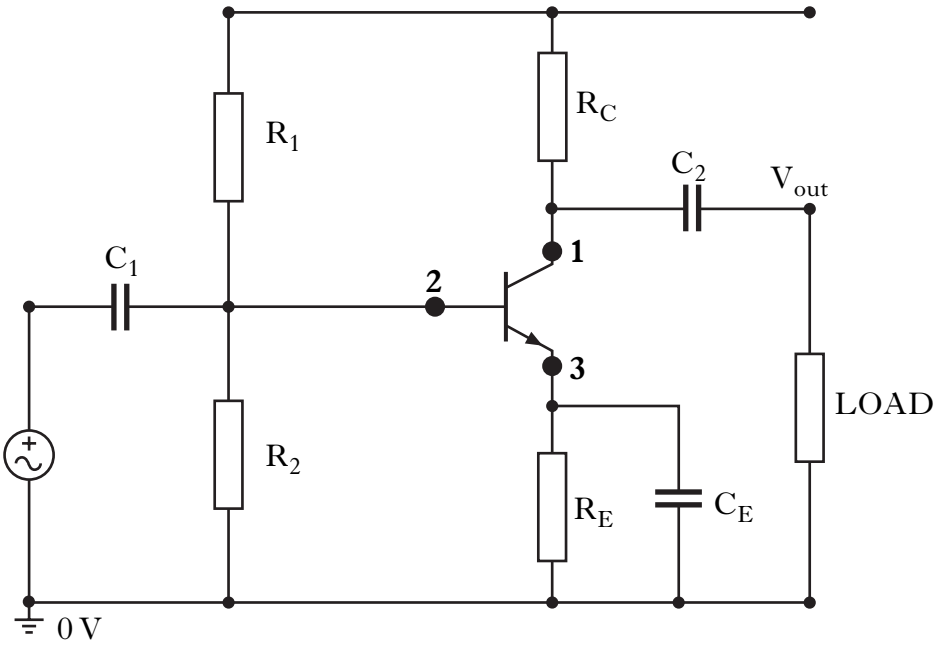


Figure Q10(*e*)(i)

10. (*e*) (continued)

(ii) Identify the circuit shown in Figure Q10(*e*)(ii) and identify the terminals 1, 2 and 3. **2,3**

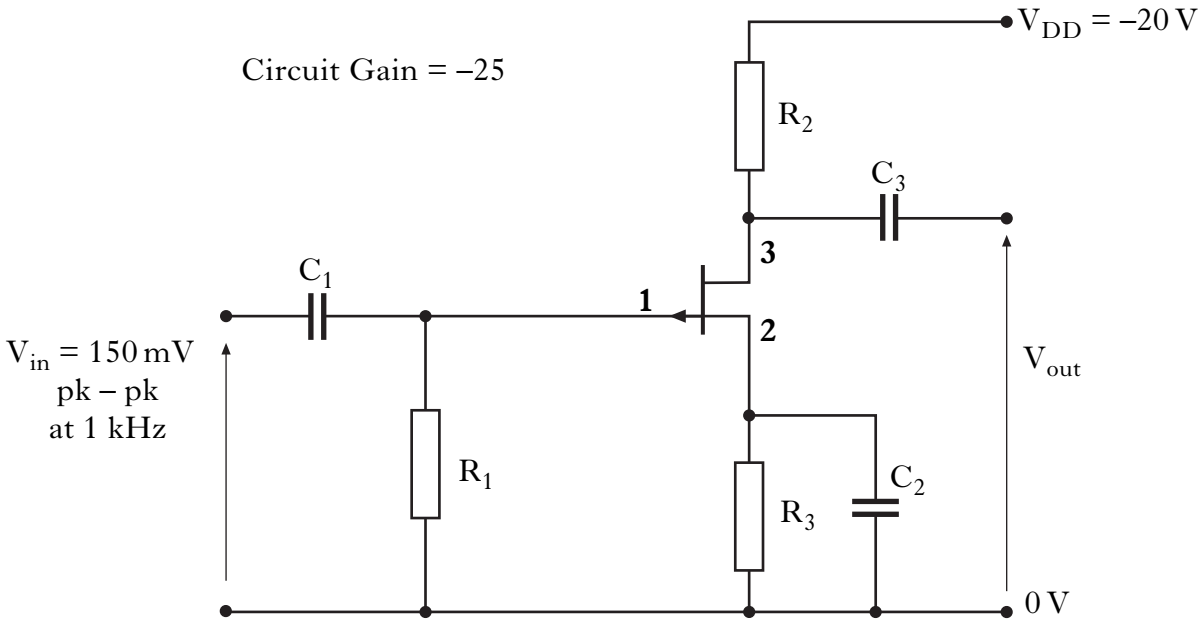


Figure Q10(*e*)(ii)

(iii) For the circuit shown in Figure Q10(*e*)(ii), determine the pk – pk output voltage. **2**

(*f*) Identify the circuit shown in Figure 10(*f*) and state **one** application. **2**

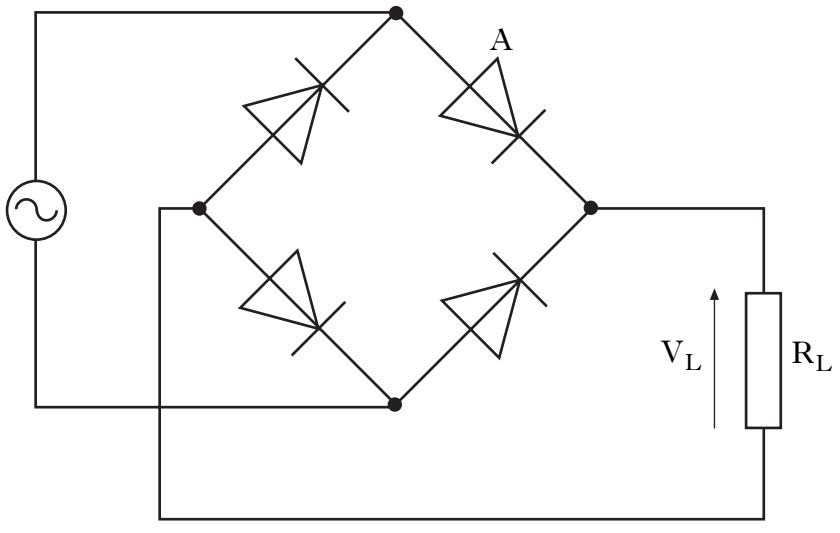


Figure Q10(*f*)

(25)

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11. (*a*)

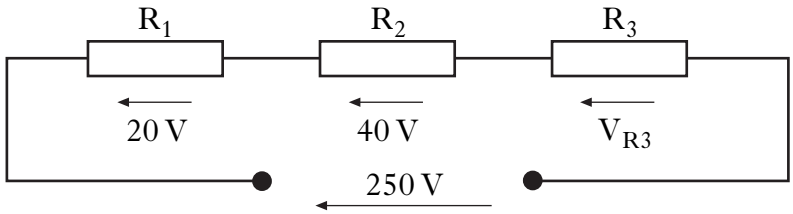

Figure Q11(*a*)

For the circuit shown in Figure Q11(*a*), determine the voltage drop V_{R3}. **1**

(*b*)

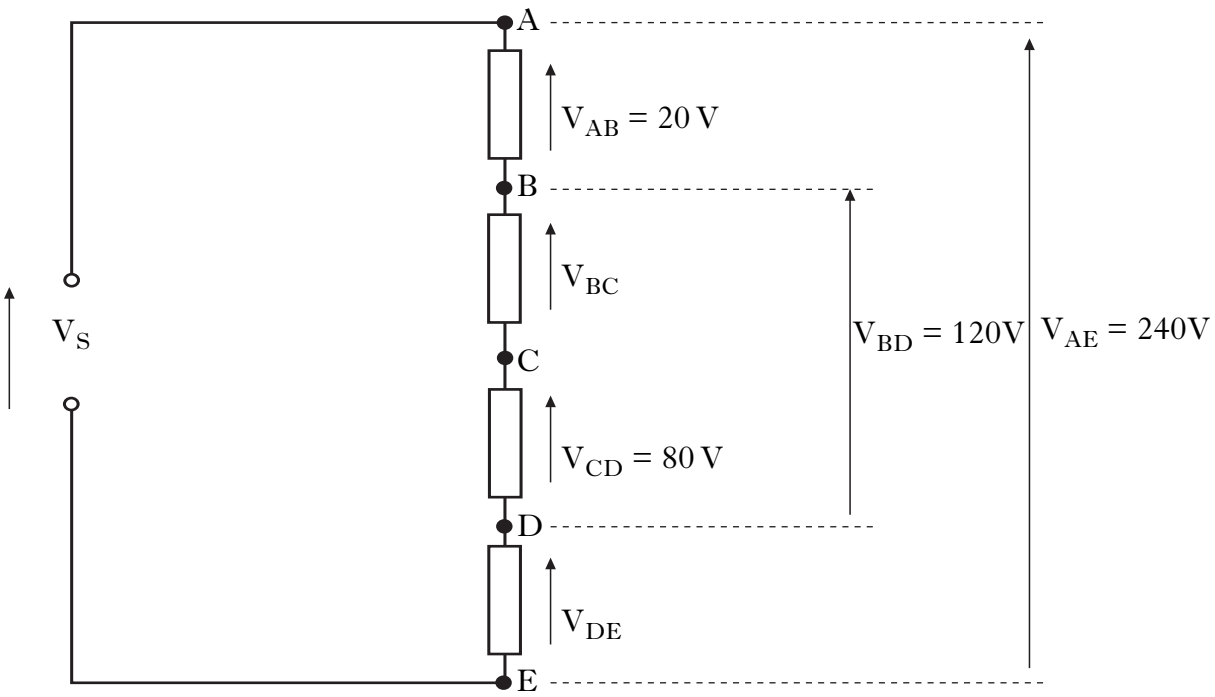

Figure Q11(*b*)

For the circuit shown in Figure Q11(*b*), determine the voltage drops:

(i) V_S; **1**

(ii) V_{BC}; **1**

(iii) V_{DE}. **1**

(*c*)

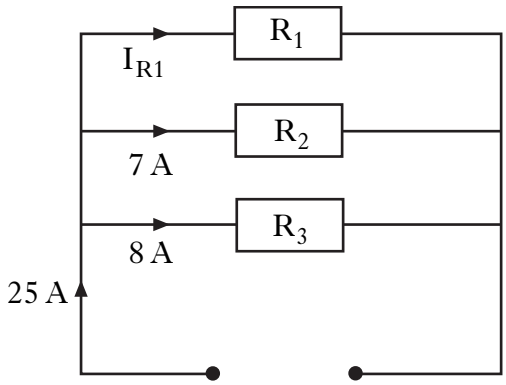

Figure Q11(*c*)

For the circuit shown in Figure Q11(*c*), determine the current I_{R1}. **1**

11. (continued)

(*d*)

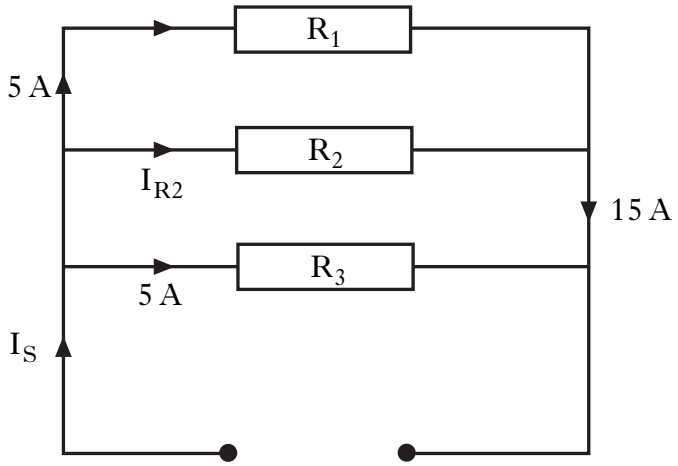

Figure Q11(*d*)

For the circuit shown in Figure Q11(*d*), determine:

(i) I_{R2}; **1**

(ii) I_S. **1**

(*e*) A domestic heating system consists of four storage heaters, R_1 to R_4, each with a 3 kW element. The circuit diagram, Figure Q11(*e*) shows how the heaters are connected.

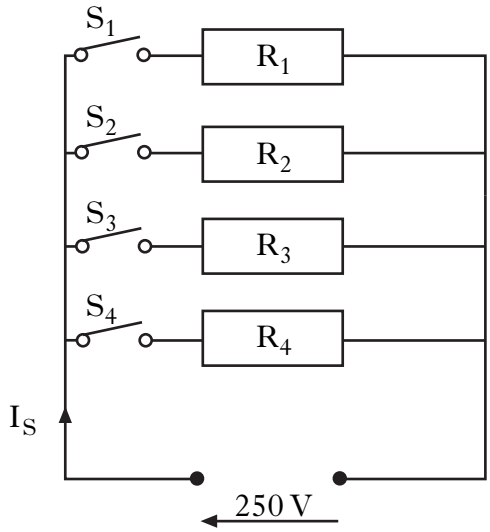

Figure Q11(*e*)

Assuming that all the switches, S_1 to S_4, are closed, calculate:

(i) the current in each heater element; **1**

(ii) the current taken from the supply; **1**

(iii) the resistance of each heater element; **2**

(iv) the total resistance of the circuit; **2**

(v) the total power dissipated in the circuit; **2**

(vi) the total energy (in kWh) consumed in 2 days. **2**

11. (continued)

(*f*) The current produced by a generator can be determined by the formula

$$i = 250 \sin\theta \text{ amperes}$$

Determine:

(i) the maximum value of the current; **1**

(ii) the value of the current generated when the angle between the generator's coil and the magnetic field is 60°; **2**

(iii) the rms value of the current. **1**

(*g*) A conductor of length 10 m and carrying a current of 10 A is placed in a magnetic field of 0·10 T.

(i) Calculate the force on the conductor. **1**

(ii) Calculate the force on the conductor when the magnetic field is increased to 0·4 T. **1**

(iii) State what will happen to the force on the conductor if both the current in the conductor and the magnetic field are reversed at the same time. **2**

(25)

Marks

12. (*a*) Add the following binary numbers:

(i) 0111_2 and 0101_2 **2**

(ii) 1000_2 and 0110_2 **2**

(*b*) For the following truth table:

A	B	C	Z
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

(i) identify the logic gate; **1**

(ii) draw the BS symbol; **1**

(iii) state the Boolean expression. **1**

(*c*) Draw the logic diagrams for the following expressions using ANSI symbols.

(i) $A.\overline{B}.C + \overline{A}.B.C + \overline{B.C} = Z$ **4**

(ii) $(\overline{P+Q+R}).(P+Q+\overline{R}).(P+\overline{Q}+R) = Z$ **4**

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12. (continued)

(*d*) Construct the truth tables for the circuit in Figures Q12(*d*)(i) and Q12(*d*)(ii).

Determine from the truth tables which single logic gate could replace each circuit.

(i)

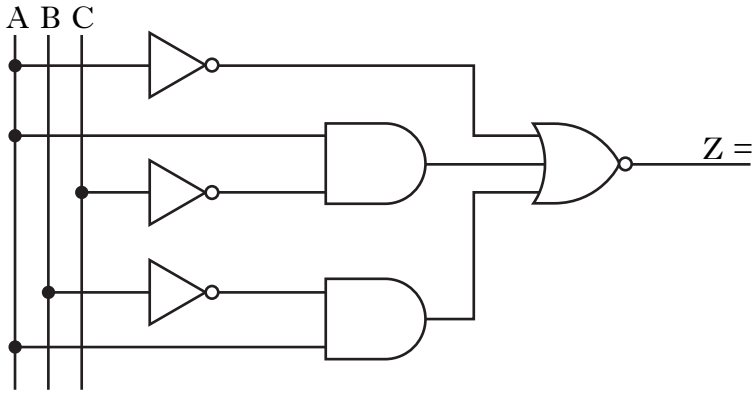

Figure Q12(*d*)(i) **5**

(ii)

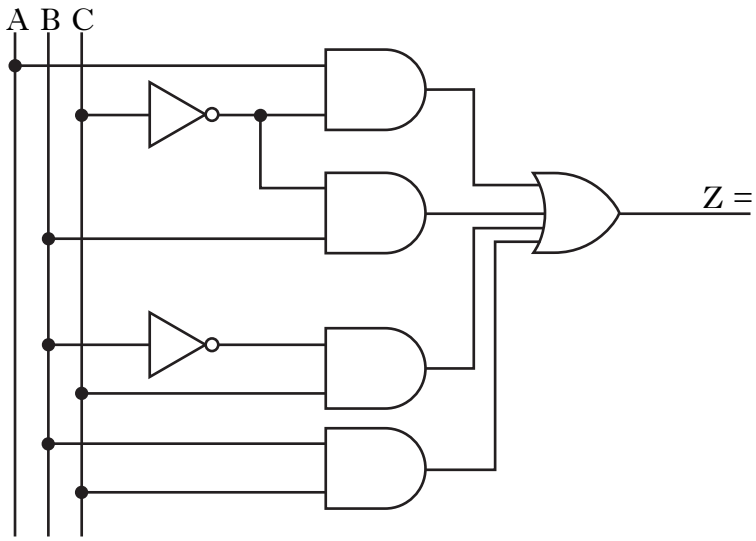

Figure Q12(*d*)(ii) **5**

(25)

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ELECTRONIC AND ELECTRICAL FUNDAMENTALS
INTERMEDIATE 2
Datasheets for Q5 and Q8

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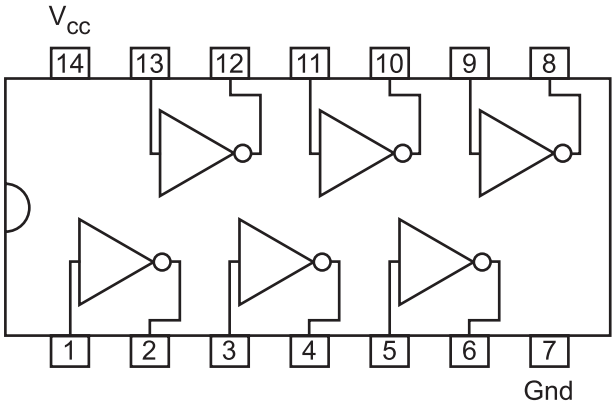
Datasheet for Question 5

LEDs

Diode Type	*Part No*	I_F mA *(max)*	V_F V *(typ)*	V_R V *(max)*	*Intensity* @ 10 mA *mcd*		*View Angle* (deg)	*Peak wavelength* (nm)
					min	*max*		
Red	L424HDT	25	2	5	0·5	3·2	100	700
H E red	L424IDT	30	2	5	3·2	12·5	100	625
Pure orange	L424NDT	30	2	5	3·2	12·5	100	610
Green	L424GDT	25	2·2	5	1·3	8	100	565
Yellow	L424YDT	30	2·1	5	1·3	8	100	590

Datasheet for Question 8



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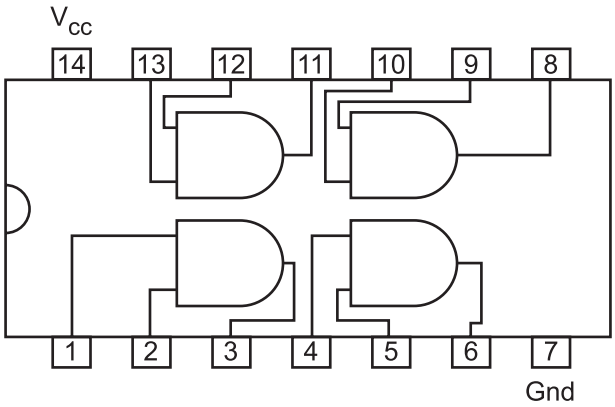

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