X025/11/01

NATIONAL QUALIFICATIONS 2013

THURSDAY, 6 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).

Datasheet is provided for question 5.

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

Section A

Attempt all the questions in this section (50 marks)

1. Convert the following numbers.

(*a*) Binary to Decimal 11101001_2 **2**

(*b*) Hexadecimal to Binary $E4_{16}$ **2**

(*c*) Decimal to Hexadecimal 215_{10} **2**

(6)

2. Identify the circuit symbols shown in Figure Q2(*a*) and Figure Q2(*b*).

(*a*)

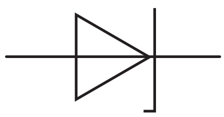

Figure Q2(*a*) **2**

(*b*)

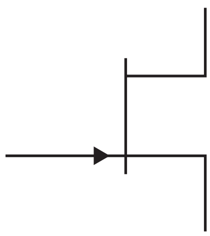

Figure Q2(*b*) **2**

(4)

Marks

3. Determine the logic input X and Y for the gates shown in Figure Q3(*a*) and Figure Q3(*b*) respectively.

(*a*)

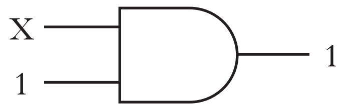

Figure Q3(*a*) **1**

(*b*)

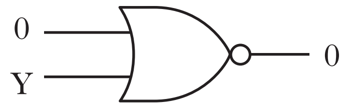

Figure Q3(*b*) **1**

(2)

4. Figure Q4 shows a current carrying conductor placed between magnetic poles. The magnetic flux density is 0·2 Tesla. The conductor experiences a force of 1·2 N when the current is 15 A.

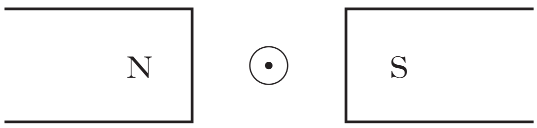

Figure Q4

(*a*) Determine the length of conductor within the magnetic field. **2**

(*b*) State what happens to the force when the current direction is reversed. **1**

(3)

[Turn over

Marks

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

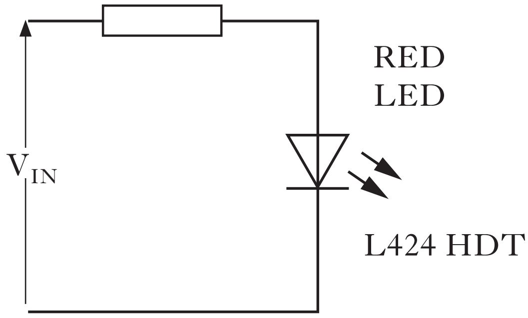

Figure Q5

(*a*) state the purpose of the series resistor; **1**

(*b*) state the maximum forward current the diode can handle; **1**

(*c*) state the typical forward voltage drop; **1**

(*d*) determine the maximum value of input voltage that can be safely applied. **2**

(5)

6. A generator produces a sinusoidal current represented by the equation

$$i = 12\sin\theta \text{ amperes}$$

Determine:

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

(*b*) the r.m.s. value of the current; **1**

(*c*) the average value of the current; **1**

(*d*) the instantaneous value of the current when $\theta = 30°$. **2**

(5)

Marks

7. With reference to the circuit shown in Figure Q7, in which resistor R_1 is 10 kΩ and R_V can be varied between 5 kΩ and 15 kΩ:

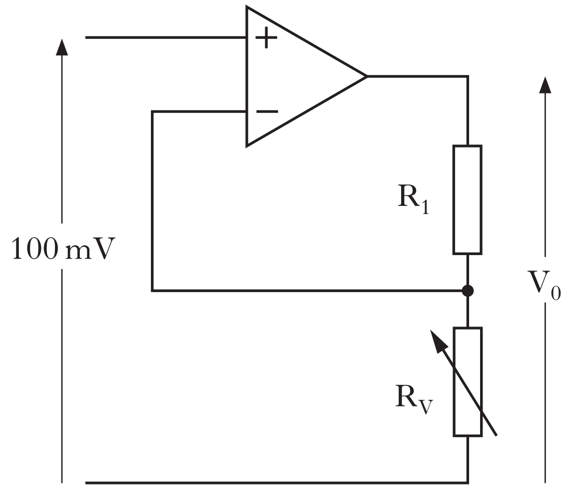

Figure Q7

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

(*b*) determine the output voltage when R_V is set to 10 kΩ; **2**

(*c*) determine the maximum possible output voltage when the input is 100 mV; **3**

(*d*) determine the minimum possible output voltage when the input is 100 mV. **3**

(9)

[Turn over

8. With reference to the circuit shown in Figure Q8: *Marks*

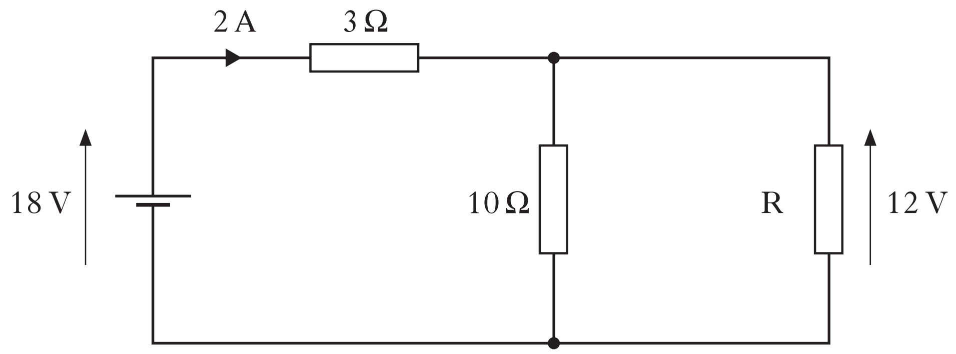

Figure Q8

(*a*) determine the voltage across the 3 Ω resistor; **1**

(*b*) determine the current through the 10 Ω resistor; **2**

(*c*) determine the value of resistor R. **3**

(*d*) A fault condition causes the 10 Ω resistor to be open circuit. Determine the new value of supply current. **2**

(8)

9. For the circuit shown in Figure Q9:

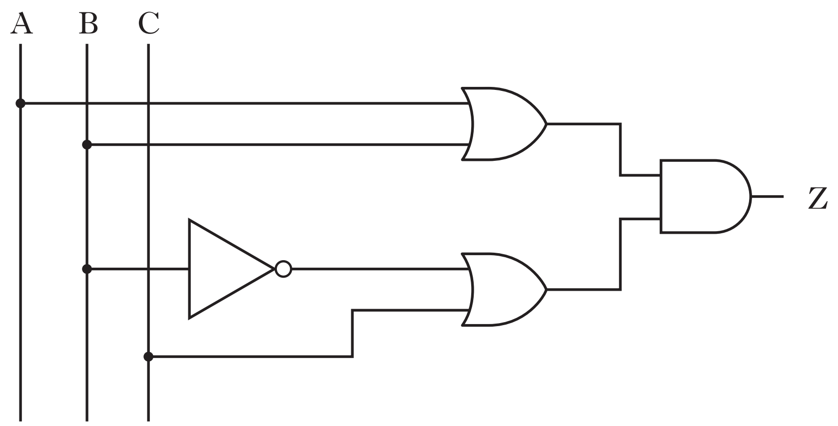

Figure Q9

(*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 faulty condition causes the output of the invertor to be permanently low (logic 0). **2**

(8)

Total Marks (50)

[Turn over for Section B on *Page eight*

Marks

Section B

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

10. (*a*) State the logic output for the logic gates shown in Figure Q10(*a*)(i) and Figure Q10(*a*)(ii).

(i)

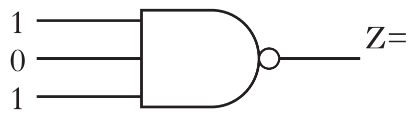

Figure Q10(*a*)(i) **2**

(ii)

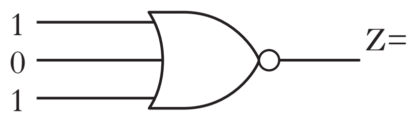

Figure Q10(*a*)(ii) **2**

(*b*) Add the following binary numbers.

(i) $0101_2 + 0101_2$ **2**

(ii) $0010_2 + 0101_2$ **2**

(*c*) Draw the logic circuit for the expression

$Z = A.B + \bar{A}.C$ **3**

(*d*) Determine the logic expression for the logic circuit shown in Figure Q10(*d*). **3**

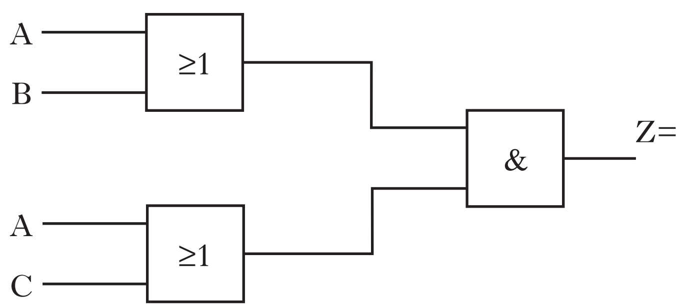

Figure Q10(*d*)

10. (continued)

(*e*) Figure Q10(*e*)(i) shows a logic circuit.

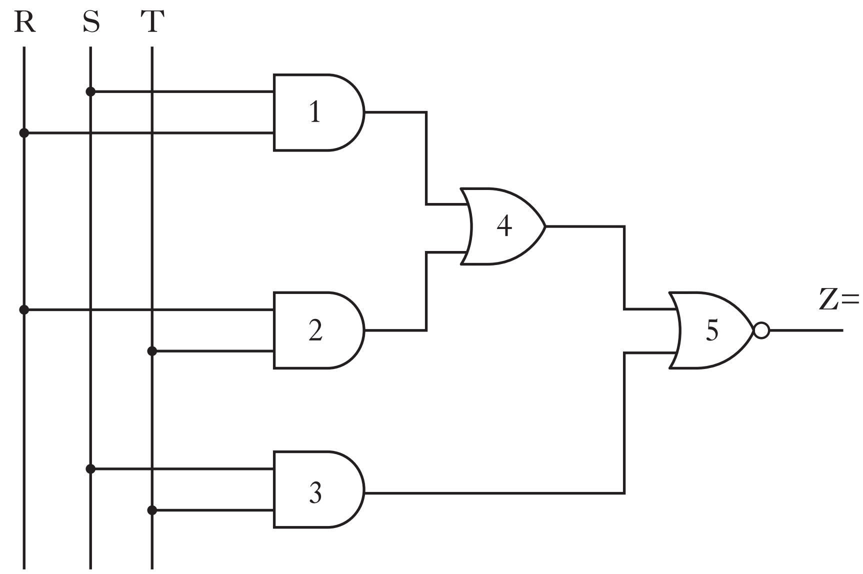

Figure Q10(*e*)(i)

(i) Determine the logic expression for the circuit. **3**

(ii) Draw the truth table for the circuit. **4**

(iii) The circuit shown in Figure Q10(*e*)(i) has developed a fault, and upon testing the outputs shown in the truth table Figure Q10(*e*)(iii) were obtained. Explain which gate (input or output) is at fault and state the nature of the fault. **4**

(25)

R	**S**	**T**	**Z**
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

Figure Q10(*e*)(iii)

11. (*a*) For the circuit shown in Figure Q11(*a*), determine:

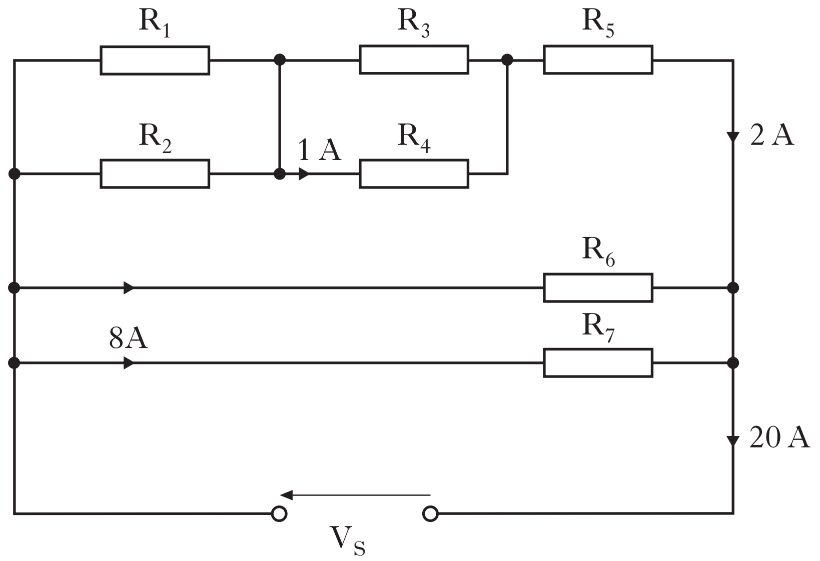

Figure Q11(*a*)

(i) the current flowing in R_3; **2**

(ii) the current flowing in R_6. **2**

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

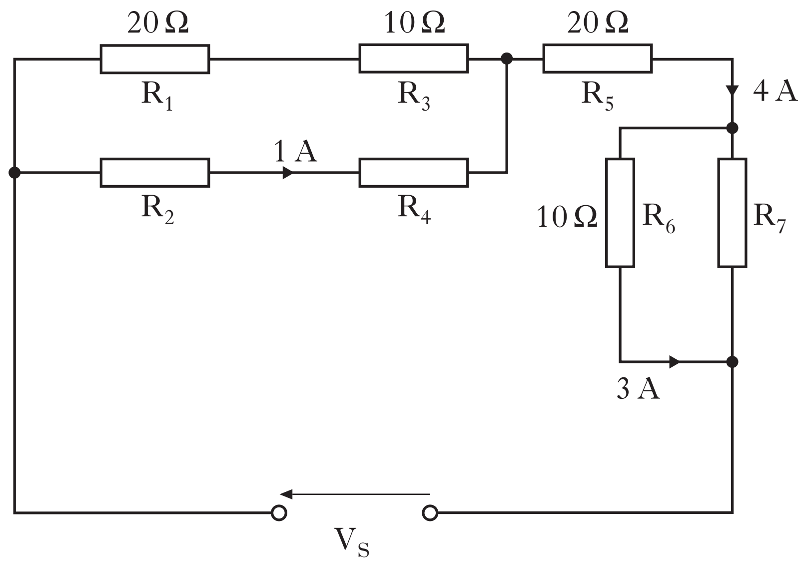

Figure Q11(*b*)

(i) the voltage drop across R_7; **2**

(ii) the supply voltage; **3**

(iii) the power dissipated in R_7; **2**

(iv) the energy consumed in 3 hours by the branch containing R_2 & R_4. **3**

11. (continued)

(*c*) A variable speed, 10 kW generator produces an output voltage of 120 V, has a flux density of 40 milliTesla, and a conductor length of 25 m. Calculate:

(i) the speed of the generator; **3**

(ii) the speed of the generator when the output voltage is 200 V; **2**

(iii) the maximum current the generator can supply when the output is 200 V. **2**

(*d*) A conductor is forced to move downwards within a magnetic field, as shown in Figure Q11(*d*).

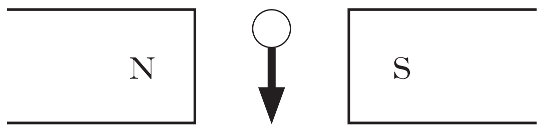

Figure Q11(*d*)

(i) State the formula used to calculate the current in the conductor. **1**

(ii) Explain how the direction of the current can be determined. **3**

(25)

[Turn over

Marks

12. (*a*) For the circuits shown in Figures Q12(*a*)(i) and (ii) the input voltage is $12\,V_{pk-pk}$, 50 Hz in each circuit.

(i) Assuming that the switch remains open, sketch the input and output waveforms for the circuit shown in Figure 12(*a*)(i), clearly indicating the differences between the input waveform and the output waveform. **3**

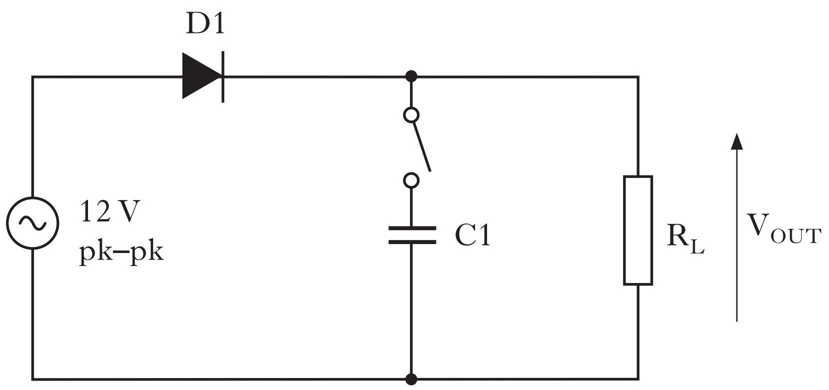

Figure Q12(*a*)(i)

(ii) Sketch the output waveform for the circuit shown in Figure 12(*a*)(ii), clearly indicating the differences between the new output waveform and the output waveform of Figure Q12(*a*)(i). **3**

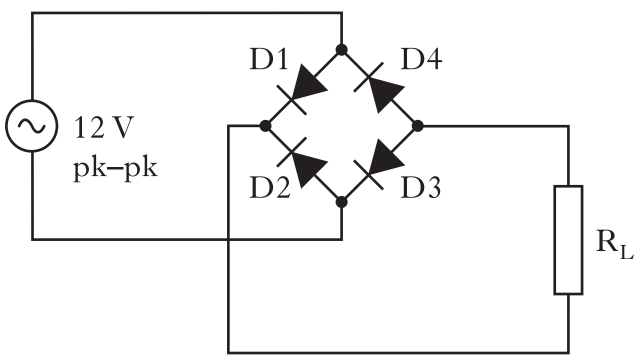

Figure Q12(*a*)(ii)

12. (continued)

Marks

(*b*) For the circuit shown in Figure Q12(*b*):

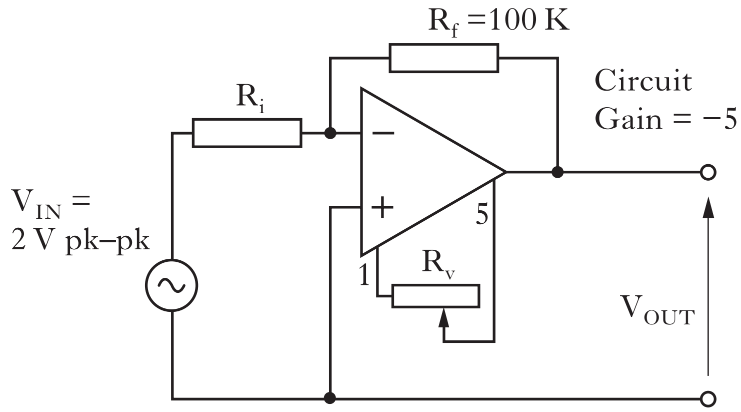

Figure Q12(*b*)

(i) state the circuit configuration; **1**

(ii) determine the output voltage; **2**

(iii) determine the value of R_i; **2**

(iv) explain the purpose of R_v. **2**

(*c*) (i) Identify the circuit shown in Figure Q12(*c*). **1**

(ii) With reference to Figure Q12(*c*), identify the purpose of each of the following components: R_1 & R_2, C_2 & C_3. **4**

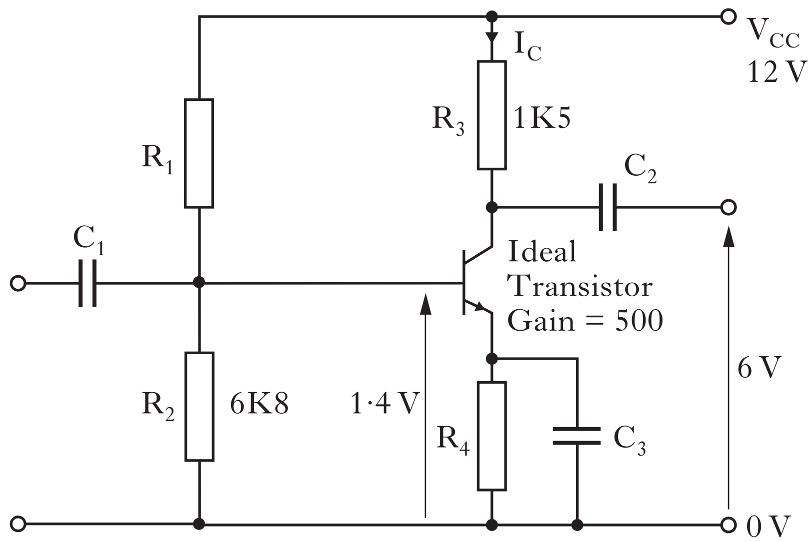

Figure Q12(*c*)

(iii) Calculate the output voltage for the circuit shown in Figure Q12(*c*) when the input voltage is $20\,mV_{pk-pk}$. **2**

[Turn over for Question 12(c) continued on *Page fourteen*

12. (*c*) (continued)

(iv) When the input voltage is increased to 40 mV_{pk-pk} the output waveform is as shown in Figure Q12(*c*)(iv).

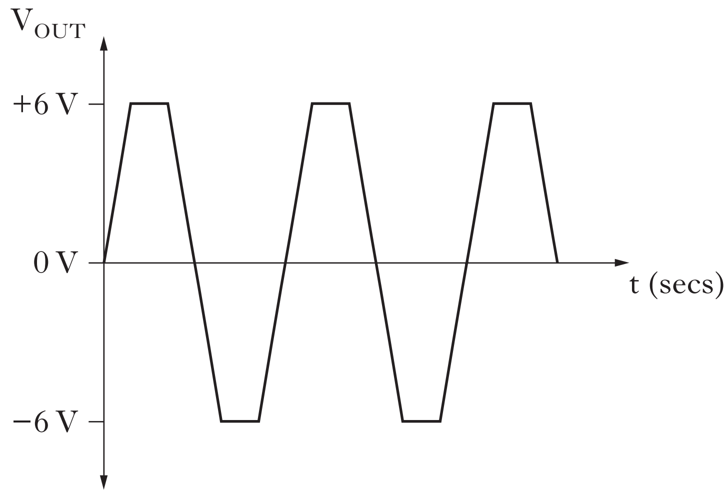

Figure Q12(*c*)(iv)

Explain why the shape of the waveform is non-sinusoidal. **3**

(v) Suggest two ways of preventing this. **2**

(25)

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ELECTRONIC AND ELECTRICAL FUNDAMENTALS
INTERMEDIATE 2
Datasheet for Q5

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	L424DT	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

[*END OF DATASHEET*]