X025/11/01

NATIONAL QUALIFICATIONS 2014

WEDNESDAY, 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).

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

Marks

Section A

Attempt all the questions in this section (50 marks)

1. Convert the following numbers.

(*a*) Hexadecimal to Decimal FD_{16} **2**

(*b*) Binary to Decimal 10101010_2 **2**

(*c*) Hexadecimal to Binary $C7_{16}$ **2**

(6)

2. For the circuit shown in Figure Q2 determine, using Kirchhoff's Voltage Law and Ohm's Law, the voltage drops V_{CD} and V_{BD} **4**

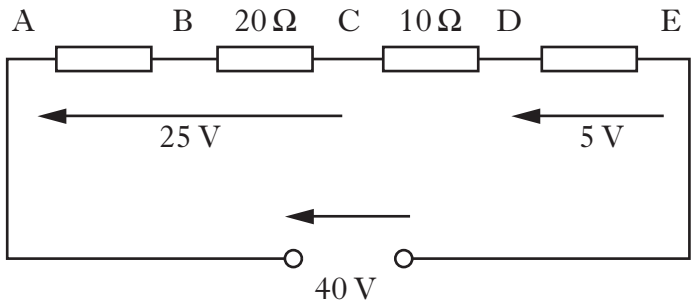

Figure Q2

(4)

3. A conductor in a magnetic field experiences a force of 25 N when the current in the conductor is 3 A.

(*a*) If the length of the conductor is 750 mm, calculate the magnetic flux density. **3**

(*b*) State what will happen to the force on the conductor if the length is changed to 2250 mm, and justify your answer. **2**

(5)

Marks

4. A conductor is rotated in a magnetic field to produce a sine wave and the voltage is measured at 100 V rms.

(*a*) Determine the maximum value of the voltage. **2**

(*b*) Determine the instantaneous value of the voltage when the conductor is at:

(i) 135° to the position of the magnetic field; **2**

(ii) 280° to the position of the magnetic field. **2**

(6)

5. The circuit shown in Figure Q5 is an operational amplifier with the ±15 V supplies omitted for clarity.

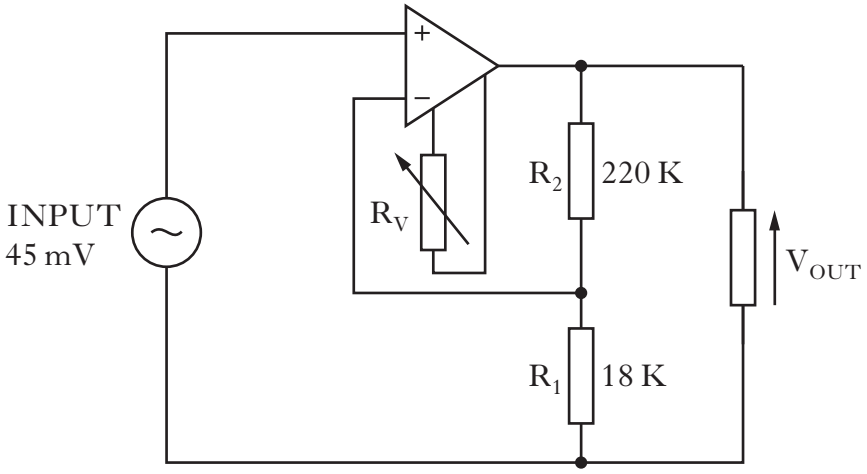

Figure Q5

(*a*) Name the circuit configuration shown in Figure Q5. **1**

(*b*) Calculate the gain of the circuit. **2**

(*c*) Calculate the output voltage. **2**

(*d*) State the purpose of the variable resistor R_V. **1**

(6)

[Turn over

Marks

6. With reference to Figures Q6(*a*) and Q6(*b*) identify the components shown and state one application for each.

(*a*)

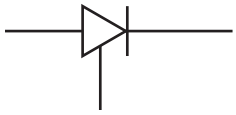

Figure Q6(*a*) **2**

(*b*)

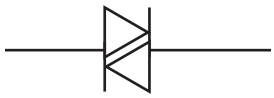

Figure Q6(*b*) **2**

(4)

Marks

7. A voltage, as shown in Figure Q7(*a*), is used as the supply voltage for the circuit shown in Figure Q7(*b*).

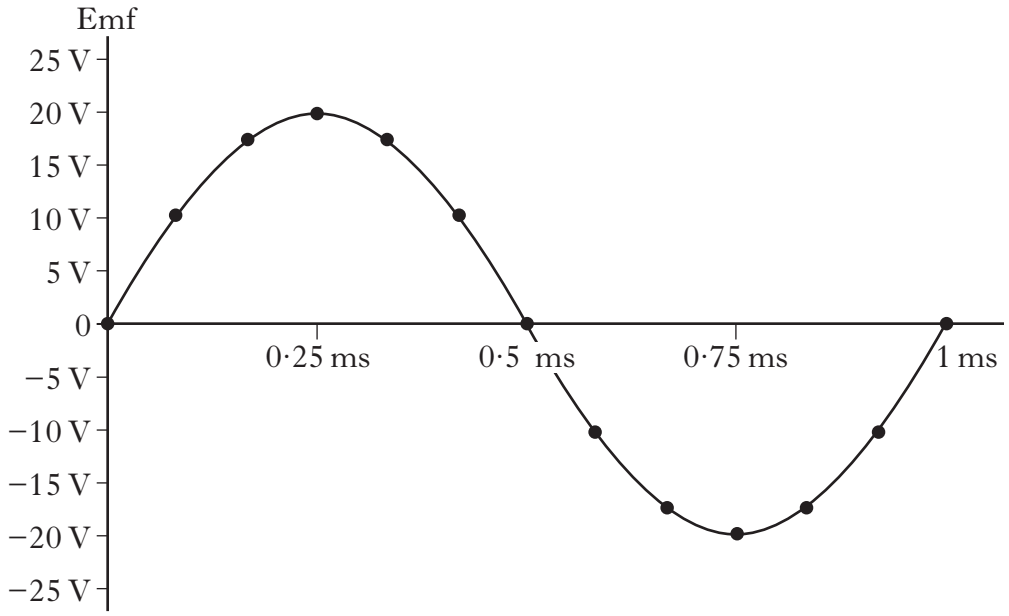

Figure Q7(*a*)

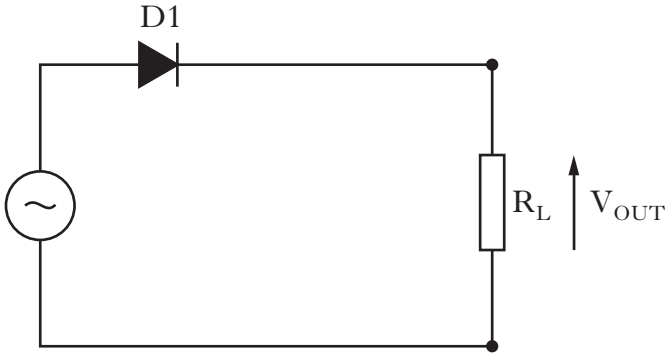

Figure Q7(*b*)

(*a*) Identify the circuit in Figure Q7(*b*). **1**

(*b*) Sketch the input voltage and output voltage obtained across the load resistor R_L clearly indicating the differences between the two voltages. **4**

(*c*) Determine the peak value of the current through R_L if R_L is 10 Ω. **3**

(8)

[Turn over

Marks

8. For each of the following truth tables identify the logic gate that produced them.

(*a*)

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

2

(*b*)

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

2

(4)

Marks

9. An emergency generator, used in a hospital, can only be started under the following conditions:

- The generator control circuit (C) is set to Automatic (logic 1) and
- the lubrication oil pump (P) is running (logic 1) and
- the main electricity supply (S) has failed (logic 0)

or

- The generator control circuit (C) is set to Test (logic 0) and
- the lubrication oil pump (P) is running (logic 1).

(*a*) Determine the logic output required to start the Generator (G). **3**

(*b*) Draw a logic diagram for this system using BS symbols. **3**

(*c*) Part of the generator output must be used to recharge the battery used for starting. State one type of device that could be used to convert the output voltage to dc. **1**

(7)

[Turn over

Section B

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

10 Figure Q10(*a*) shows the currents in a circuit.

(*a*) Determine the currents I_1, I_2, I_3, I_4, I_5, I_6 and I_7. **7**

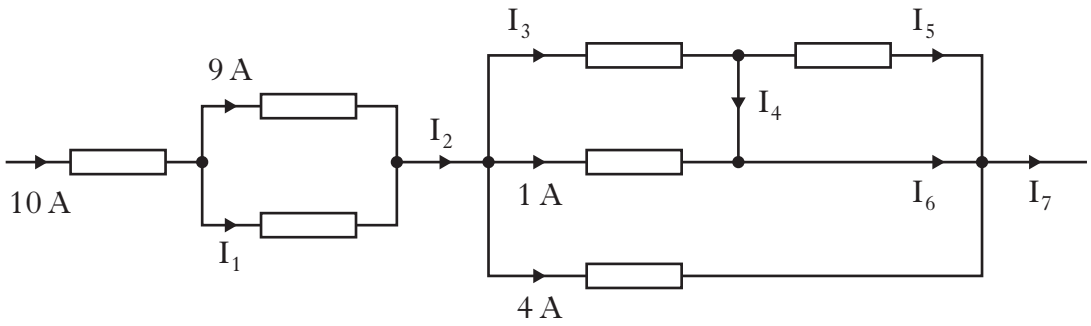

Figure Q10(*a*)

(*b*) With reference to the circuit shown in Figure Q10(*b*), determine the voltages, with respect to 0V, at:

(i) Point A; **1**

(ii) Point B; **2**

(iii) Point C. **2**

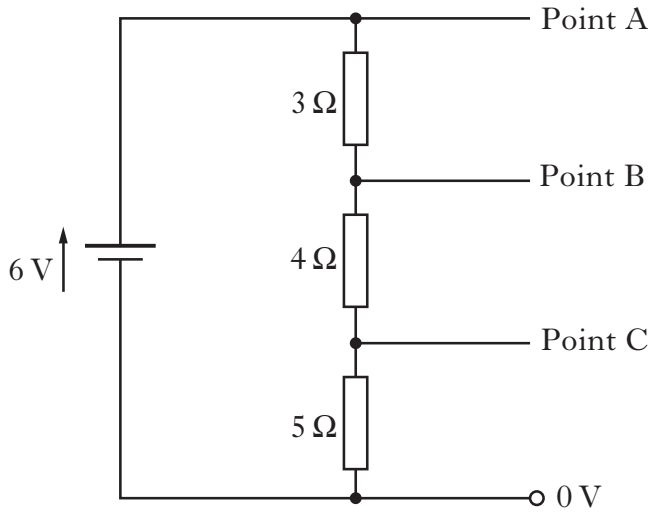

Figure Q10(*b*)

10. (continued)

(*c*) For the circuit shown in Figure Q10(*c*) below, determine:

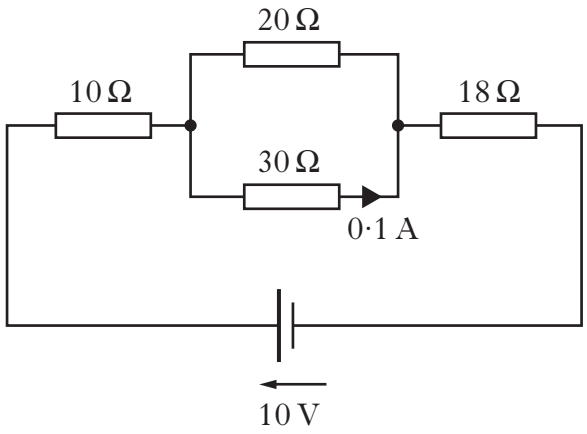

Figure Q10(*c*)

(i) the total circuit resistance; **3**

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

(iii) the current through the 20 Ω resistor; **2**

(iv) the circuit power; **1**

(v) the energy consumed by the circuit in 1·5 hours. **2**

A fault condition causes one of the resistors to be 'open-circuited' and one to be 'short-circuited', resulting in the circuit power decreasing.

(vi) Determine which resistors are faulty and the nature of the fault. **4**

(25)

[Turn over

Marks

11. (*a*) Perform the following binary additions.

(i) $0101_2 + 0111_2$ **2**

(ii) $0110_2 + 0011_2$ **2**

(*b*) Draw the logic circuit diagram for the following Boolean expressions using ANSI symbols.

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

(ii) $F = (A + B).\overline{(\bar{B} + C)}.(A + \bar{B} + C)$ **4**

(*c*) For the logic circuit shown in Figure Q11(*c*):

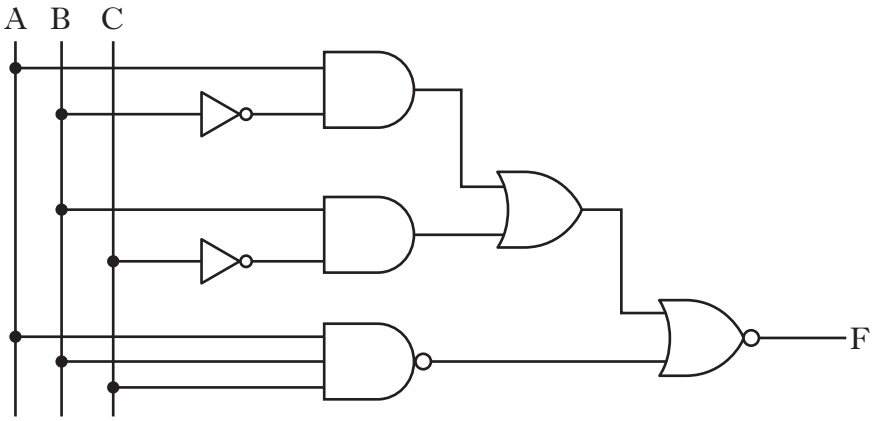

Figure Q11(*c*)

(i) determine the Boolean expression; **3**

(ii) construct the circuit truth table; **4**

(iii) state the single gate that could perform the same circuit function. **1**

A fault condition causes input line 'C' to be permanently 'high'.

(iv) Determine the circuit output at F for this fault condition. **5**

(25)

Marks

12. (*a*) For the circuit shown in Figure Q12(*a*) below, the variable resistor (R_V) can be varied between 2 kΩ and 4 kΩ.

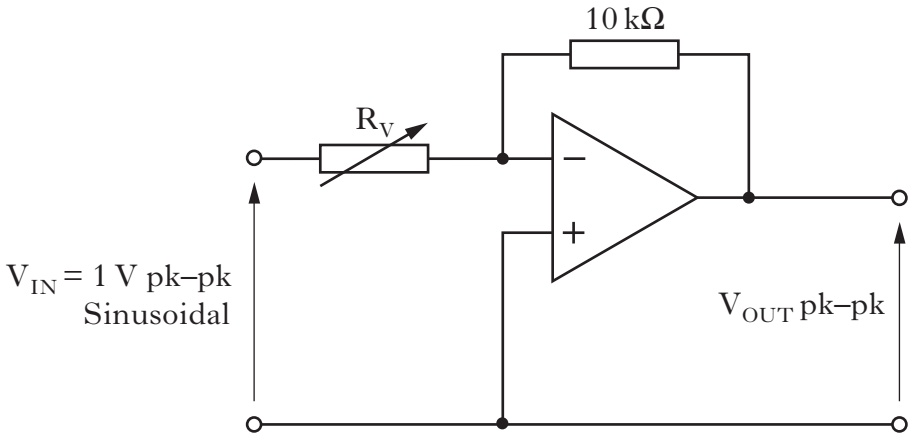

Figure Q12(*a*)

(i) Identify the circuit configuration. **1**

(ii) Determine the maximum V_{OUT} pk–pk. **3**

(iii) Determine the maximum rms value for V_{OUT}. **2**

(iv) Sketch two cycles of the input voltage and the maximum output voltage clearly indicating the input and output phase relationship and peak values. **3**

(*b*) A sinusoidal input signal of 10 V pk–pk is applied to the circuit shown in Figure Q12(*b*) below.

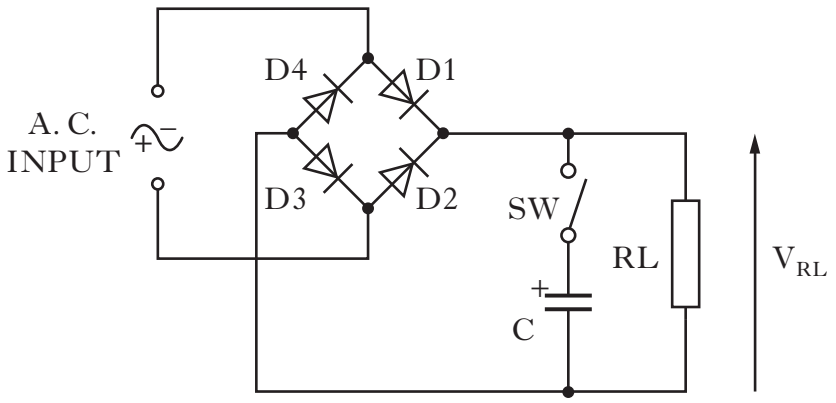

Figure Q12(*b*)

(i) State the function (or process) performed by the circuit. **1**

(ii) State which diodes are conducting during the positive cycle. **2**

(iii) Explain why the performance of the circuit is improved when the switch is closed. **3**

(iv) Sketch the input and output (V_{RL}) waveforms, to the same timebase, when the switch is closed, assuming a forward diode volt drop of 0·7 V. **3**

[Turn over for Question 12(*c*) on *Page twelve*]

Marks

12. (continued)

(*c*) For the circuit shown in Figure Q12(*c*) below:

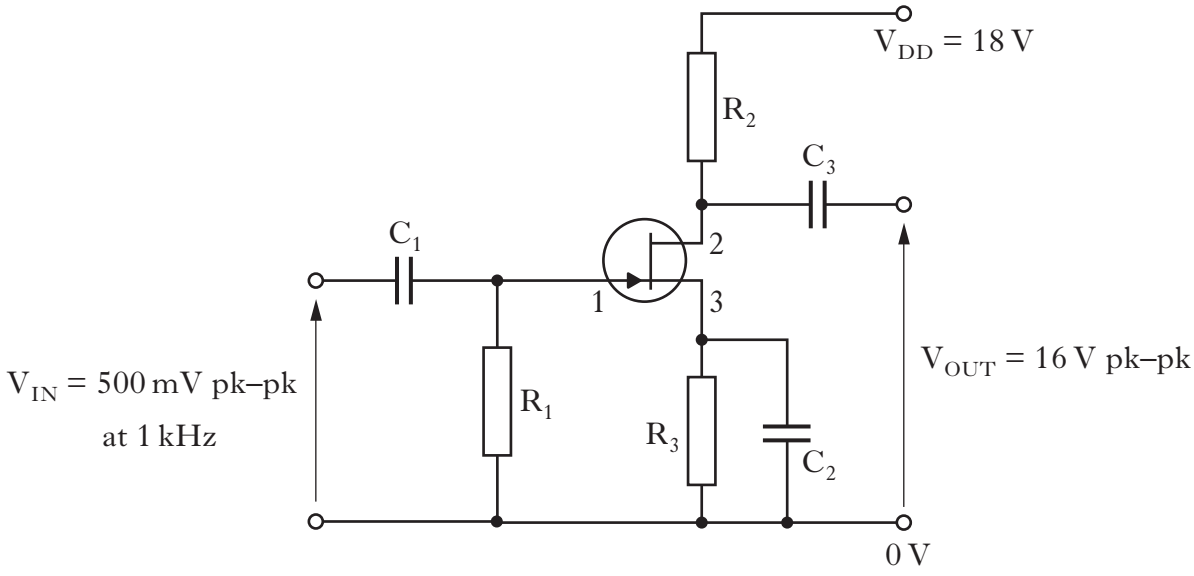

Figure Q12(*c*)

(i) identify the circuit configuration; **2**

(ii) identify the transistor terminals 1, 2 and 3; **3**

(iii) determine the circuit gain. **2**

(25)

[*END OF QUESTION PAPER*]