

X025/201

NATIONAL
QUALIFICATIONS
2010

TUESDAY, 8 JUNE
1.00 PM – 3.30 PM

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).

Datasheets are provided for questions 5 and 10(b).

A Worksheet is provided for questions 10(b) and 10(c).

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) $1F_{16}$ | Hexadecimal to Decimal: | 1 |
| (b) 126_{10} | Decimal to Binary: | 1 |
| (c) 10011110_2 | Binary to Hexadecimal: | 1 |
| | | (3) |

2. With reference to Figures Q2(a), (b) and (c), identify the components shown and state one application for each.

(a)

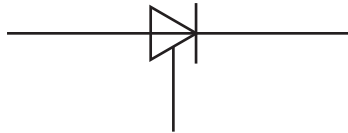


Figure Q2(a)

2

(b)

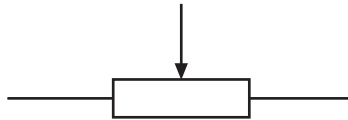


Figure Q2(b)

2

(c)

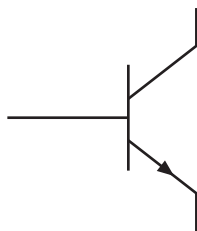


Figure Q2(c)

2
(6)

3. In the diagram Figure Q3(a), shown below, an iron ring has been placed in a magnetic field and the field pattern has been plotted.

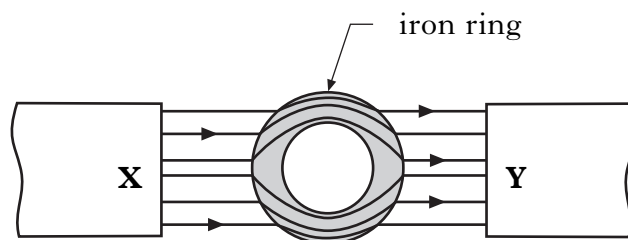


Figure Q3(a)

- (a) Identify the magnetic pole **X**. 1
- (b) Draw the field pattern obtained when the iron ring is replaced by a brass ring. 2
(3)
4. Draw, using BS symbols, the logic diagrams for the following expressions. 3
- (a) $Z = R.\bar{S}.T + R.\bar{T}$ 3
- (b) $Z = \overline{A+B+C} . \overline{A+B+C}$ 3
(6)
5. With reference to Figure Q5 and the data sheets provided, determine:

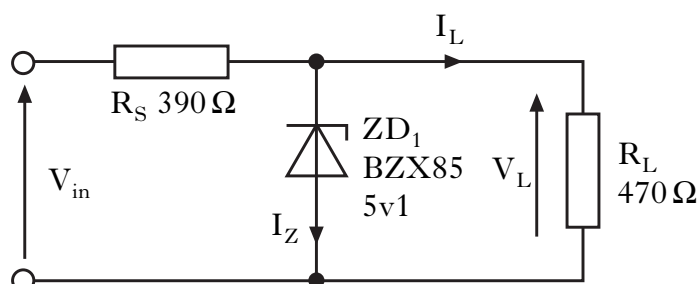


Figure Q5

- (a) the maximum power the Diode ZD_1 can handle; 1
- (b) the maximum current in the Diode ZD_1 ; 2
- (c) the load current I_L when $V_L = 5.1$ V; 2
- (d) the maximum permitted value of supply voltage. 3
(8)

6. (a) State the formula for determining the force on a current carrying conductor. **1**

- (b) A current carrying conductor is placed between the poles of a magnet. The length of the conductor in the magnetic field is 500 mm and the magnetic flux density is 0.5 Tesla.

If the force on the conductor is 5 Newtons, calculate the current in the conductor. **2**

- (c) The formula for determining the voltage generated when a current carrying conductor is moved in a magnetic field is $E = Blv$.

Determine the voltage generated if the velocity of the conductor is 4 m s^{-1} , the field strength is 0.5 T and the length of the conductor is 5 m. **2**

(5)

7.

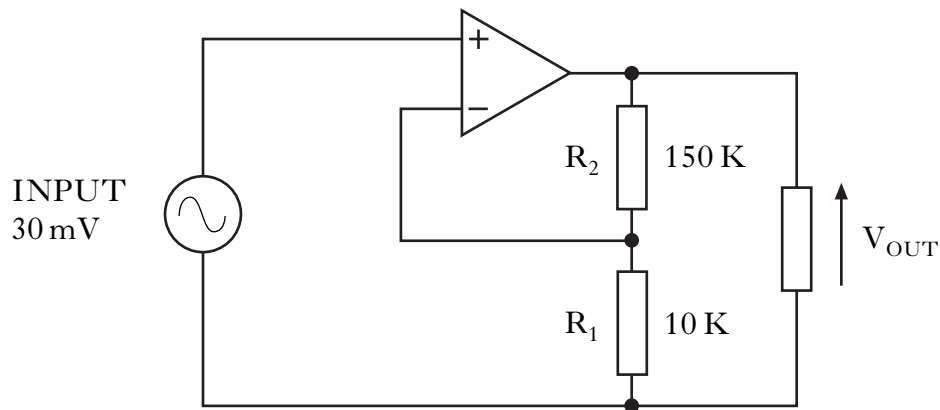


Figure Q7

The circuit shown in Figure Q7 is an operational amplifier with the $\pm 15 \text{ V}$ supplies omitted for clarity.

- (a) Name the circuit configuration shown in Figure Q7. **1**

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

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

(5)

8.

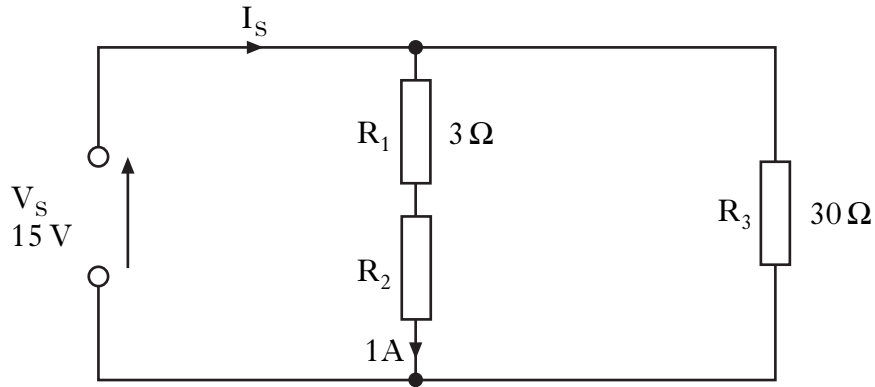


Figure Q8

For the circuit shown in Figure Q8 determine:

- | | |
|---|------------|
| (a) the current in the resistor R_3 ; | 2 |
| (b) the supply current I_S ; | 1 |
| (c) the voltage across the resistor R_1 ; | 1 |
| (d) the value of the resistor R_2 ; | 2 |
| (e) the total circuit resistance. | 2 |
| | (8) |
-
9. A high pressure gas test can only be carried out when the following conditions are met and there is a logic “1” at the output of the control circuit.
- The explosion proof door (A) is closed and locked (logic 1)
 - The warning beacon (B) has been activated (logic 1)
 - The emergency stop (C) has not been pressed (logic 0)
- | | |
|---|------------|
| (a) Determine the logic expression for the control circuit. | 2 |
| (b) Draw the truth table for the expression. | 2 |
| (c) Draw the logic diagram for the control circuit. | 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) Add the following binary numbers.

$$1010_2 + 1110_2$$

2

- (b) Using Worksheet Q10(b) and the supplied datasheet for the circuit shown in Figure Q10(b) below, draw the logic circuit diagram on the worksheet and label all gate inputs and outputs with the appropriate pin connections.

8

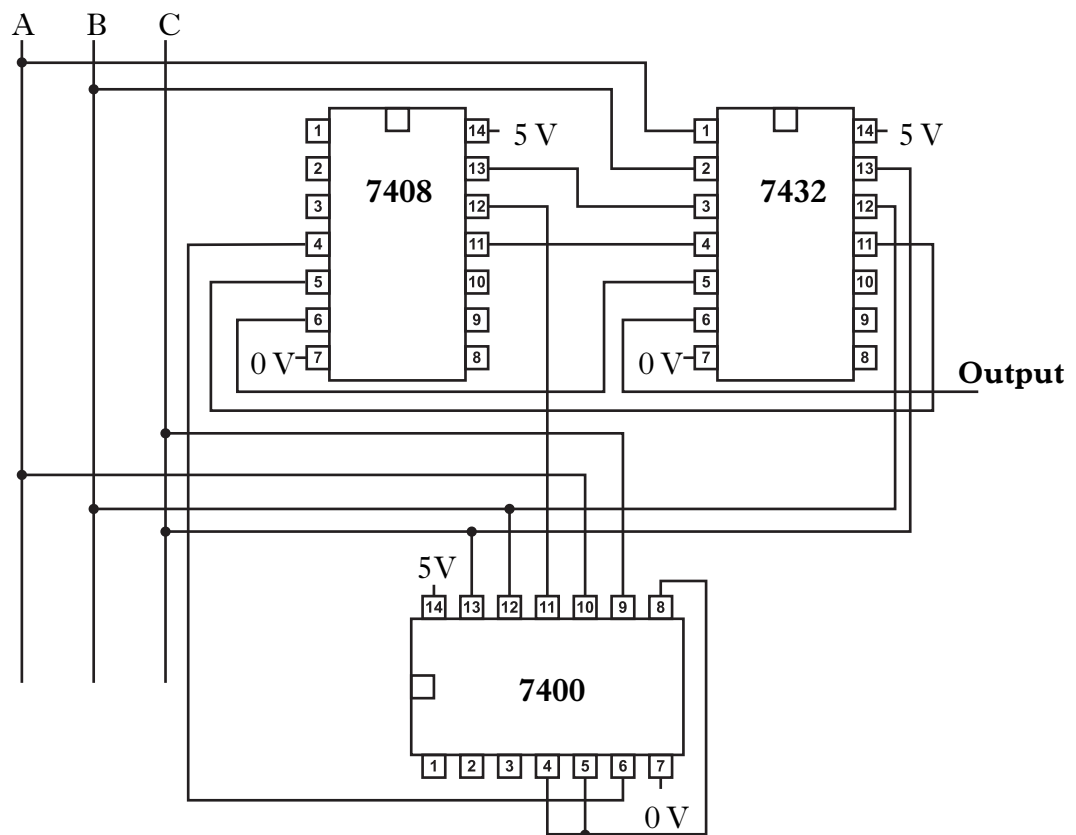


Figure Q10(b)

10. (continued)

(c) Using Worksheet Q10(c) for the circuit shown in Figure Q10(c) below:

- (i) determine the circuit Boolean expression; 3
- (ii) complete the circuit truth table on the Worksheet. 8
- (iii) A fault condition causes pin 11 on the 7400 to be permanently low. State what type of gate could replace the complete circuit under this fault condition. You must explain your answer. 4
- (25)**

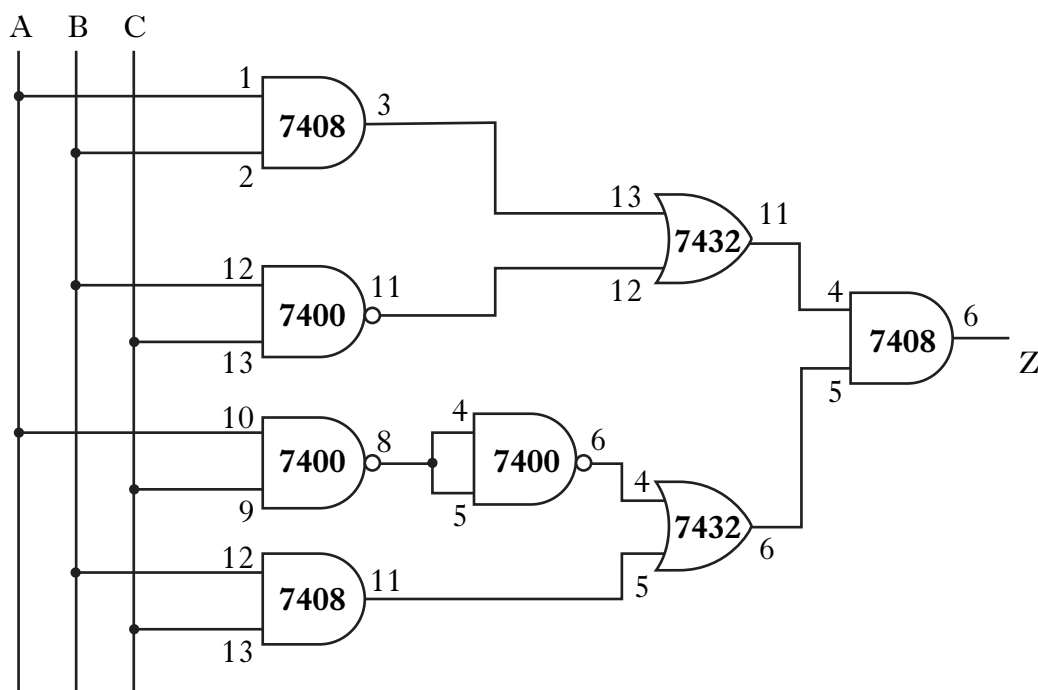
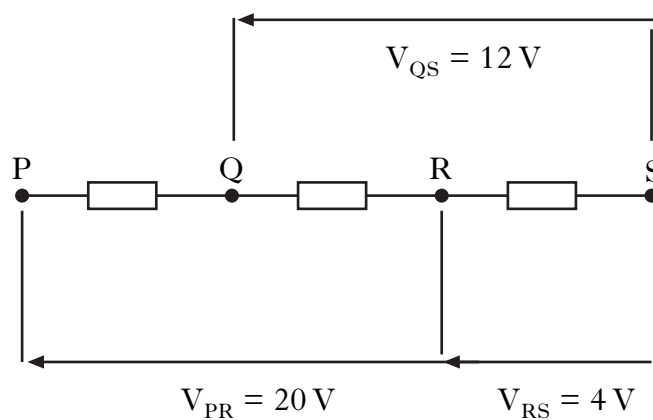


Figure Q10(c)

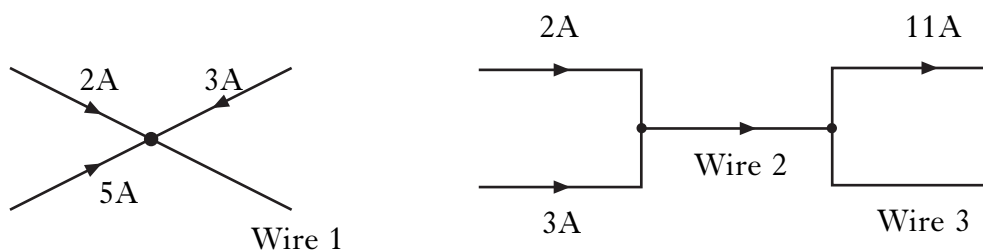
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11. (a) For the diagram shown in Figure Q11(a) below, determine:



- (i) the voltage V_{QR} ; 2
- (ii) the voltage V_{PQ} . 2

- (b) For the circuits shown in Figure Q11(b) below, determine:



- (i) the size and the direction of the current in wire 1; 2
- (ii) the size of the current in wire 2 and wire 3. 2

11. (continued)

- (c) For the circuit shown in Figure Q11(c) below, the variable resistor can be varied between $5\ \Omega$ and $15\ \Omega$. It is initially set at $10\ \Omega$.

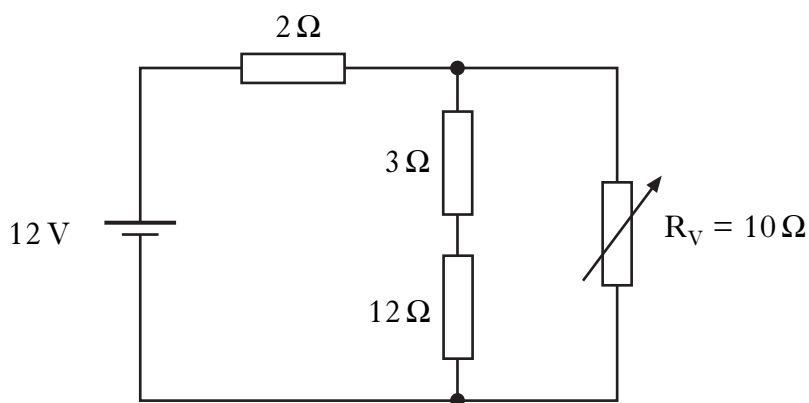


Figure Q11(c)

- | | |
|---|-------------|
| (i) Show that the total circuit resistance is $8\ \Omega$. | 2 |
| Determine: | |
| (ii) the supply current; | 1 |
| (iii) the voltage across the $2\ \Omega$ resistor; | 1 |
| (iv) the voltage across the $10\ \Omega$ resistor (R_V); | 3 |
| (v) the current through the $10\ \Omega$ resistor (R_V); | 2 |
| (vi) the power dissipated by the circuit; | 2 |
| (vii) the energy consumed in five minutes; | 2 |
| (viii) the value that R_V should be set to for minimum circuit current; | 2 |
| (ix) the value that R_V should be set to for maximum circuit power. | 2 |
| | (25) |

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12. For the circuit shown in Figure Q12(a) below, the variable resistor (R_V) can be varied between $1\text{ k}\Omega$ and $100\text{ k}\Omega$.

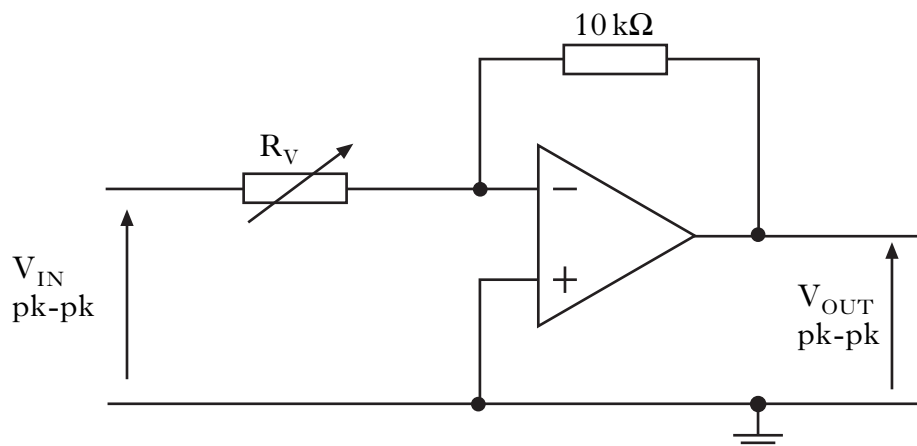


Figure Q12(a)

- (a) Determine the value of R_V required to obtain the following.
- (i) Maximum V_{OUT} 2
 - (ii) Minimum V_{OUT} 2
 - (iii) $V_{OUT} \text{ (pk-pk)} = V_{IN} \text{ (pk-pk)}$ 2
- (b) When the output voltage is 3.4 V pk-pk and the input voltage is 1.36 V pk-pk , determine:
- (i) the value of R_V to obtain this output voltage; 2
 - (ii) the rms value of V_{OUT} . 2

12. (continued)

(c) For the circuit shown in Figure Q12(c) below;

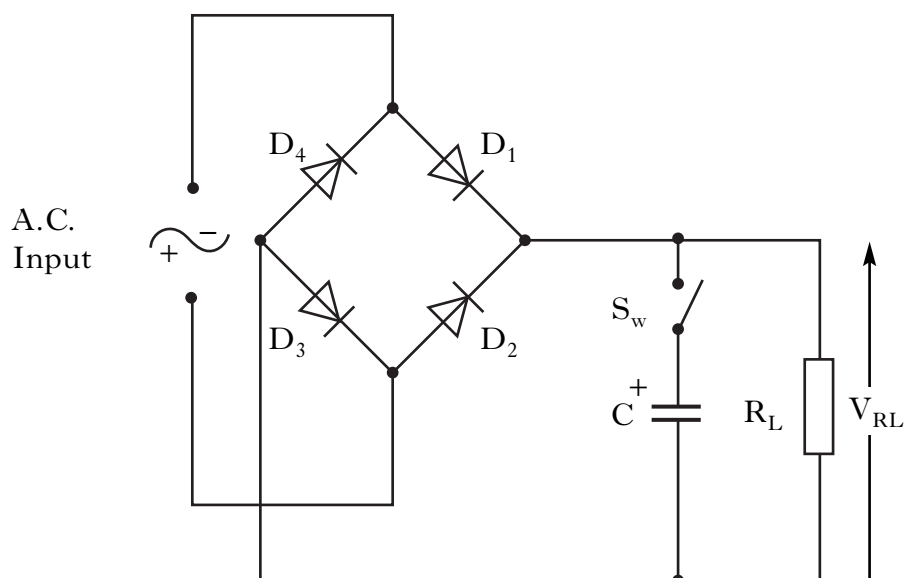


Figure Q12(c)

- | | |
|--|---|
| (i) explain the purpose of the diode arrangement in terms of load current; | 2 |
| (ii) explain why the polarity of V_{RL} is always the same. | 2 |

Sketch the waveform for the voltage across V_{RL} (neglecting diode voltdrops) when the switch is:

- | | |
|--------------|---|
| (iii) open; | 2 |
| (iv) closed. | 2 |

[Turn over

12. (continued)

(d) For the circuit shown in Figure Q12(d) below:

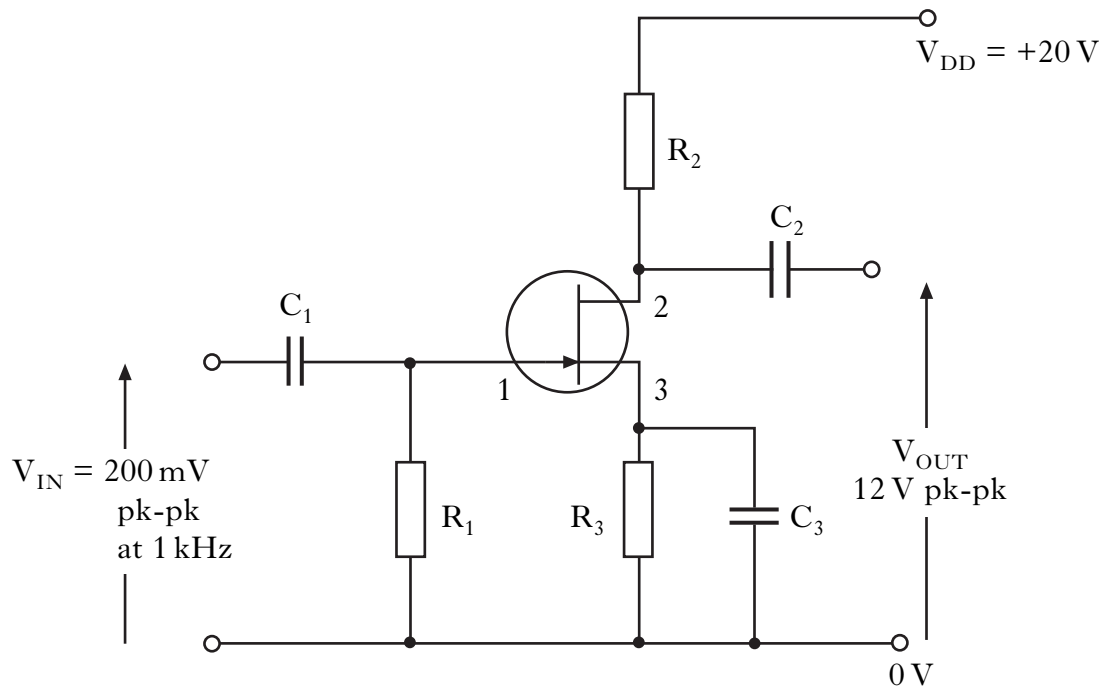


Figure Q12(d)

- | | |
|--|-------------|
| (i) identify the circuit configuration; | 2 |
| (ii) identify the transistor terminals 1, 2 and 3; | 3 |
| (iii) determine the circuit gain; | 1 |
| (iv) state the purpose of capacitor C_1 . | 1 |
| | (25) |

[END OF QUESTION PAPER]

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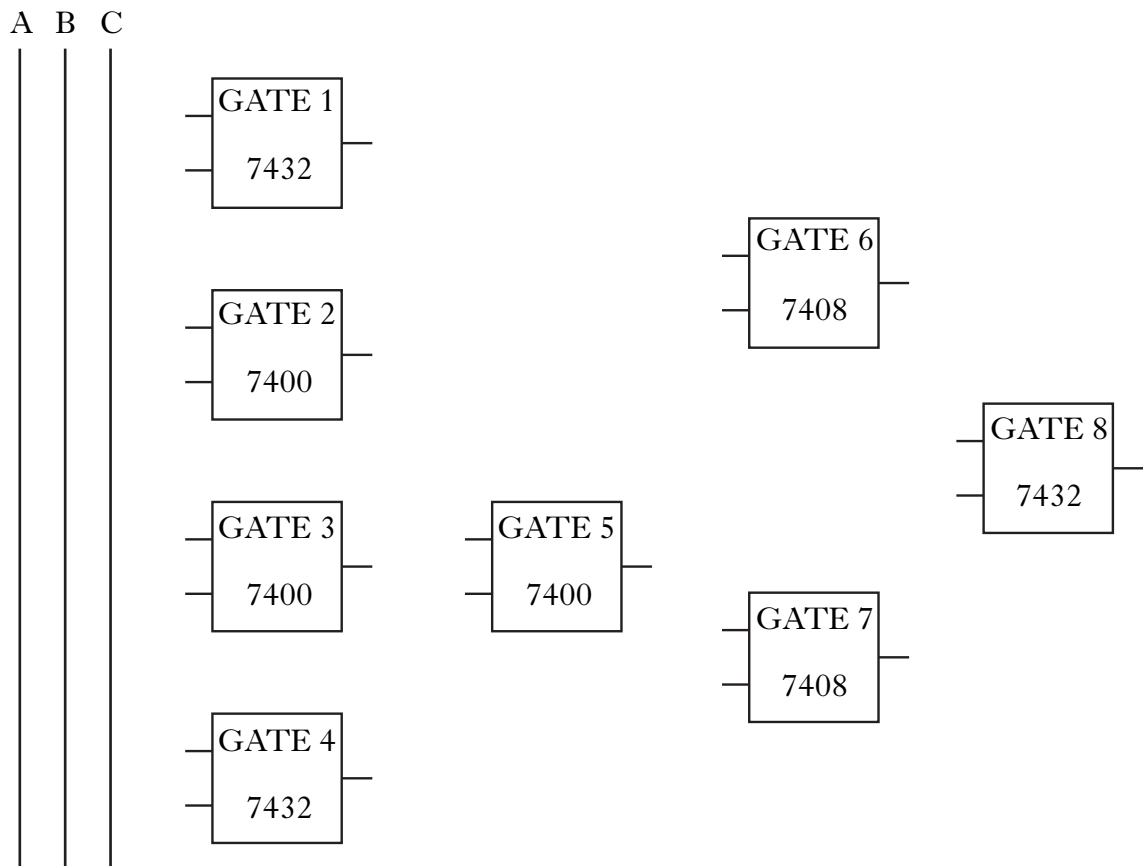
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Worksheet for Q10(*b*) and (*c*).



Worksheet for Question 10(b)



Worksheet for Question 10(c)

INPUTS			GATE OUTPUT								Fault condition
A	B	C	7408 Pin 3	7400 Pin 11	7400 Pin 8	7408 Pin 11	7400 Pin 6	7432 Pin 11	7432 Pin 6	7408 Pin 6	
0	0	0									
0	0	1									
0	1	0									
0	1	1									
1	0	0									
1	0	1									
1	1	0									
1	1	1									

[END OF WORKSHEET]

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INTERMEDIATE 2
Datasheet for Q5 and Q10(*b*).



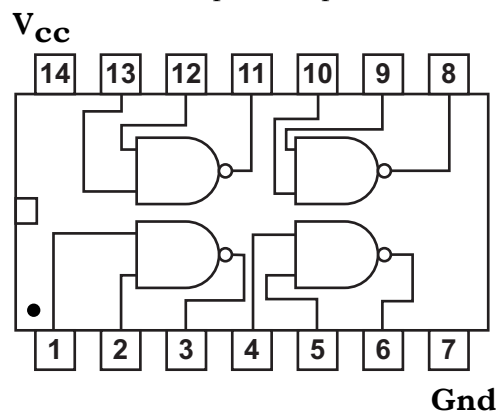
Datasheet for Question 5

ZENER DIODES

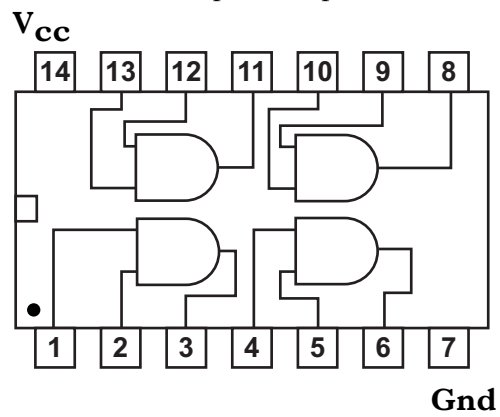
<i>Diode Series</i>	<i>Zener Voltage Range (V)</i>	<i>Power (mW)</i>	<i>Non Repetitive Power (W)</i>	<i>Max Junction Temp (°C)</i>
UDZ (SMT)	2·02 – 36·87	200	N/A	N/A
PLVA400A	5·2 – 7·0	400	30	175
BZX79	2·4 – 75	500	30	200
BZX85	3·6 – 62	1·3 W	11	175
BZX284(SMT)	2·4 – 75	400	N/A	N/A
BZT03C	6·2 – 150	3·25W	N/A	N/A
1N5333	3·9 – 120	5 W	N/A	N/A
1N53	3·3 – 200	5 W	N/A	N/A
BZY93	8·2 – 75	20 W	N/A	N/A

Datasheet for Question 10(b)

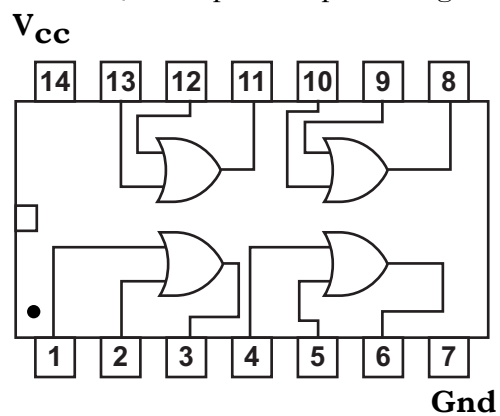
7400 Quadruple 2-input NAND



7408 Quadruple 2-input AND



7432 Quadruple 2-input OR gate



[END OF DATASHEET]

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