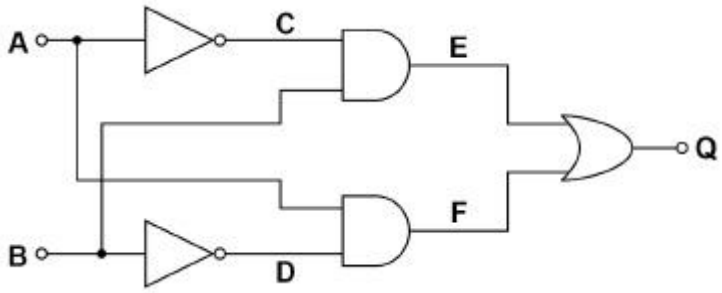
Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

(a) Two logic inputs, **A** and **B**, feed into the logic circuit shown in **Figure 1**. The logic output from the circuit is **Q**.

Figure 1



Deduce the Boolean expression for the output of this logic circuit in terms of inputs **A** and **B**. Include all the logic operations that take place between the inputs and the output.

Q = _____

(2)

(b) The truth table shows some of the logic states for the logic gates in **Figure 1**.

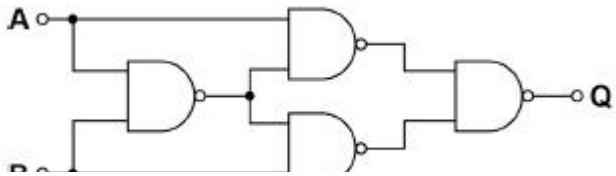
Complete the truth table.

B	A	C	D	E	F	Q
0	0		1		0	0
0	1		1		1	1
1	0		0		0	1
1	1		0		0	0

(2)

(c) **Figure 2** shows a different logic circuit that produces the same logic output as that of **Figure 1**.

Figure 2



A manufacturer wants to produce a system that uses this logic function, but is undecided as to which circuit to use.

Suggest, giving reasons, **two** benefits of using the logic circuit in **Figure 2** compared to the logic circuit in **Figure 1**.

_____

_____

_____

_____

_____

_____

(2)

(d) State the single logic gate that would perform the same logic function as the circuits shown in **Figure 1** and **Figure 2**.

_____

(1)

(Total 7 marks)

Q2.

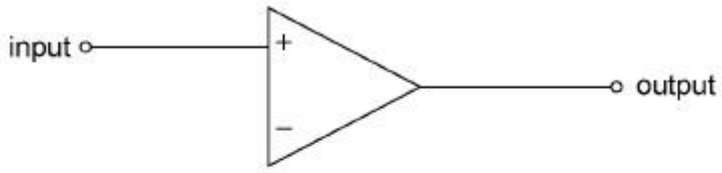
(a) An ultrasound sensor produces an output that needs to be amplified to 3.0 V
The amplifier used has a voltage gain of 40

Calculate the input voltage V_{in} to the amplifier from the sensor.

V_{in} = _____ V

(1)

(b) An operational amplifier in non-inverting mode is used to amplify the output of the sensor. The partially completed circuit diagram is shown below.



Complete the circuit diagram above by adding and labelling two resistors, R_{in} **and** R_f, **so that the operational amplifier is correctly configured in its non-inverting mode.**

The power lines should not be shown in the completed diagram.

(2)

(c) Determine, using resistors selected from the list below, how the voltage gain of 40 can be achieved by the non-inverting amplifier of the diagram.

1 kΩ 3.6 kΩ 10 kΩ 39 kΩ 150 kΩ

R_{in} = _____ **kΩ**

R_f = _____ **kΩ**

(2)

(d) The ultrasound frequency detected by the sensor is 50 kHz
For this operational amplifier

gain × bandwidth = 1.0 MHz

Discuss whether this operational amplifier is suitable for amplifying the sensor's output voltage.

_____

_____

_____

_____

_____

_____

(2)
(Total 7 marks)

Q3.

In a recording studio the output from a microphone is an analogue signal.
The equipment in the studio converts this analogue signal into a digital signal before storing it.

Discuss aspects of the analogue-to-digital conversion in this context.

In your answer you should include:

- what is meant by quantisation
- factors that affect the quality of the digital version of the analogue signal
- the advantages and disadvantages of digitising the analogue signal.

You may use diagrams to help make clear aspects of your answer.

(Total 6 marks)