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

Q1.

A student needs to monitor the temperature of a pond using a remote link. To provide the link the student decides to use radio transmitter and receiver modules.

The radio modules available to the student are available with either amplitude modulation (AM) or with frequency modulation (FM).

(a) Describe what is meant by amplitude-modulated and by frequency-modulated radio waves.

In your answer you should:

- indicate the principal features of each of these two types of modulation
- explain the differences between them
- refer to the advantages and disadvantages of using each type of modulation.

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(6)

(b) The radio modules chosen by the student transmit a signal that is amplitude modulated having a carrier frequency of 434 MHz. The data sheet for the modules specifies quarter-wave aerials for both the transmitter and receiver.

Calculate the length of a quarter-wave aerial.

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length of aerial = _____ m

(2)

(c) The output from the temperature sensor in the pond is connected to an astable oscillator. The frequency f (in Hz) of the astable varies with temperature θ (in °C) according to the equation

$$f = 7.3(6\theta + 273)$$

During the course of the year the temperature of the pond varies between 4°C and 22°C. The highest frequency produced by the astable is 3.0 kHz.

Calculate the lowest frequency in kHz produced by the astable.

lowest frequency = _____ kHz

(1)

(d) Deduce the maximum bandwidth required by the AM carrier wave produced by the radio transmitter as the signal from the astable is transmitted.

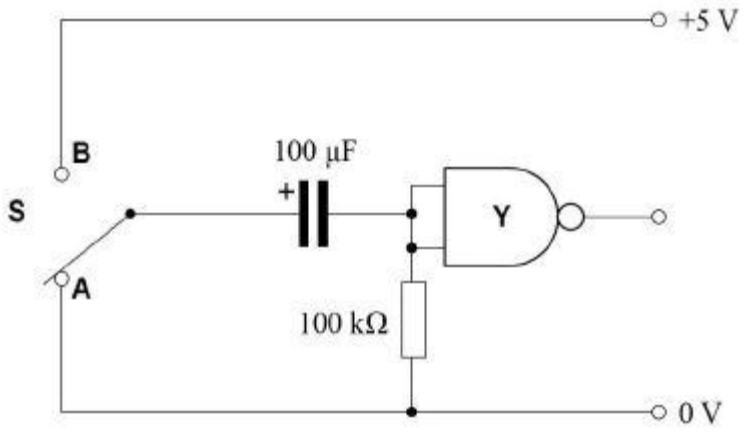
(2)

(Total 11 marks)

Q2.

A student experiments with the circuit shown in **Figure 1**.

Figure 1



Y is a NAND gate for which an input of less than 2.5 V is logic state 0 and input greater than 2.5 V is logic state 1.

Switch **S** is set to position **A** for a long time so that the capacitor is uncharged.

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(a) Explain why the output of **Y** is logic state 1.

_____

_____

_____

(1)

(b) When **S** is moved to position **B**, the capacitor charges through the 100 kΩ resistor.

Show that the capacitor will be charged to 2.5 V after about 7 s.

(2)

(c) Suggest an application for a circuit such as that shown in **Figure 1**.

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(1)

(Total 4 marks)

Q3.

(a) Describe what is meant by amplitude modulation (am).

_____

_____

_____

(1)

(b) A radio wave has an unmodulated frequency of 120 kHz. It is amplitude modulated by a signal from an audio transducer of frequency 2.2 kHz.

Calculate the bandwidth of the modulated wave.

bandwidth = _____ kHz

(1)

(c) Explain why frequency modulation (fm) is not used for commercial radio transmissions in the

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medium and long wave bands.

_____

_____

(1)

(d) State and explain **one** advantage of transmitting digital signals using frequency modulation (fm) rather than amplitude modulation (am).

_____

_____

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_____

(2)

(Total 5 marks)

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