RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

Bachelor of Science in Information Technology
First Year - Semester I Examination – July / August 2023

ICT 1303 – BASIC ELECTRONICS AND DIGITAL LOGIC DESIGN

Time: Three (03) hours

- There are **SIX (06)** questions in **THREE (03)** pages.
- All questions carry equal marks.
- Answer **ANY FIVE (05)** questions.

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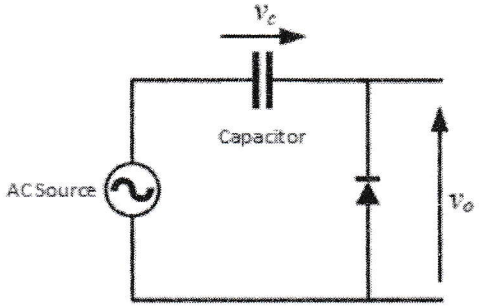
1. a) Explain why it is necessary to mix impurities with pure semiconductors to make them suitable to be used in electronic devices. (05 marks)

   b) Discuss what happens when a PN junction is formed. (05 marks)

   c) Explain the operation of the following circuit using sketches of input and output waveforms. Assume that initial value of v_c is non-zero.



   (05 marks)

   d) Briefly explain the rectification function of diodes using suitable diagrams. (05 marks)

2. a) Briefly explain the differences of the three regions (collector, base, and emitter) of a bipolar junction transistor. (05 marks)

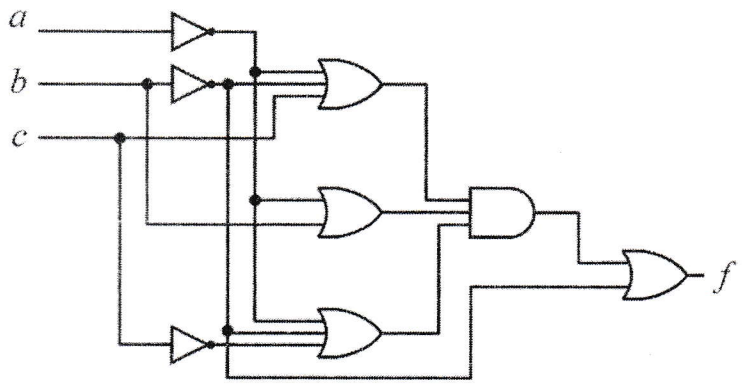
b) Briefly discuss how a bipolar junction transistor can function as a switch. (05 marks)

c) Explain how an enhancement MOSFET works. (05 marks)

d) Explain how a single MOSFET can be used as an inverter (NOT gate). (05 marks)

3. a) Prove that, $(\bar{a} + \bar{b} + c)(\bar{a} + b)(\bar{a} + \bar{b} + \bar{c}) = \bar{a}$ using Karnaugh Maps. (05 marks)

b) Find the minimal circuit for the function implemented by the following circuit using the proof in part a.



(05 marks)

c) Show that an X-OR gate can be used to subtract two bits. (05 marks)

d) Design a 2-to-1 multiplexer using only NAND gates. (05 marks)

4. An air conditioner is controlled by an electronic circuit. It is operated by three signals that represent temperature, humidity, and the presence of people in the room. A fourth signal is used to switch off the air conditioner manually. The air conditioner needs to operate only when the manual switch is on and there are people in the room. It should run when either the temperature, humidity, or both are high. Design the electronic circuit that controls the air conditioner. You are required to write down the truth table, minterms and the Boolean expression. Then minimize the expression and draw the minimal circuit. Clearly state all assumptions you made. (20 marks)

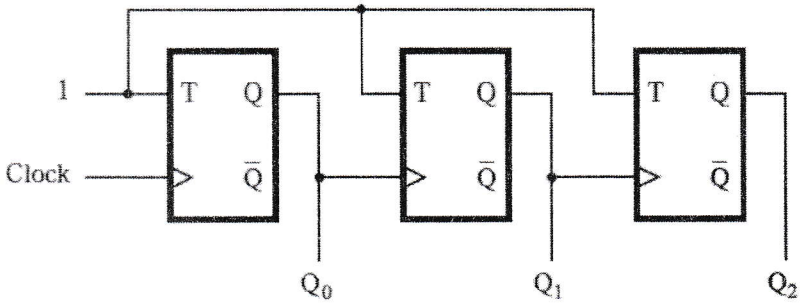
5. a) Discuss how a simple latch can be used as a memory element.

(05 marks)

b) Show the difference between edge-triggered flip-flops and level-sensitive flip-flops using timing diagrams.

(05 marks)

c) Explain the output of the following circuit using timing diagrams.



(10 marks)

6. Design an octal (modulo-8) synchronous up/down counter using JK flip-flops. (20 marks)

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