R22

Code No: 183AP

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech II Year I Semester Examinations, December- 2024/ January -2025

DIGITAL ELECTRONICS

(Common to CSE(IOT), AI&DS)

Time: 3 Hours **Max. Marks: 60**

Note: This question paper contains two parts A and B.
i) **Part- A** for 10 marks, ii) **Part - B** for 50 marks.

- Part-A is a compulsory question which consists of ten sub-questions from all units carrying equal marks.
- Part-B consists of **ten questions** (numbered from 2 to 11) **carrying 10 marks each**. From each unit, there are two questions and the student should answer one of them. Hence, the student should answer five questions from Part-B.

PART- A

(10 Marks)

1.a) Convert the following number to decimal $(198)_{12}$. [1]
b) Give the 2's complement of 1000110110. [1]
c) In Boolean logic, what does the term "minterm" refer to? [1]
d) Which logic gate combination can replace an XOR gate in a digital circuit? [1]
e) What is a multiplexer? [1]
f) What is a priority encoder? [1]
g) What is a ripple counter? How many flip-flops are required for a 3-bit ripple counter? [1]
h) Define a "modulus counter." [1]
i) What is the main purpose of a memory decoder in a RAM module? [1]
j) What is the function of a Look-Up Table (LUT) in an FPGA? [1]

PART- B

(50 Marks)

2.a) What is a Boolean function? Differentiate between canonical and standard forms of Boolean expressions with examples. Express the Boolean function $F(A,B,C) = A + BC$ in both SOP and POS form.
b) Design a two-level implementation of the Boolean function $F = (A + B)(C + D)$ using NAND and NOR gates. [5+5]

OR

3.a) Define Boolean Algebra and list its basic axioms. Also State and Prove DeMorgan's Theorem.
b) Obtain the truth table of the following Boolean function, express the function in Sum of minterms and Product of Maxterms and also obtain the Dual and Complement of the function. $F = (xy + z).(y + xz)$. [5+5]

4.a) Explain the concept of "don't-care" conditions and their use in Boolean function minimization. Simplify the Boolean function $F(A,B,C,D) = \Sigma(0,2,5,7,8,10,12,15)$ with don't-care conditions at $d(A,B,C,D) = \Sigma(1,6,11,14)$ using a 4-variable K-map. Show the steps and final simplified expression.

b) Explain the properties of the Exclusive-OR (XOR) function and illustrate how it is used in arithmetic operations and error detection. Given the Boolean expression: $F(A,B,C) = A \oplus B \oplus C$ expand the function in terms of basic AND, OR, and NOT operations. [5+5]

OR

5.a) Explain two-level logic gate implementations. Using a two-level NAND-only implementation, simplify and implement the function $F(A,B,C,D) = AB + CD + \bar{A}\bar{C} + \bar{B}\bar{D}$. Draw the circuit and provide a detailed explanation of each simplification step.

b) Implement a logic circuit that represents a 5-input majority function, where the output is high if three or more inputs are high. Using K-map minimization, simplify the Boolean expression and implement it using only NAND gates. [5+5]

6.a) Design a 3-to-8 decoder circuit and explain how it can be used to implement any Boolean function of three variables.

b) Write a VHDL code to implement a 4-bit binary adder. Describe each part of the code, including entity, architecture, and signal declaration. [5+5]

OR

7.a) Design a 4-to-1 multiplexer circuit using basic logic gates. Show how this multiplexer can be used to implement any 2-variable Boolean function.

b) Design a 4-bit magnitude comparator circuit using basic logic gates. Explain how you can determine if one number is greater than, equal to, or less than another number using this circuit. [5+5]

8.a) A clocked sequential circuit has one input X and one output Z. The output Z is "1" if and only if the input X has been "1" for exactly two consecutive clock cycles. Derive the state diagram for this circuit, identify the states, and explain the transition conditions.

b) Design a 3-bit asynchronous (ripple) down-counter. Draw the circuit diagram and timing diagram to show its operation from an initial count of "111" to "000." [5+5]

OR

9.a) Design a sequence generator that outputs the sequence "001, 011, 101, 111" continuously. Show the state diagram, state table, and the resulting flip-flop excitation table. Identify the flip-flop type best suited for implementing this sequence generator and justify your choice.

b) Explain the operation of a Parallel-In Parallel-Out (PIPO) shift register. How can this type of register be used in data processing applications? Design a 4-bit PIPO shift register using D flip-flops. [5+5]

10.a) Implement the Boolean function $F = AB + \bar{A}C$ using a PAL. Show the configuration of the PAL and explain how each input is connected to generate the function.

b) Design a 2x4 ROM that stores the binary numbers "1001," "1100," "0110," and "0011" in each address. Show the circuit diagram and explain the operation of ROM for any one address input. [5+5]

OR

11.a) Define memory decoding. Design a memory decoder for a 4x8 memory system and explain how it helps in accessing specific memory locations within the system.

b) Design a 4x4 memory array with 4-bit words using SRAM cells. Draw the circuit diagram and explain the read and write operations in detail. [5+5]

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