INTERNATIONAL CENTRE FOR APPLIED SCIENCES
MAHE, MANIPAL

B.Sc. (Applied Sciences) in Engg.

End – Semester Theory Examinations – Nov./ Dec. 2020

III SEMESTER - SWITCHING CIRCUIT AND LOGIC DESIGN (ICS 232)

(Branch: CS)

Time: 3 Hours **Date: 25 November 2020** **Max. Marks: 100**

- ✓ **Answer any FIVE full questions.**
- ✓ **Missing data, if any, may be suitably assumed**
- ✓ **Plagiarism in any format will invite penalty marks.**

1A. Convert the following expressions to canonical forms: **[10M]**

I: $AB + BC'D + A'D$

II: (A+B') (C'+D') (B'+C')

III: Y (ABC) = (A+B') (B+C) (A+C')

IV: Y= AB+ACD

V: Y= AB+CD

1B. Suppose, the output of a 3- input system is high for the input combinations: 010, 011, 101 and 111. **[10M]**

I: Derive the truth table for the system along with minterms and maxterms.

II: Formulate the Sum of Products expression for the output.

III: Construct the circuit for the canonical form and calculate the cost of the canonical circuit.

IV: Construct a minimal form of the circuit and compute its cost.

V: Calculate how many transistors are required if the circuit is implemented using CMOS.

2. Answer the following questions. Give appropriate examples and neat diagrams wherever necessary. **[20M]**

A: With the help of neat diagrams explain use of PMOS and NMOS transistors in CMOS circuits.

B: What are the advantages of using CMOS transistors in circuit design?

C: Explain power dissipation in CMOS transistors with the help of an appropriate example.

D: Explain concept of fan-in and fan-out with the help of an appropriate example.

E: How does the power dissipation vary in CMOS as compared to that in NMOS transistors?

3A. Answer the following questions: **[10M]**

I: Minimize the following switching expression using Boolean algebra

$$F(X,Y,Z) = \bar{X}\bar{Y}\bar{Z} + \bar{X}\bar{Y}Z + \bar{X}YZ + \bar{X}Y\bar{Z} + X\bar{Y}\bar{Z} + XY\bar{Z}$$

II: For the minimal expression obtained in Q3.A.I, construct a circuit using basic gates. Compute the cost of the circuit.

III: Construct an Exclusive –OR circuit for a two input system using appropriate type of Metal-Oxide –Semiconductor Field Effect transistors.

III: Name the technology that you have used to construct the Ex-OR in Q3.A. II and discuss the cost efficiency of the circuit with the help of supporting calculations.

IV: Give suggestions as to how the implementation of an Ex-OR gate can be made cost-efficient.

V: Derive the truth table corresponding to the Boolean expression: $(x + y).z'$

3B. Simplify each of the following 5 expressions: **[10M]**

$$\overline{\overline{(a+d)} \cdot \overline{(\bar{b}+c)}}$$

$$\overline{\overline{(a \cdot b \cdot \bar{c})} + \overline{(\bar{c} \cdot d)}}$$

$$\overline{\bar{a}+d} \cdot \overline{b+\bar{c}} \cdot \overline{c+d}$$

$$F = BC + B\bar{C} + BA$$

$$Y = AB' + (A' + B).C$$

4. Fill in the blanks with the result of the expression given on left hand side in the following questions. Write only the result: **[20M]**

1) $a+0=$ _____
2) $\bar{a}\cdot 0=$ _____
3) $a+\bar{a}=$ _____
4) $a+a=$ _____
5) $a+ab=$ _____
6) $a+\bar{a}b=$ _____
7) $a(\bar{a}+b)=$ _____
8) $ab+\bar{a}b=$ _____
9) $(\bar{a}+\bar{b})(\bar{a}+b)=$ _____
10) $a(a+b+c+\ldots)=$ _____

For 11,12 and 13 f(a,b,c) = a + b + c

11) $f(a,b,ab) =$ _____

12) $f(a,b,\bar{a}\cdot\bar{b}) =$ _____

13) $f[a,b,\overline{(ab)}] =$ _____

14) $y + y\bar{y} =$ _____

15) $xy + x\bar{y} =$ _____

16) $\bar{x} + y\bar{x} =$ _____

17) $(w + \bar{x} + y + \bar{z})y =$ _____

18) $(x + \bar{y})(x + y) =$ _____

19) $w + [w + (wx)] =$ _____

20) $x[x + (xy)] =$ _____

5A. Explain the structure of a Field Programmable Gate Array with the help of a neat diagram. **[5M]**

5B. Provide any 5 points of difference between a Programmable Logic Array (PAL) and a Programmable Array Logic (PLA). **[5M]**

5C. With the help of an example explain the working of any basic gates implemented using CMOS technology. **[5M]**

5D. With supporting diagrams, examples and reasoning explain the difference between a Pull-up network and a Pull-down network. **[5M]**

6. large room has three doors and a switch near each door controls the light in the room. The light is turned ON or OFF by changing the state of any one of the switch.

Specifically:

1. The light is OFF when all three switches are open.
2. Closing any one switch will turn the light ON.
3. Then closing the second switch will have to turn OFF the light.
4. If the light is OFF when the two switches are closed, then by closing third switch light will be turned ON.

With suitable assumptions, solve the following: **[20M]**

A. Complete the truth table based on the information given above.
B. Write the Sum of Products Canonical expression for the above.
C. Can the expression be reduced further? If yes then derive the minimal form. Otherwise derive the Product of Sum expression.
D. Explain different ways in which any switching function can be minimized.
E. Draw a circuit diagram and calculate the cost for the final circuit.

7. Answer the following questions: **[20M]**

A. State and prove the Consensus theorem for a three-input system.
B. Explain with an example the De-Morgan's Theorem in Boolean algebra. State any one application of De-Morgan's theorem in switching algebra.
C. Check the validity of :
$x1.x3' + x2'x3' + x1x3 + x2'x3 = x1'x2' + x1x2 + x1x2'$
D. Simplify the switching expression:
$(x + y).\overline{[x'.(y' + z')]}$ + x'y' + x'z'

8. Explain the following terms with reference to switching algebra and circuit design. Include diagrams and examples in your answers. **[20M]**

A. Analysis
B. Synthesis
C. Duality
D. Canonical expressions
E. Precedence of operators

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