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KIRIRI WOMENS' UNIVERSITY OF SCIENCE AND TECHNOLOGY
UNIVERSITY EXAMINATIONS, 2024/2025 ACADEMIC YEAR
SECOND YEAR, SECOND SEMESTER EXAMINATION
FOR THE DEGREE OF BACHELOR OF SCIENCE (COMPUTER SCIENCE)

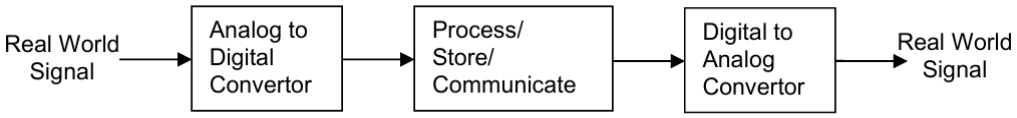
KCS 2206: DIGITAL LOGIC AND DESIGN

DATE: 10TH DECEMBER, 2024
TIME: 2:30PM-4:30PM

INSTRUCTIONS TO CANDIDATES
ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS

QUESTION ONE: COMPULSORY (30 MARKS)

a) A microphone has an analog to digital converter for converting a voice signal, the voice signal is processed and stored in memory chip where it is retrieved, converted to analog and communicated as an amplified signal through the speaker as illustrated in the block diagram architecture below.



Explain any three main reasons why analog data is converted to digital data. **(6 Marks)**

b) Based on the definition of a digital (2-valued) system, what are some examples where a digital system could apply? What are the variables and on/off or high/low states? **(4 Marks)**

c) Explain decimal number system and binary number system based on the following parameters;

i) Base or radix **(2 Marks)**

ii) Digits **(2 Marks)**

iii) Position of the digit **(2 Marks)**

d) Computer memory is typically organized in 8-bit groups or bytes. Why groups of 8? **(2 Marks)**

e) Convert the following signed binary number into it's equivalent decimal value.

10010110 **(4 Marks)**

f) Study the Boolean expression represented below

Y = $\bar{A}.\bar{B}$ +A.B

i) Draw a truth table and show the output Q of the above expression. **(4 Marks)**

ii) Name and draw the logic gate represented by the above expression. **(4 Marks)**

QUESTION TWO: (20 MARKS)

a) Express the following Boolean expression in canonical form sum of products (SOP) notation and draw a truth table. **(8 Marks)**

$f(a,b,c) = \bar{a}.\bar{b}c + \bar{a}.b.c. + \bar{a}.\bar{b}.\bar{c} + \bar{a}.b.\bar{c}$

b) Giving an example(s) for each, explain the following types of Boolean functions.

i) Pure form Boolean function **(4 Marks)**

ii) Mixed form Boolean function **(4 Marks)**

c) Logic circuits for digital systems may be combinational or sequential where combinational circuit consists of input variables, logic gates, and output variables. State the four design procedure steps for designing a combinational circuit. **(4 Marks)**

QUESTIONS THREE: (20 MARKS)

a) The table below shows a three variable truth table for a Boolean function.

a	b	c	**f**
0	0	0	**1**
0	0	1	**0**
0	1	0	**1**
0	1	1	**1**
1	0	0	**0**
1	0	1	**0**
1	1	0	**0**
1	1	1	**1**

i) Show the SOP and POS expressions for the above truth table. **(4 Marks)**

ii) Show the minterms and maxterms for the above expressions. **(4 Marks)**

iii) Perform minimization of the above SOP expression using K-map method. **(8 Marks)**

iv) Draw a logic circuit for the simplified expression above. **(4 Marks)**

QUESTION FOUR: (20 MARKS)

a) Using suitable diagrams, explain how half adder works showing the truth table, block diagram and logic circuit. **(8 Marks)**

b) State any two advantages and two disadvantages of half adders **(4 Marks)**

c) Convert the following numbers into their equivalent decimal numbers.

i) 11001.01_2 **(4 Marks)**

ii) $B0.10_{16}$ **(4 Marks)**

QUESTION FIVE: (20 MARKS)

a) Given a signed decimal number -38, in 8-bit format, calculate its two's complement using the three different methods available for obtaining the diminished complement of a given number in Boolean complement operations. **(10 Marks)**

b) Using Boolean laws and theorems, you can perform manipulation of Boolean functions or simply minimize Boolean functions for simpler construction of logic circuits. Using these Boolean laws and theorems, simplify the expression below. **(4 Marks)**

$$f = \bar{x}yz + \bar{x}y\bar{z} + xz$$

c) Illustrate the above simplified expression in a truth table and draw the simplified logic circuit. **(6 Marks)**