KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2010/2011 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF COMPUTER SCIENCE

COURSE CODE: COMP 223

COURSE TITLE: DIGITAL CIRCUIT DESIGN

STREAM: Y2S2

DAY: THURSDAY

TIME 9.00 – 11.00 A.M

DATE: 09/12/2010

INSTRUCTIONS:

- *Answer Question **ONE** and any other **TWO** Questions. Question One carries **30marks** while each of the other Two Questions carry 2**0marks**.*

PLEASE TURNOVER

QUESTION 1 (30 marks)

a) i) Perform the following arithmetic

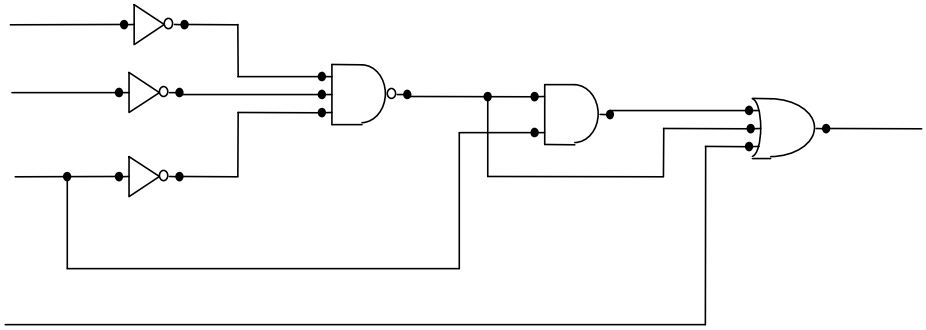
I) CDFH + ABCH **(2mks)**

II) 00001000 – 00000011 **(2mks)**

ii) Convert $(15.625)_{10}$ into binary **(2mks)**

b) i) State De-Morgan's theorem of two variables **(2mks)**

ii) Consider the given logic circuit



If the inputs are A, B, C and D in that order from top to bottom and the output is Y;

I) obtained the unsimplified output logic expression for the above circuit **(3mks)**

II) Using De-Morgan's and Boolean theorem's, simplify the output logic expression in (I) **(3mks)**

III) Draw a logic circuit of the simplified function in (II) **(1mk)**

c) i) What is a logic gate? **(1mk)**

ii) Show using diagrams how you can use a NAND gate to implement an AND function and an OR function **(4mks)**

d) i) What is a truth table? **(1mk)**

ii) State two uses of truth tables **(2mks)**

iii) Negate the given logic function **(2mks)**

$$X.\bar{Y} + \bar{X}.Y$$

e) In a chemical processing plant, a liquid chemical is used in a manufacturing process. The chemical is stored in three different tanks. A level sensor in each tank produces a HIGH voltage when the level of chemical in the tank drops below a specified fixed point.

Design and draw a circuit that monitors the chemical level in each tank and indicates when the level in any two of the tanks drops below the specified point **(3mks)**

f) Draw a combinational circuit to implement the given logic function **(2mks)**

$W = XY(Z + Y) + XZ$

QUESTION 2 (20 marks)

a) i) Draw a logic symbol of a NOR gate **(1mk)**

ii) Manipulate the given logic function into a form which can be implemented using NOR gates only **(5mks)**

$$Y = \bar{A}B\bar{C} + AC + \bar{B}$$

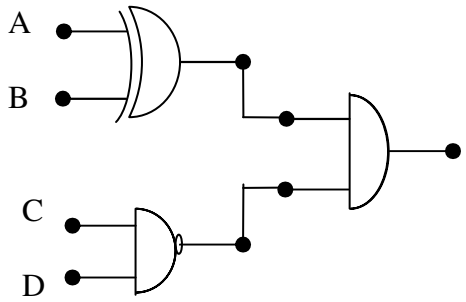
iii) Draw the logic diagram of the resulting manipulated function in (ii) above **(3mks)**

b) Simplify the following logic expressions and draw the logic circuits for the simplified functions.

i) $W = X.Y + \bar{X}.Y + \bar{X}.\bar{Y}$ **(3mks)**

ii) $Y = \overline{(\bar{A} + C) \cdot (B + \bar{D})}$ **(4mks)**

f) Determine the output of the following logic circuits:



(4mks)

QUESTION 3 (20 marks)

a) i) Design a two bit comparator circuit that will produce a logic 1 output when the two input signals are identical **(3mks)**

ii) Manipulate the output logic expression of the two bits circuit in (i) into a form which can be implemented using NAND gates only. **(2mks)**

iii) Draw the circuit diagram of the manipulated function in (ii) **(2mks)**

b) i) What is Karnaugh map? **(1mk)**

ii) Prepare K-map for the given function **(3mks)**

$$W = \bar{A}\bar{B}CD + ABCD + A\bar{B}D + \bar{A}CD + \bar{A}C\bar{D}$$

iii) Use the prepared K-map to simplify the function, write down the simplified logic function **(2mks)**

c) Explain the following logic circuits

i) Sequential logic circuit **(2mks)**

ii) Combinational logic circuit **(2mks)**

d) State and explain two classifications of sequential logic circuits **(3mks)**

QUESTION 4 (20 marks)

a) Differentiate between the following **(4mks)**

i). Programmable logic devices and fixed logic devices

ii). Serial input/output and parallel input/output register

b) i a) i) What is a counter? **(1mk)**

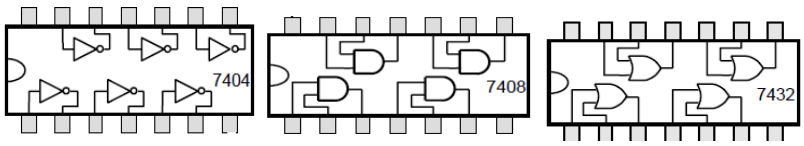
ii) State two uses of counters **(2mks)**

iii) Draw a 4-bit asynchronous binary counter using JK flip-flops **(4mks)**

iv) State two advantages of synchronous counters **(2mks)**

c) Connect the chips provided below to implement

$Y = A.B + \bar{B}C$, given that pin 7 and 14 on each IC represent GND and $+V_{ss}$ respectively. **(5mks)**



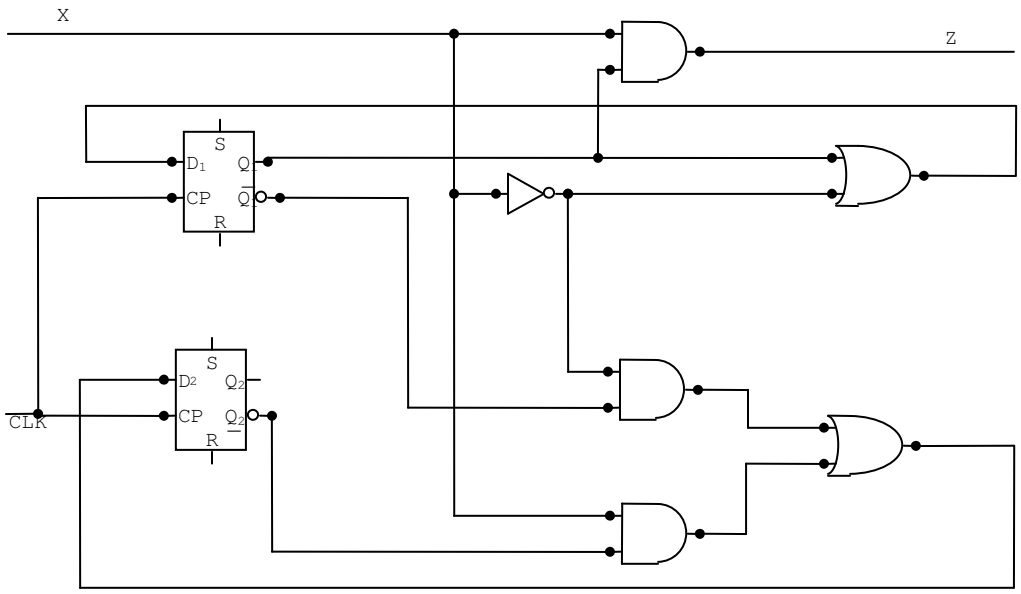
d) State two uses of shift register **(2mks)**

QUESTION 5 (20 marks)

a) Define the following terms as used with sequential circuits **(4mks)**

i). State
ii). State diagrams
iii). State tables
iv). Clock width

b) Consider the following sequential circuit



The circuit has one input X, one output Z and two state variables Q_1 and Q_2

i). Write the Boolean expressions which can be used to determine the behaviour of the circuit **(3mks)**
ii). From the Boolean expressions in (i), develop the state table for this circuit. Assume the circuit present state is 00 and input $X = 0$ **(4mks)**
iii). Use the state table to develop the state diagram for this circuit. **(4mks)**

c) i) What is a programmable array? **(1mk)**
ii) Draw a programmable array which can give **(4mks)**

$W_1 = \bar{A}.B$, $W_2 = \bar{A}.\bar{B}$, $W_3 = A\bar{B}$, $W_4 = A.B$