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: TUESDAY

TIME: 2.00 – 4.00 P.M.

DATE: 22/03/2011

INSTRUCTIONS:

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

PLEASE TURN OVER

QUESTION 1 (30 marks)

a) i) Perform the following arithmetic

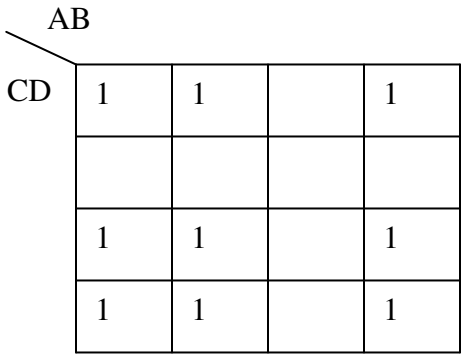
I) 102FH + ABCH (2mks)

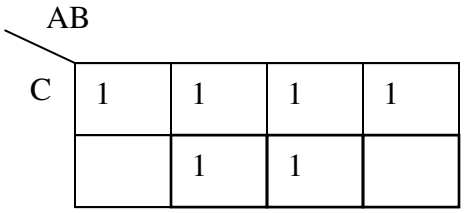
II) $00001000_2 - 00000011_2$ (2mks)

ii) Convert $(3.625)_{10}$ into binary (2mks)

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

ii) Write a simplified logic expression for the given logic K-maps (6mks)





c) i) Draw circuit symbol of NAND 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 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 (3mks)

$W = XY(Z + Y) + X \oplus Z$

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)

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

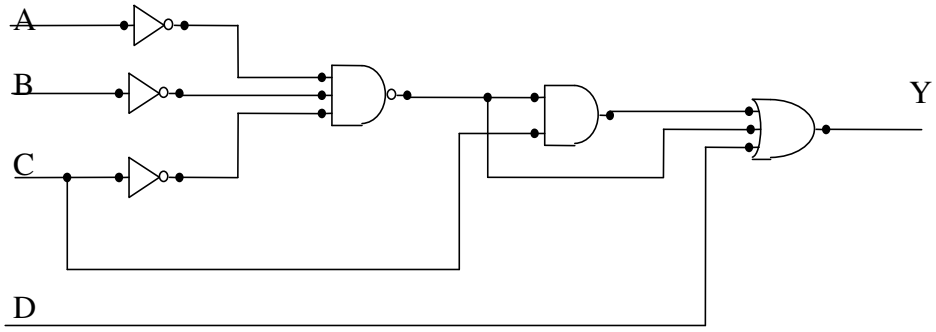
iii) Draw the logic diagram of the resulting manipulated function in (ii) above (3mks)

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

i) $W = X.Y + \bar{X}.Y + \bar{X}.\bar{Y}$ (2mks)

ii) $Y = \overline{(\bar{A} + C) \cdot (B + \bar{D})}$ (2mks)

c) Consider the given circuit.



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)

QUESTION 3 (20 marks)

a) i) Design and draw 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) Prepare K-map for the given function (6mks)

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

II) $Y = B + AC$

ii) Use the prepared K-map to simplify the function (I) and write down the simplified logic function (2mks)

c) Explain the following logic circuits

i) Sequential logic circuit (1mks)

ii) Combinational logic circuit (1mks)

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). Finite state machines and algorithmic state machines.

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

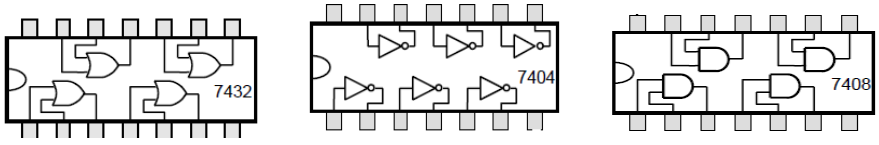
ii) State two uses of counters (2mks)

iii) Draw a 4-bit ripple digital counter. (4mks)

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

c) Connect the chips provided below to implement

$W = \left(\overline{X + Y}\right).(Z + Y)$, given that pin 7 and 14 on each IC represent GND and $+V_{ss}$ respectively. (5mks)



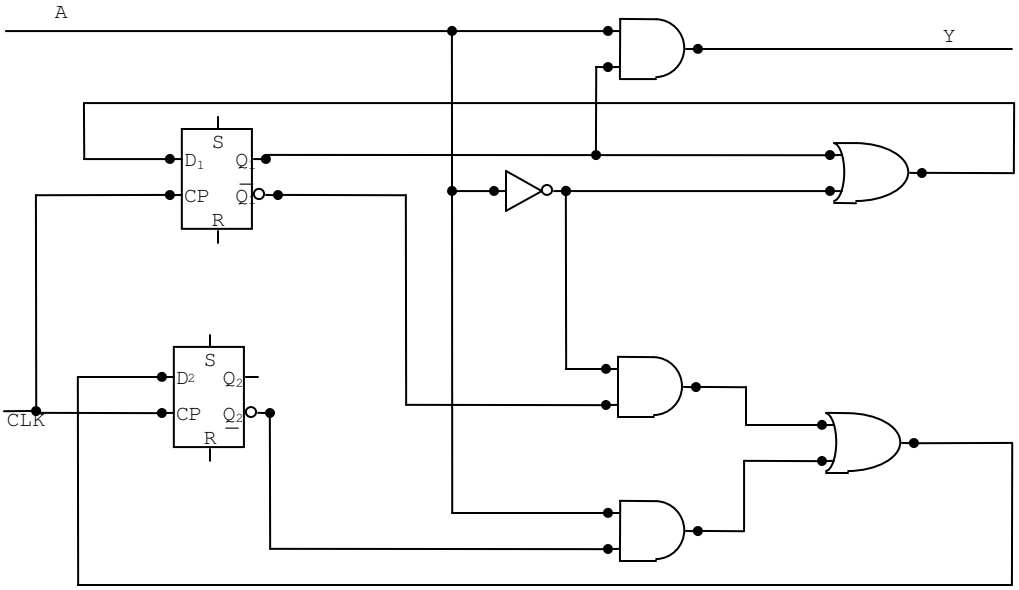
d) State two uses of shift register (2mks)

QUESTION 5 (20 marks)

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

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

b) Consider the following sequential circuit



The circuit has one input A, one output Y and two state variables Q_1 and Q_2

i). Write the Boolean expressions which can be used to determine the behavior of the circuit (3mks)

ii). From the Boolean expressions in (i), develop the state table for this circuit. (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)

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