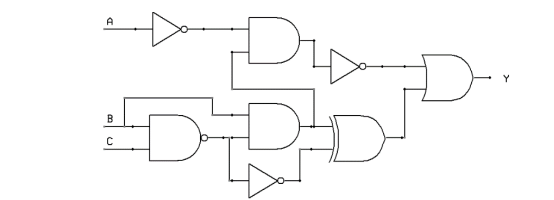
**1. A. Write the Boolean expression of the following circuit diagram [2 marks].**



Or Simplified:

K =

L =

M =

N =

O =

P =

**B. Set up the truth table [9 marks]**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **A** | **B** | **C** | |  |  | | |  | |  | |  | |  | | |  | | | **Y** |
| 0 | 0 | 0 | | 1 | 0 | | | 0 | | 1 | | 0 | | 1 | | | 0 | | | 1 |
| 0 | 0 | 1 | | 1 | 0 | | | 0 | | 1 | | 0 | | 1 | | | 0 | | | 1 |
| 0 | 1 | 0 | | 1 | 1 | | | 1 | | 1 | | 0 | | 0 | | | 1 | | | 1 |
| 0 | 1 | 1 | | 1 | 0 | | | 0 | | 0 | | 1 | | 1 | | | 1 | | | 1 |
| 1 | 0 | 0 | | 0 | 0 | | | 0 | | 1 | | 0 | | 1 | | | 0 | | | 1 |
| 1 | 0 | 1 | | 0 | 0 | | | 0 | | 1 | | 0 | | 1 | | | 0 | | | 1 |
| 1 | 1 | 0 | | 0 | 0 | | | 1 | | 1 | | 0 | | 1 | | | 1 | | | 1 |
| 1 | 1 | 1 | | 0 | 0 | | | 0 | | 0 | | 1 | | 1 | | | 1 | | | 1 |
|  |  |  | |  |  | | |  | |  | |  | |  | | |  | | |  |
| **A** | | | **B** | | | **C** |  | | **K** | | **L** | | **M** | | **N** | **O** | | **P** | **Y** | | |
| 0 | | | 0 | | | 0 | 1 | | 0 | | 0 | | 1 | | 0 | 1 | | 0 | 1 | | |
| 0 | | | 0 | | | 1 | 1 | | 0 | | 0 | | 1 | | 0 | 1 | | 0 | 1 | | |
| 0 | | | 1 | | | 0 | 1 | | 1 | | 1 | | 1 | | 0 | 0 | | 1 | 1 | | |
| 0 | | | 1 | | | 1 | 1 | | 0 | | 0 | | 0 | | 1 | 1 | | 1 | 1 | | |
| 1 | | | 0 | | | 0 | 0 | | 0 | | 0 | | 1 | | 0 | 1 | | 0 | 1 | | |
| 1 | | | 0 | | | 1 | 0 | | 0 | | 0 | | 1 | | 0 | 1 | | 0 | 1 | | |
| 1 | | | 1 | | | 0 | 0 | | 0 | | 1 | | 1 | | 0 | 1 | | 1 | 1 | | |
| 1 | | | 1 | | | 1 | 0 | | 0 | | 0 | | 0 | | 1 | 1 | | 1 | 1 | | |

**2. A. Given the two following decimal numbers : 37, -126**

**i) Represent the two numbers in One’s Complement representation (using 8-bit binary in the result) [4 marks]**

37 as a binary number = 0010 0101

We find 126 as a binary number which = 0111 1110

To get ones complement, you invert the bits of the binary number:

37 represented in one's complement = 1101 1010

-126 represented in one’s complement = 1000 0001

**ii) Represent the two numbers in Two’s Complement representation (using 8-bit binary in the result) [6 marks]**

37 as a binary number = 0010 0101

We find 126 as a binary number which = 0111 1110

To get two’s complement, you invert the bits of the binary number and add one.

37 inverted or represented in one's complement = 1101 1010

-126 inverted or represented in one’s complement = 1000 0001

-126 represented in two’s complement = 1000 0010

37 represented in two’s complement = 1101 1011

**B. Convert the positive number Ν=1010000001001 in single precision floating point format [3 marks]**

Step 1: 1010000001001 = 1.010000001001 x 212

Step 2: N = (-1)S (1+F)(2E-127)

S = 0 (Positive Number)

F = 01000000100100000000000

E - 127 = 12, E = 13910 = 1000 10112

N =

|  |  |  |
| --- | --- | --- |
| 0 | 10001011 | 01000000100100000000000 |

**3. If main memory is of 4 giga bytes and every word is of 2 bytes how many bits do we need to address any single word in memory? [4 marks]**

4 giga bytes = 4000mb, which is 212 + 220  = 232

Memsize = number.words x word.size so,

4000mb = 231  x 21

We need log2 231 or 31 bits to address each word

**4. How much RAM memory can a 16-bit CPU can use? Provide your answer in bytes. [4 marks]**

A 16 bit cpu means that the address space capacity = 216 words

216 words = 64 x 210  = 64KB = 65,536 bytes

So the maximum amount of RAM that it can use is 65,536 bytes.

**5. Consider a 7-stage pipelined CPU where every stage is 30nsecs. How much time does it take to execute 1000 CPU instructions if no stall cycles occur? Provide the answer in nsecs. [5 marks]**

7 x 30 = 210

1000 x 210 = 210,000nsecs

**6. Let a CPU with CPU frequency 2 GHz. It executed 1.5 million instructions in 6 million CPU clock cycles.**

**A. What is the average value of the CPI for this CPU? [4 marks]**

6,000,000 / 1,500,000 = 4

The average value of the CPI for this CPU = 4

**B. How long did it take to complete all the instructions? [3 marks]**

6,000,000 / 2GHz = 2billion = 0.003 seconds

**7. A CPU has an average CPI of 2.5. It took 1.6 seconds to execute 9.6 million instructions. What is the speed of this CPU? [6 marks]**

Speed = instruction / (time \* CPI)

Speed = 9.6 million / 1.6 \* 2.5

9.6 million / 4 = 2.4 million = 2.4MHz

**8. Convert the following C code into assembly code. Do not simplify the code. The assembly code must be a) provided as a separate .asm file and b) included in the delivered .docx file [50 marks]**

; A simple template for assembly programs.

.386 ; Specify instruction set

.model flat, stdcall ; Flat memory model, std. calling convention

.stack 4096 ; Reserve stack space

ExitProcess PROTO, dwExitCode: DWORD ; Exit process prototype

.data ; data segment

; define your variables here

A BYTE 3,2,3,1,7,5,0,8,9,2

B BYTE 0,0,0,0,0,0,0,0,0,0

.code ; code segment

main PROC ; main procedure

; write your assembly code here

lea ebx, A ; loads A into ebx

mov esi, 0

update:

; (3\*i + 1)/5

mov eax, 3 ; moves 3 into eax

mul esi ; multiplies i by eax

add eax, 1 ; adds 1 to eax

mov ecx, 5 ; moves 5 into ecx

div ecx ; divs eax by 5

mov ecx, eax ; moves eax into ecx

; (2\*i + ecx)

mov eax, 2 ; moves 2 into eax

mul esi ;multiplies i bys esi

add eax, ecx ; adds ecx to eax

; 2\*eax

mov ecx, 2 ; moves 2 into ecx

mul ecx ; multiplies 2 by eax

;B[i] = A[i] + eax

mov ecx, [ebx + TYPE A \* esi] ; moves i position of array into ecx

add eax, ecx ; adds ecx to eax

mov [ebx + TYPE B \* esi], eax ; moves eax into the i position of B array in ebx

inc esi;

cmp esi, 10

jne update ; end or start of loop

INVOKE ExitProcess, 0 ; call exit function

main ENDP ; exit main procedure

END main ; stop assembling