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|  | **Department of Computer Science****Faculty of Computing****UNIVERSITI TEKNOLOGI MALAYSIA** |

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| **SUBJECT NAME:** | **COMPUTER ORGANIZATION AND ARCHITECTURE** |
| **SUBJECT CODE:** | **SECR 2033** |
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| **LAB TITLE:** | **Programming 2: Arithmetic Equations & Operations**  |
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| **COMMENTS:** |  |
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**Part B: Arithmetic Equation Coding in Assembly Language (Equation to Code)**

**MARKS:**

**\_\_\_\_\_\_\_\_**

1. Execute the program below. Determine output of the program by inspecting the content of the related registers. Fill in Table 1 with the content of each register or variable on every LINE, in **Hexadecimal** (as per the output). Please complete the comments for every LINE.

INCLUDE Irvine32.inc

.data

var1 word 1

var2 word 9

.code

main PROC

 mov ax, var1 ; LINE1

 mov bx, var2 ; LINE2

 xchg ax, bx ; LINE3

 mov var1, ax ; LINE4

 mov var2, bx ; LINE5

 call DumpRegs

 exit

main ENDP

END main

**Answer:**

|  |  |  |
| --- | --- | --- |
|  |  | **Table 1** |
| LINE1 | **AX = 0001h** | Move the value of var1 (1d) into register |
| **var1 = 0001h** | AX |
|  |
| LINE2 | **BX =0009h** | Move the value of var2 (9d) into register |
| **var2 =0009h** | BX |
|  |  |
| LINE3 | **AX =0009h** | Exchange the value of register AX and register BX |
| **BX =0001h** |  |
|  |  |
| LINE4 | **AX =0009h** | Move the value of register AX (9d) into var1  |
|  **var1 =0009h** |  |
|  |  |
| LINE5 | **BX =0001h** | Move the value of register BX (1d) into var2  |
| **var2 =0001h** |  |
|  |  |

2. Execute the program below. Determine output of the program by inspecting the content of the related registers and watches. Fill in Table 2 with the content of each register or variable on every LINE, in **Hexadecimal** (as per the output). Please complete the comments for every LINE.

**Arithmetic expression: Rval = (-Xval + (Yval – Zval)) + 1**

include irvine32.inc

.data

Rval DWORD ?

Xval DWORD 26

Yval DWORD 30

Zval DWORD 40

.code

main proc

 mov eax,Xval ; LINE1

 neg eax ; LINE2

 mov ebx,Yval ; LINE3

 sub ebx,Zval ; LINE4

 add eax,ebx ; LINE5

 inc eax ; LINE6

 mov Rval,eax ; LINE7

 exit

main endp

end main

**Answer:**

|  |  |  |
| --- | --- | --- |
|  |  | **Table 2** |
| LINE1 | **EAX = 0000001Ah** |  | Move the value of Xval (26d) |
| **Xval = 0000001Ah** |  | into register EAX |
|  |  |
| LINE2 |  **EAX =FFFFFFE6h** |  | Negate the value of register EAX(26d become -26d) |
|  |  |  |  |
| LINE3 |  **EBX =00000001Eh** |  | Move the value of Yval (30d) into register EBX |
| **Yval =00000001Eh** |  |  |
|  |  |  |
| LINE4 | **EBX = FFFFFFF6h** |  | Subtract the value of register EBX by Zval (40d) |
| **Zval =00000028h** |  |  |
|  |  |  |
| LINE5 | **EAX =FFFFFFDCh** |  | Add the value of register EBX (-10d) to the register EAX(-26d) |
| **EBX =FFFFFFF6h** |  |  |
|  |  |  |
| LINE6 | **EAX =FFFFFFDDh** |  | Increase the register EAX by 1(become -35) |
|  |  |  |  |
| LINE7 | **EAX =FFFFFFDDh** |  | Move the value of register EAX into Rval |
| **Rval =FFFFFFDDh** |  |  |
|  |  |  |

3. Execute the program below. Determine output of the program by inspecting the content of the related registers. Fill in Table 3 with the content of each register or variable on every LINE, in **Hexadecimal** (as per the output). Please complete the comments for every LINE.

**Arithmetic expression: var4 = [(var1 \* var2) + var3] - 1**

include irvine32.inc

.data

var1 DWORD 5

var2 DWORD 10

var3 DWORD 20

var4 DWORD ?

.code

main proc

 mov eax, var1 ; LINE1

 mul var2 ; LINE2

 add eax, var3 ; LINE3

 dec eax ; LINE4

 exit

main endp

end main

**Answer:**

**Table 3**

|  |
| --- |
|  |
| LINE1 | **EAX = 00000005h** |  | Move the value of var1 (5d) |
| **var1 = 00000005h** |  | into register EAX |
|  |  |
| LINE2 | **EAX =00000032h** |  |  Multiply the  |  Register EAX |
| **var2 =0000000Ah** |  | by value of var2(10d) |  |
|  |  |  |  |
| LINE3 | **EAX =00000046h** |  | Add value of  |  var3(20d)  |
| **var3 =00000014h** |   | into register EAX |  |
|  |  |  |  |
| LINE4 |  **EAX =00000045h** |  | Decrement value of register EAX by 1 |  |
| **var4 =00000000h** |  |  |  |
|  |  |  |  |

4. Execute the program below. Determine output of the program by inspecting the content of the related registers. Fill in Table 4 with the content of each register or variable on every LINE, in Hexadecimal (as per the output). Please complete the comments for every LINE.

**Arithmetic expression: var4 = (var1 \* 5) / (var2 – 3)**

include irvine32.inc

.data

 var1 WORD 40

 var2 WORD 10

 var4 WORD ?

.code

main proc

 mov ax,var1 ; LINE1

 mov bx,5 ; LINE2

 mul bx ; LINE3

 mov bx,var2 ; LINE4

 sub bx,3 ; LINE5

 div bx ; LINE6

 mov var4,ax ; LINE7

 exit

main endp

end main

**Answer:**

**Table 4**

|  |  |  |  |
| --- | --- | --- | --- |
| LINE1 | **AX = 0028h** |  | Move the value of var1 (40d) |
| **var1 = 0028h** |  | into register AX |
|  |  |
| LINE2 | **BX =0005h** |  | Move the value of 5d into register BX |
|  |  |  |  |
| LINE3 | **AX =00C8h** |  | Multiply register AX by register BX |
| **BX =0005h** |  |  |
|  |  |  |
| LINE4 | **BX =000Ah** |  | Move the value of var2 (10d) |
| **var2 =000Ah** |  | into register BX |
|  |  |  |
| LINE5 | **BX =0007h** |  | Subtract register BX by 3 |
|  |  |  |  |
|  | **AX =001Ch** |  |  |
| LINE6 | **BX =0007h** |  | Divide register AX by BX, with remainder =DX  |
|  | **DX =0004h** |  |  |
| LINE7 | **AX =0001Ch** |  | Move the value of register AX into var4 |
| **var4 =0001Ch** |  |  |
|  |  |  |

**Table 5 – Initial Registers Values**

|  |  |  |  |
| --- | --- | --- | --- |
| **EAX** | **EBX** | **ECX** | **EDX** |
| 10H | 20H | 2H | 0H |

5. Refer to Table 5 above for the following TWO ( 2 ) tasks.

1. Write and execute the instructions below, then fill in the table with the correct value of the registers. Also note the changes.

\*\****Note****: Always start with the initial value of the registers given in Table 5.*

a. MUL BX

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000200H |  |  00000020H | 00000002H | 00000000H |
| b. MUL CX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000020H |  |  00000020H | 00000002H | 00000000H |
| c. MUL AX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000100H |  |  00000020H | 00000002H | 00000000H |
| d. DIV BX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000000H |  |  00000020H | 00000002H | 00000010H |
| e. DIV CX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000008H |  |  00000020H | 00000002H | 00000000H |
| f. DIV AX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000001H |  |  00000020H | 00000002H | 00000000H |

1. Write and execute the instructions below, then fill in the table with the correct value of the registers. Also note the changes.

\*\****Note****: Always start with the initial value of the registers given in Table 5.*

a. MUL EBX

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000200H |   |  00000020H | 00000002H | 00000000H |
| b. MUL ECX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000020H |  |  00000020H | 00000002H | 00000000H |
| c. MUL EAX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000100H |   |  00000020H | 00000002H | 00000000H |
| d. DIV EBX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000000H |  |  00000020H | 00000002H | 00000010H |
| e. DIV ECX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000008H |  |  00000020H | 00000002H | 00000000H |
| f. DIV EAX |  |  |  |
|  |  |  |  |
| **EAX** |  | **EBX** | **ECX** | **EDX** |
| 00000001H |  |  00000020H | 00000002H | 00000000H |