# CSC 3210

# Computer Organization and Programming

## Lab Work 2

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# Lab Work 2 Instructions

- Lab 2(a): Run a sample assembly language code  (3 points)
- Lab 2(b): Math problems (2 points)
- Lab 2(c): Registers and Memory related Problems (5 points)

Due Date: posted on iCollege

# Lab 2(a)

Run a sample assembly code in Microsoft visual Studio

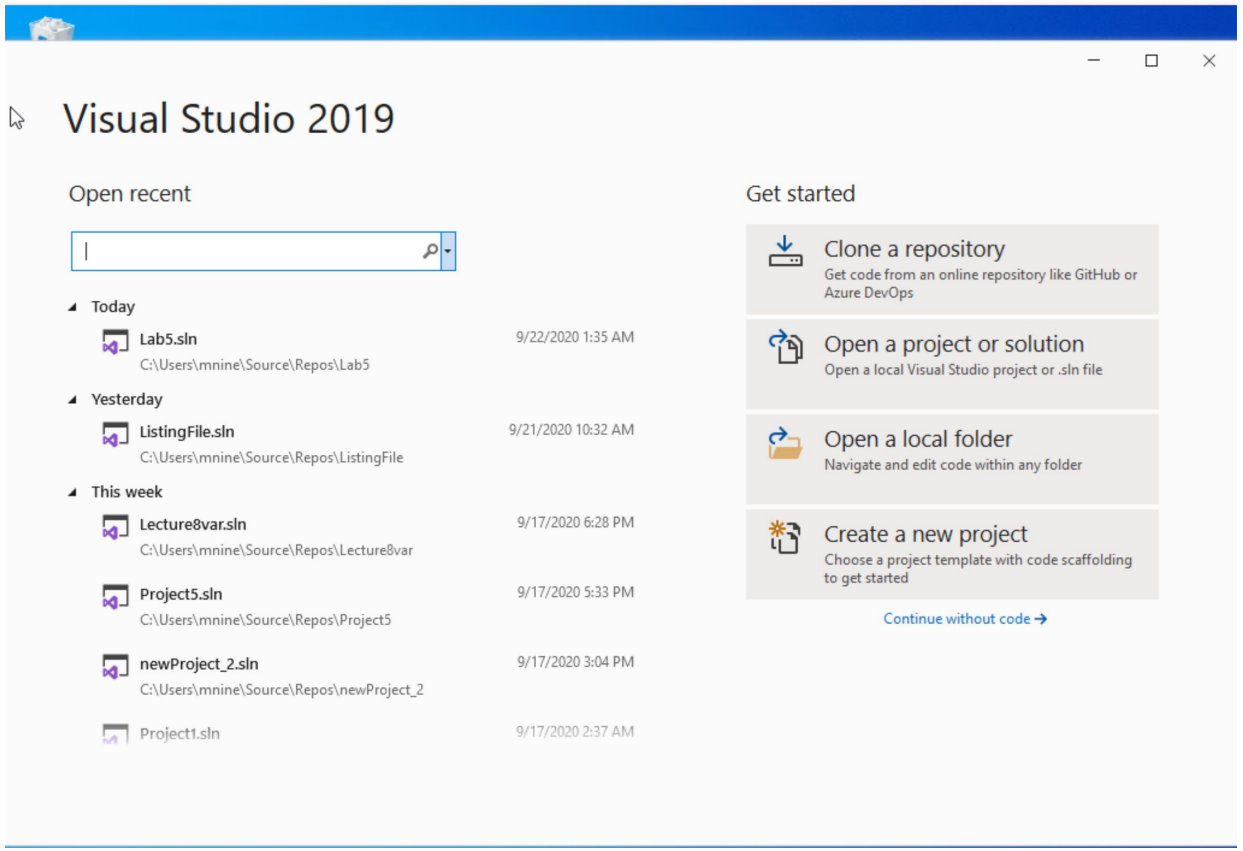
# Lab 2(a) Instructions

- Follow the instructions to run the first program in assembly language.
- Take  screenshot/screenshots showing the code and the register contents.
- Submit to the iCollege

# Create a new Project

(1) Start Visual Studio

(2) Click Create a new Project

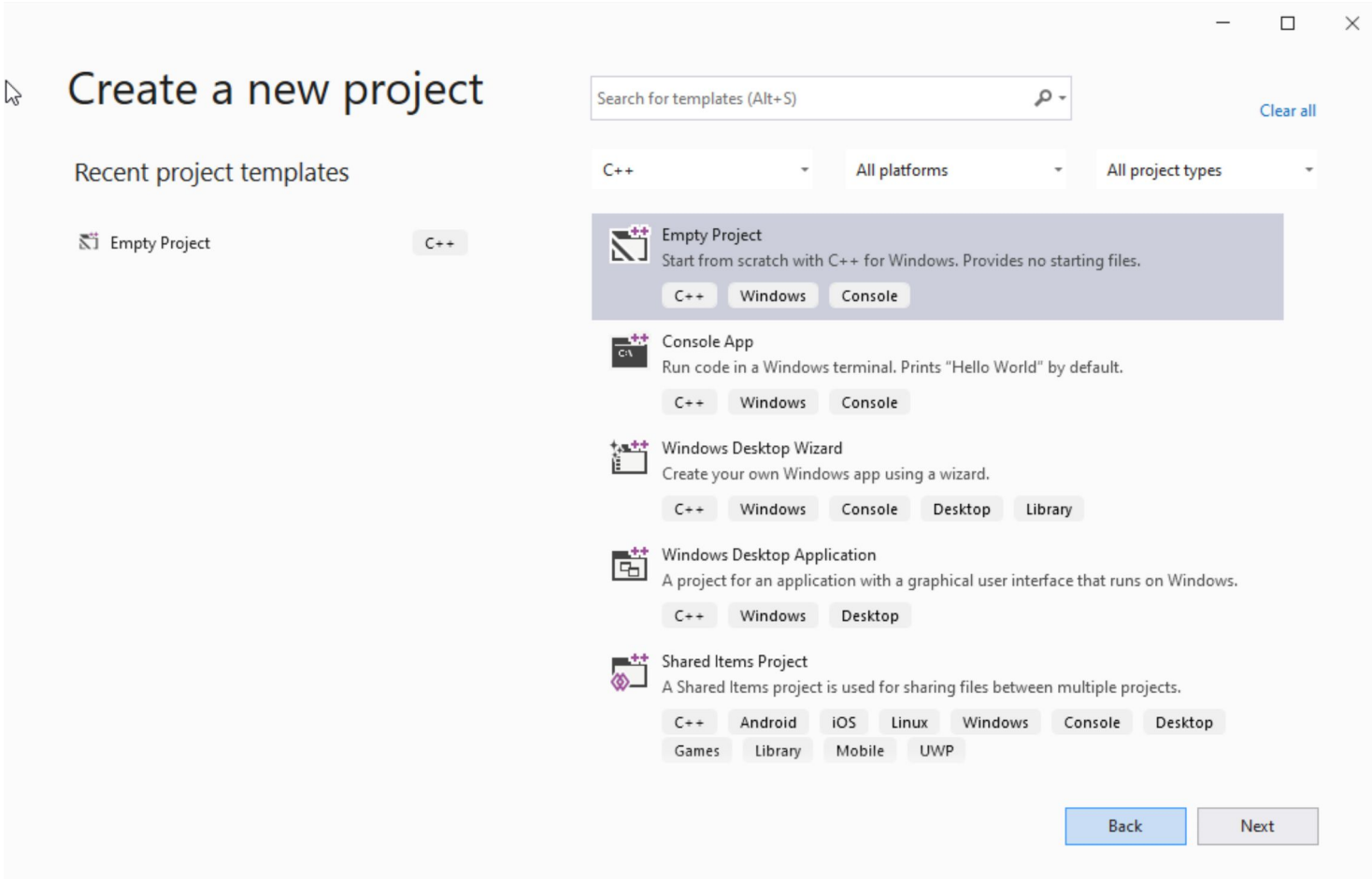


# Create a new Project

(1) Select C++ as language

(2) Select Empty Project

(3) Click Next

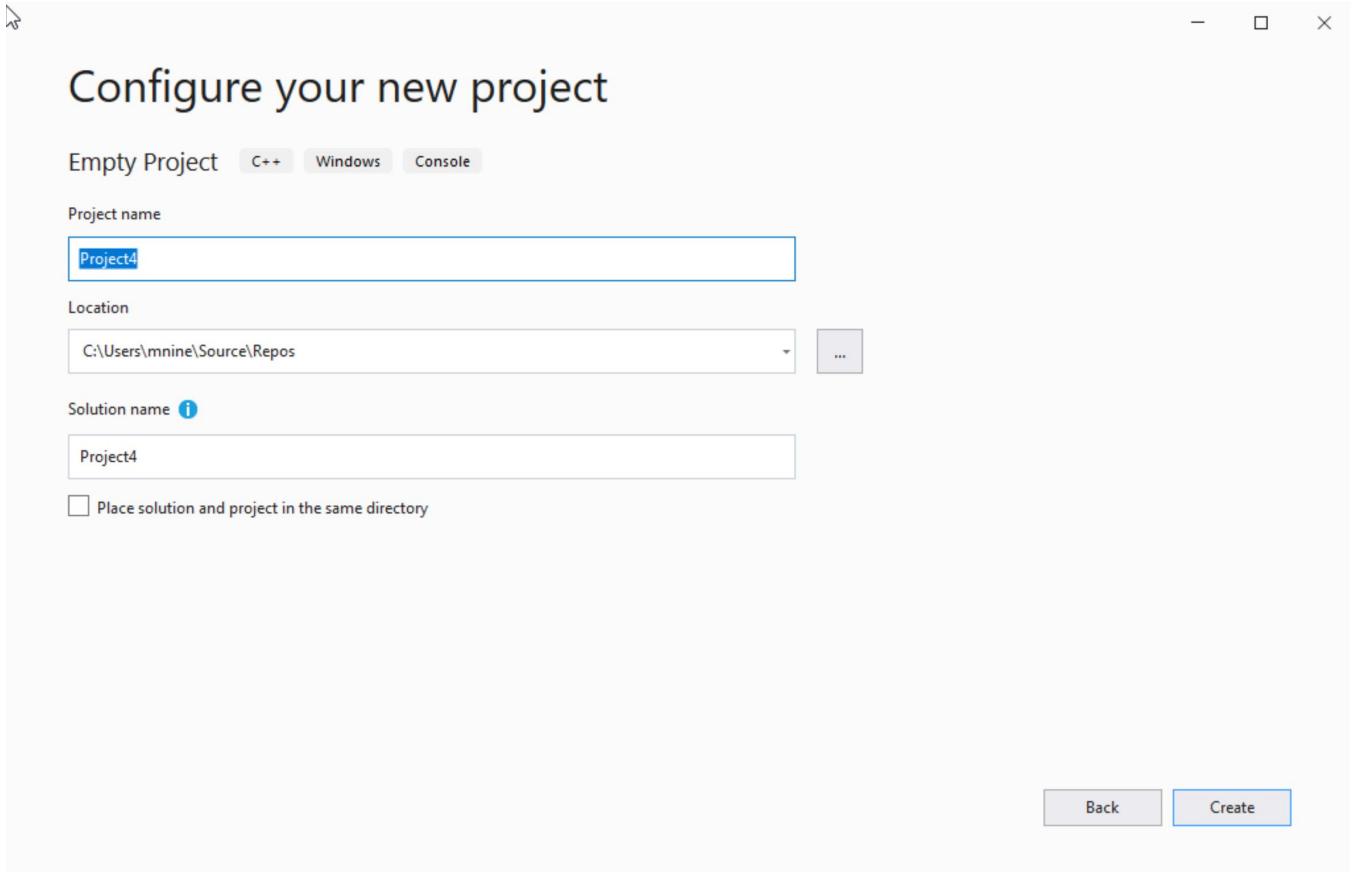


# Create a new Project

(1) You can change the project name as you like

(1) Also you can change the project location

(2) Click Next

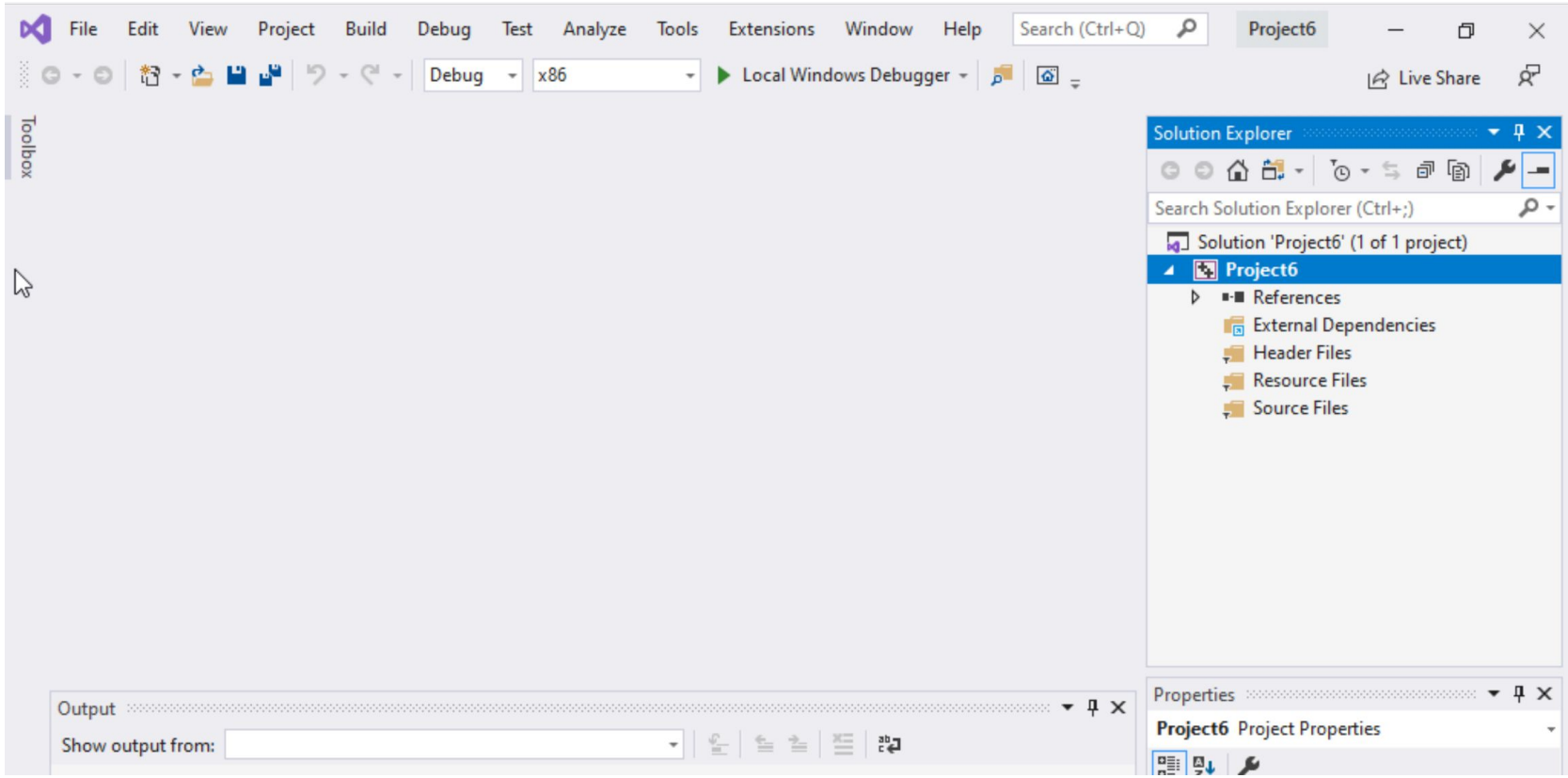


# Create a new Project

Delete the

Following folders:

- Header files
- Resources Files, and
- Source Files



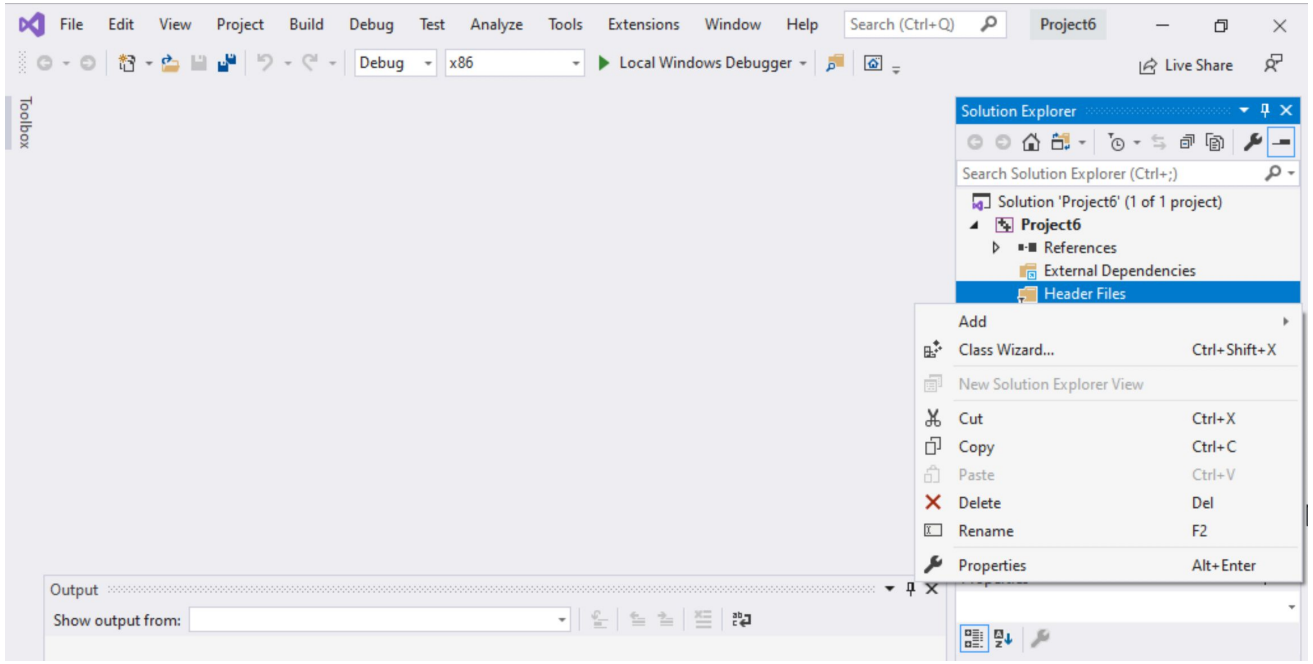
# Create a new Project

To delete :

Select the folders

Right click on it

Select delete



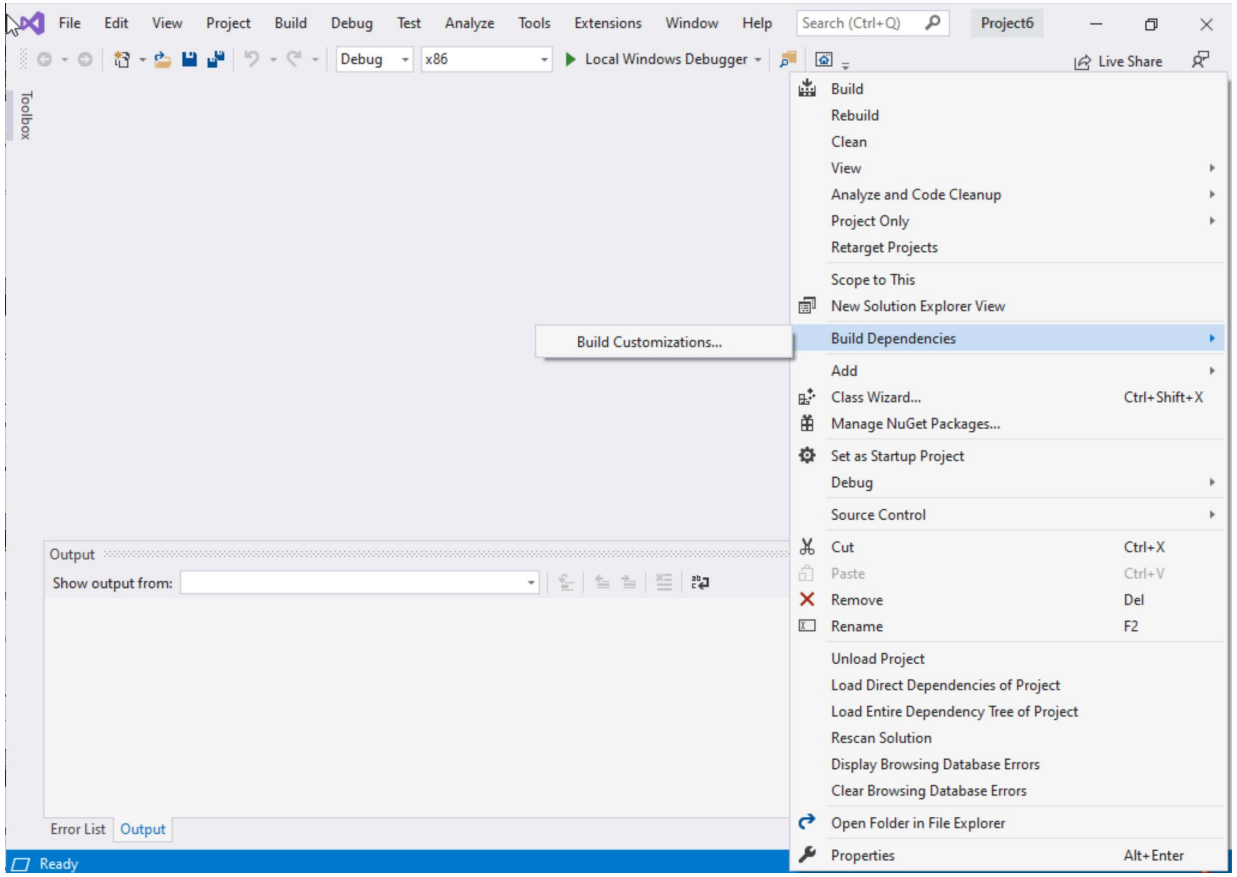
# Create a new Project

Select Project Name on solution explorer

Right click on it

Go to Build Dependencies

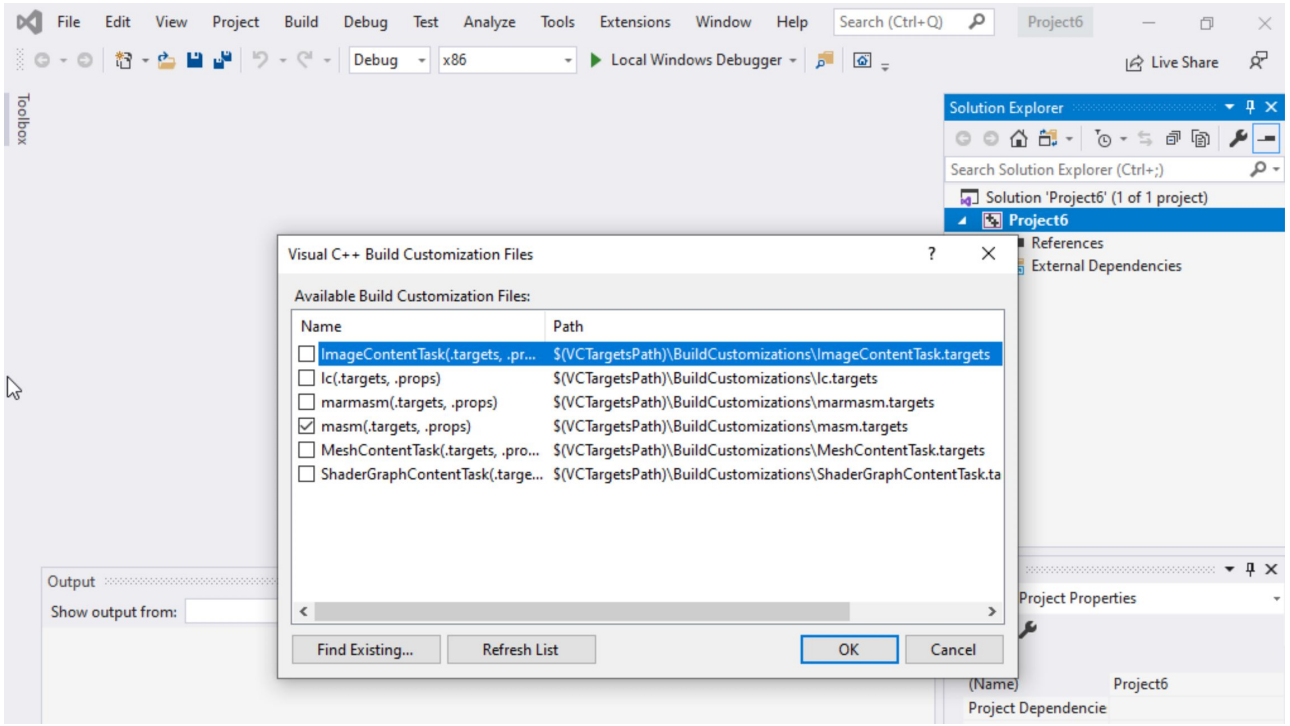
Click on Build Customizations



# Create a new Project

Select mash(.target, .props)

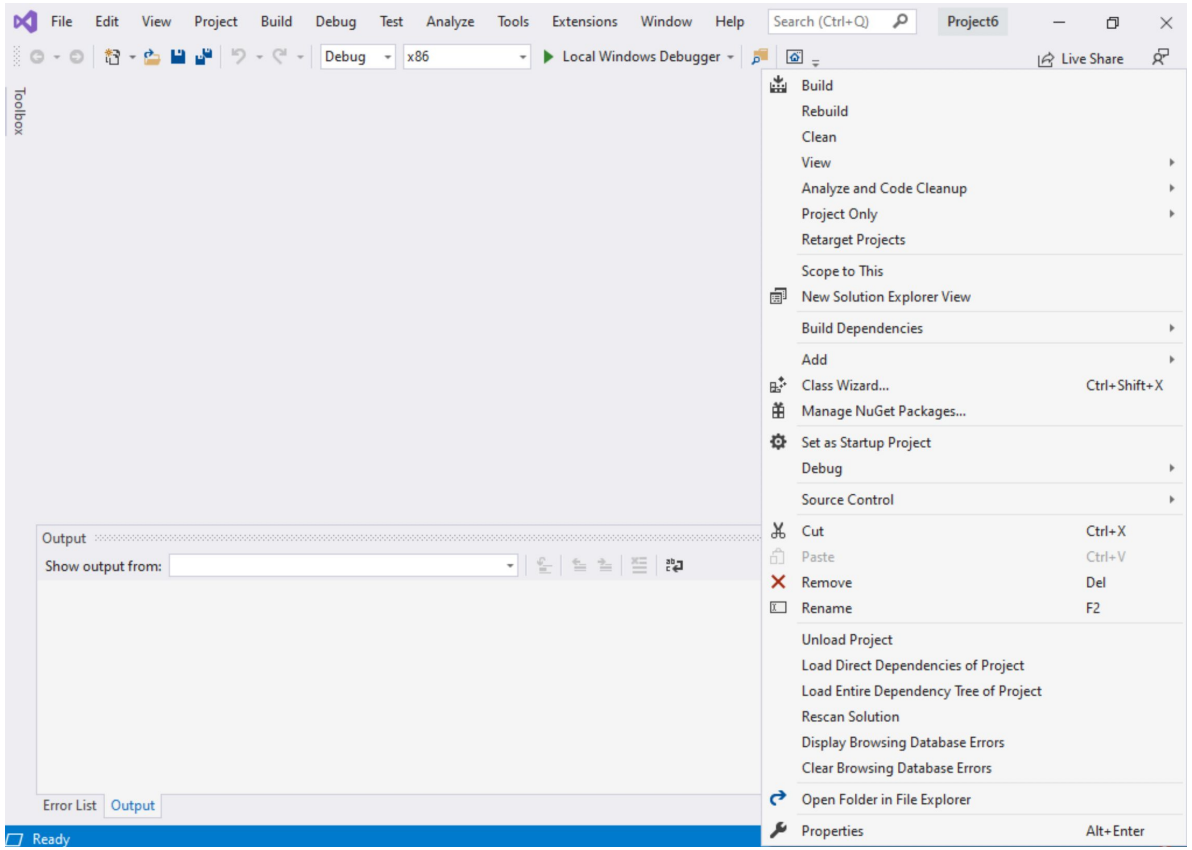
Click ok



# Create a new Project

Right click on the Project name in the solution explorer

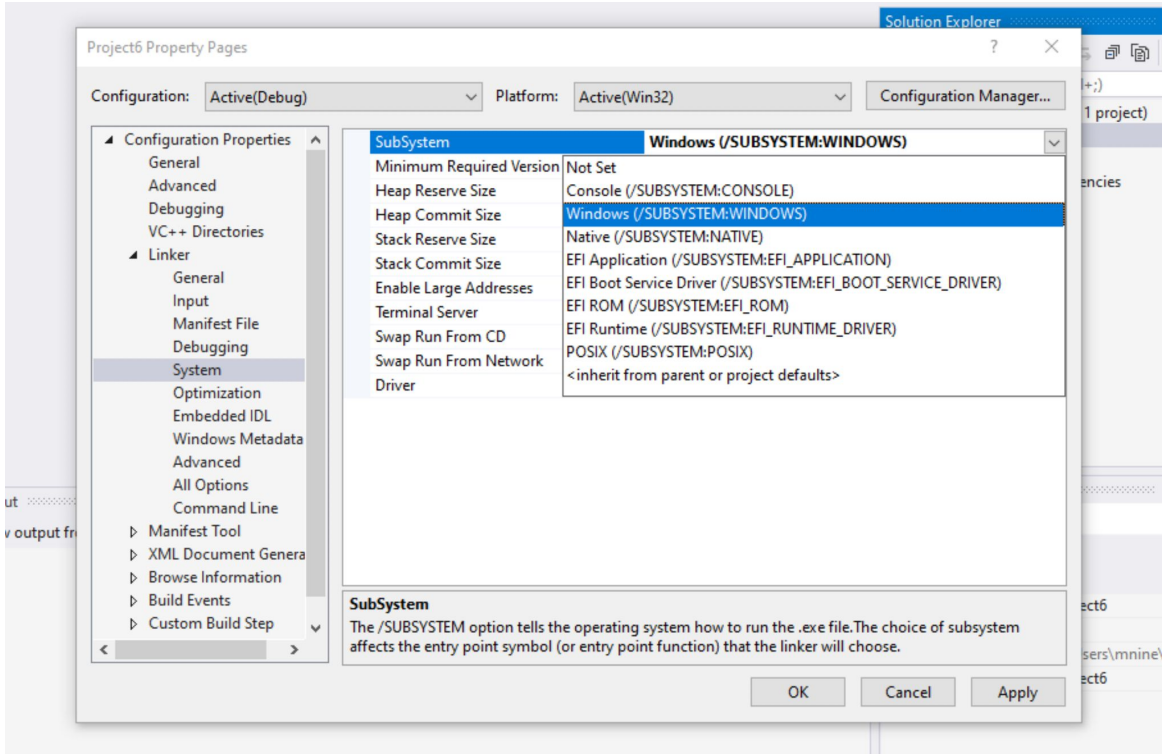
Click properties



# Create a new Project

Select Windows(/SUBSYSTEM:WINDOWS)

Click OK



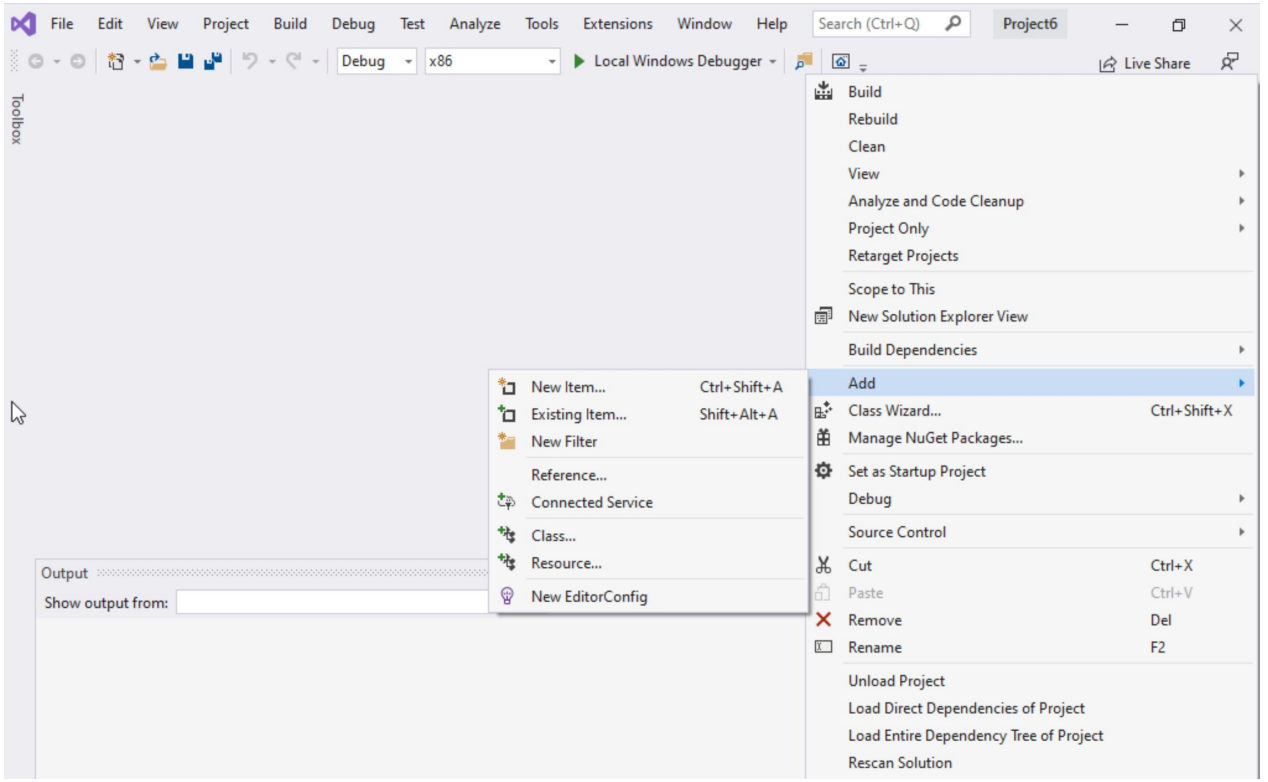
# Create a new Project

Select Project name on solution explorer

Right click on it

Expand Add

Choose New Item

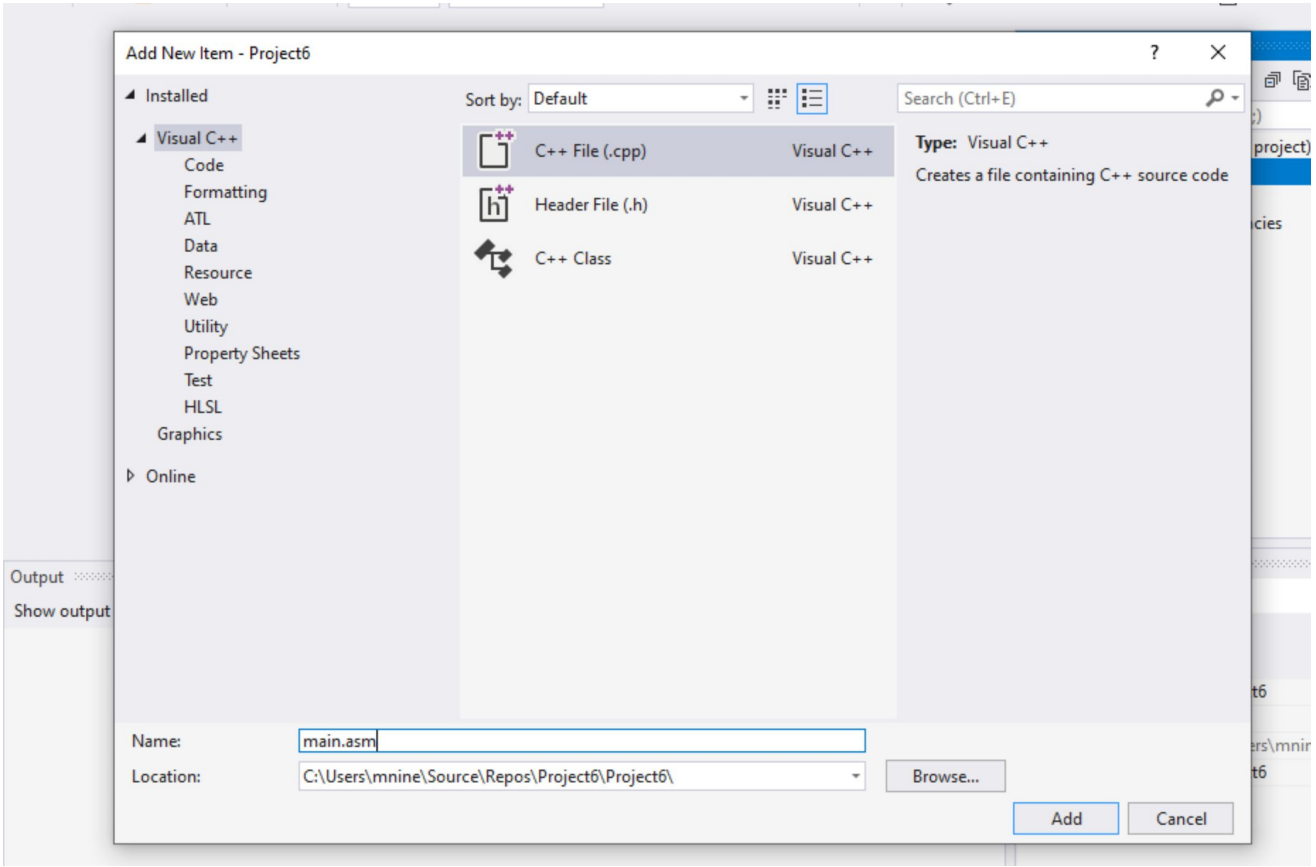


# Create a new Project

Select C++ File(.cpp)

Name: main.asm

Click Add

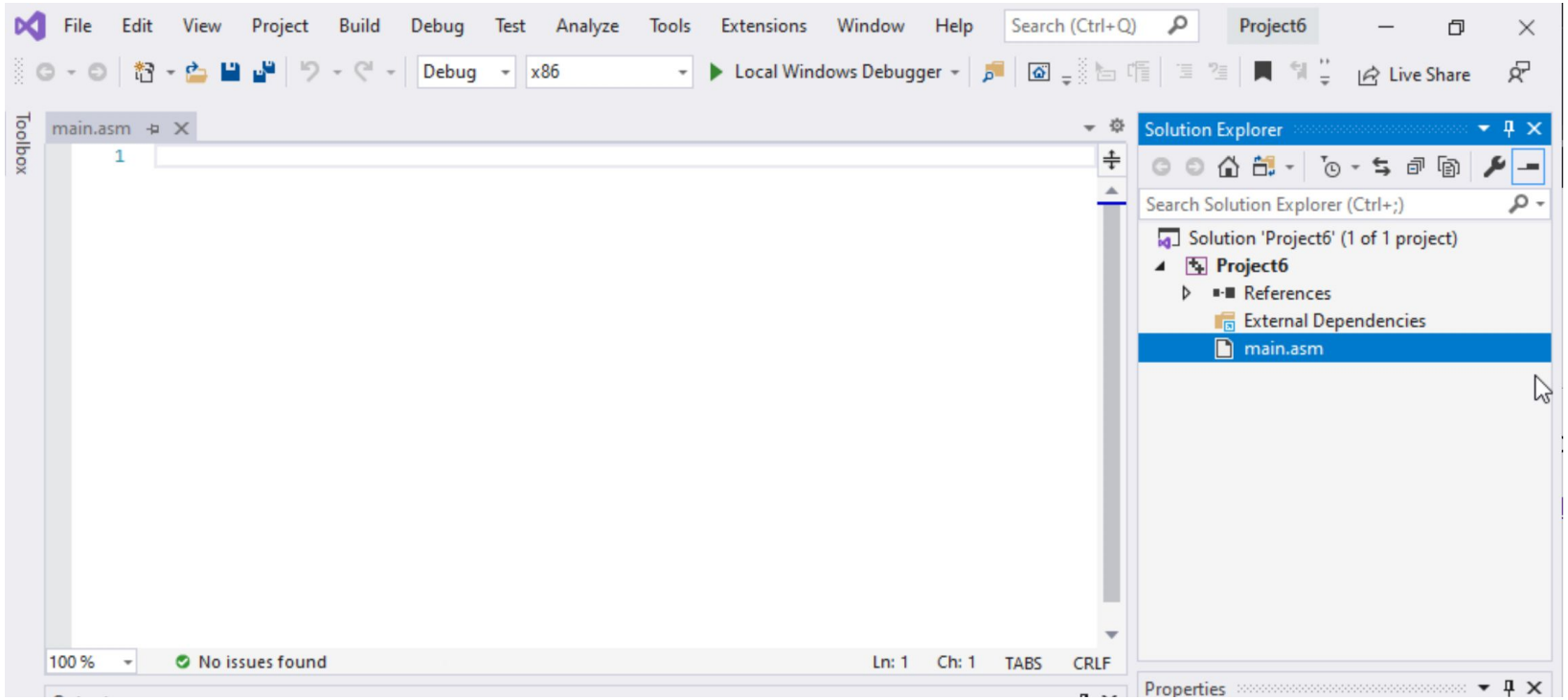


# Create a new Project

Select main.asm

Add your code

In the main.asm File.



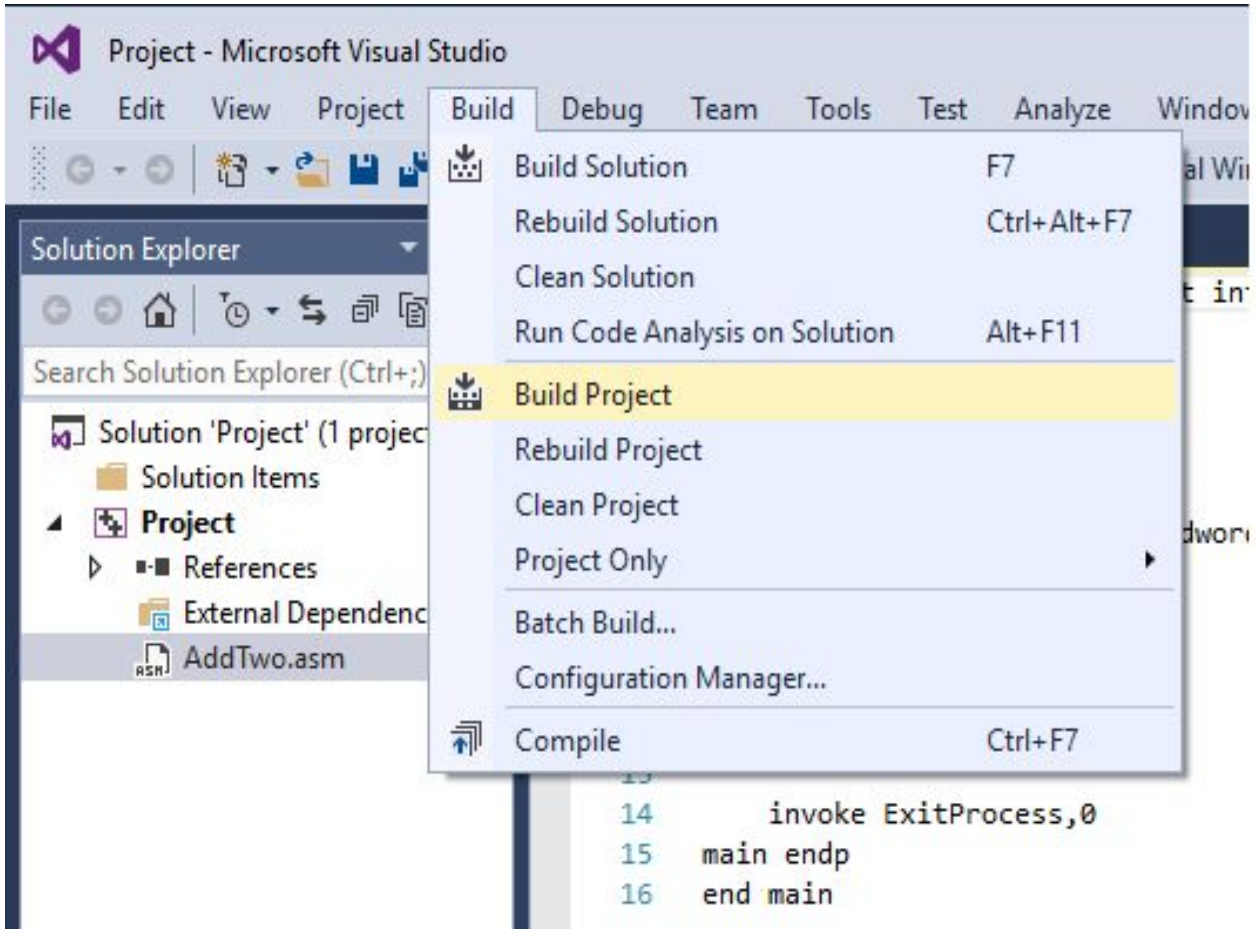
# Sample Code

Type the sample code in the main.asm

```
.386
.model flat, stdcall
.stack 4096

ExitProcess PROTO, dwExitCode:DWORD

.code
main PROC
    mov eax, 5
    add eax, 6

    INVOKE ExitProcess, 0
main ENDP
END main
```

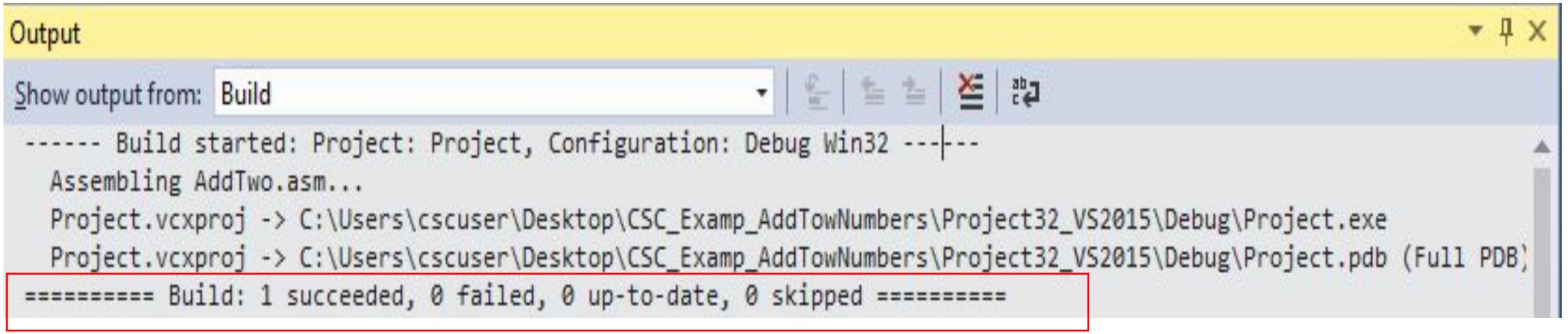
# Run the code

- Select **Build Project** (this will assemble and link your program) from the **Build menu**.
- This will **assemble** and **link** your program



# Run the code

- You should see messages like the following, indicating the build progress:



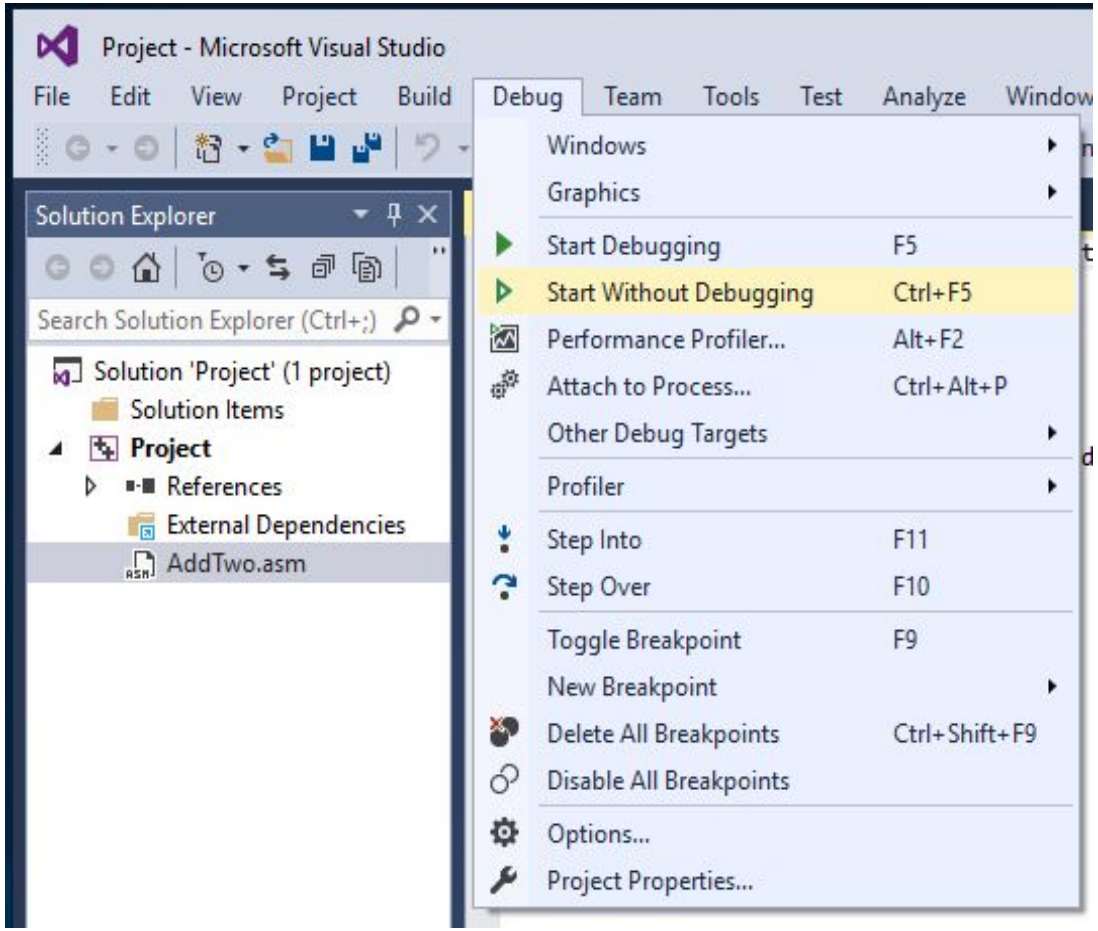

**Note:** if you see **1 failed** or more, then there must be at least one error that needs to be corrected

# Run the code

- **Run** the Program by selecting **Start without Debugging** from the **Debug menu**.
- Press any keyto end running

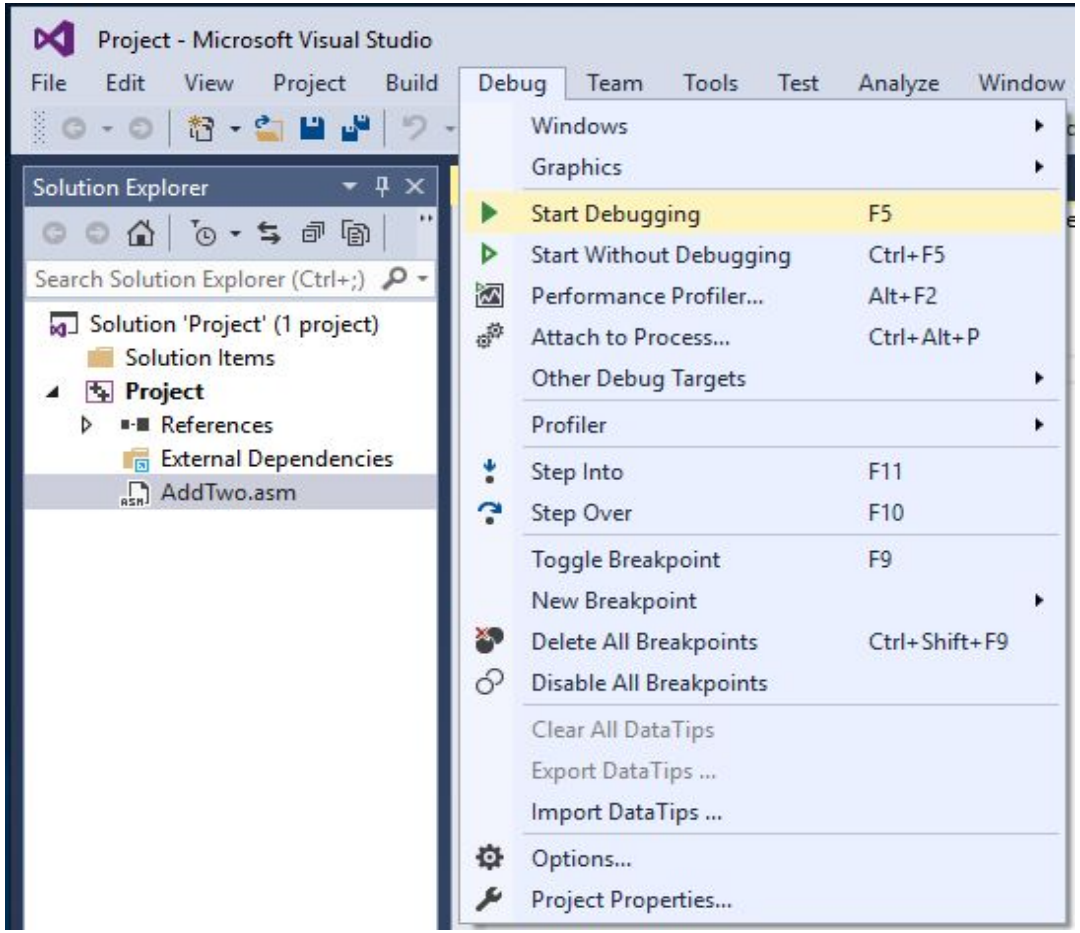
**- You will not see the result as the result is in a register**

**- See next slide**



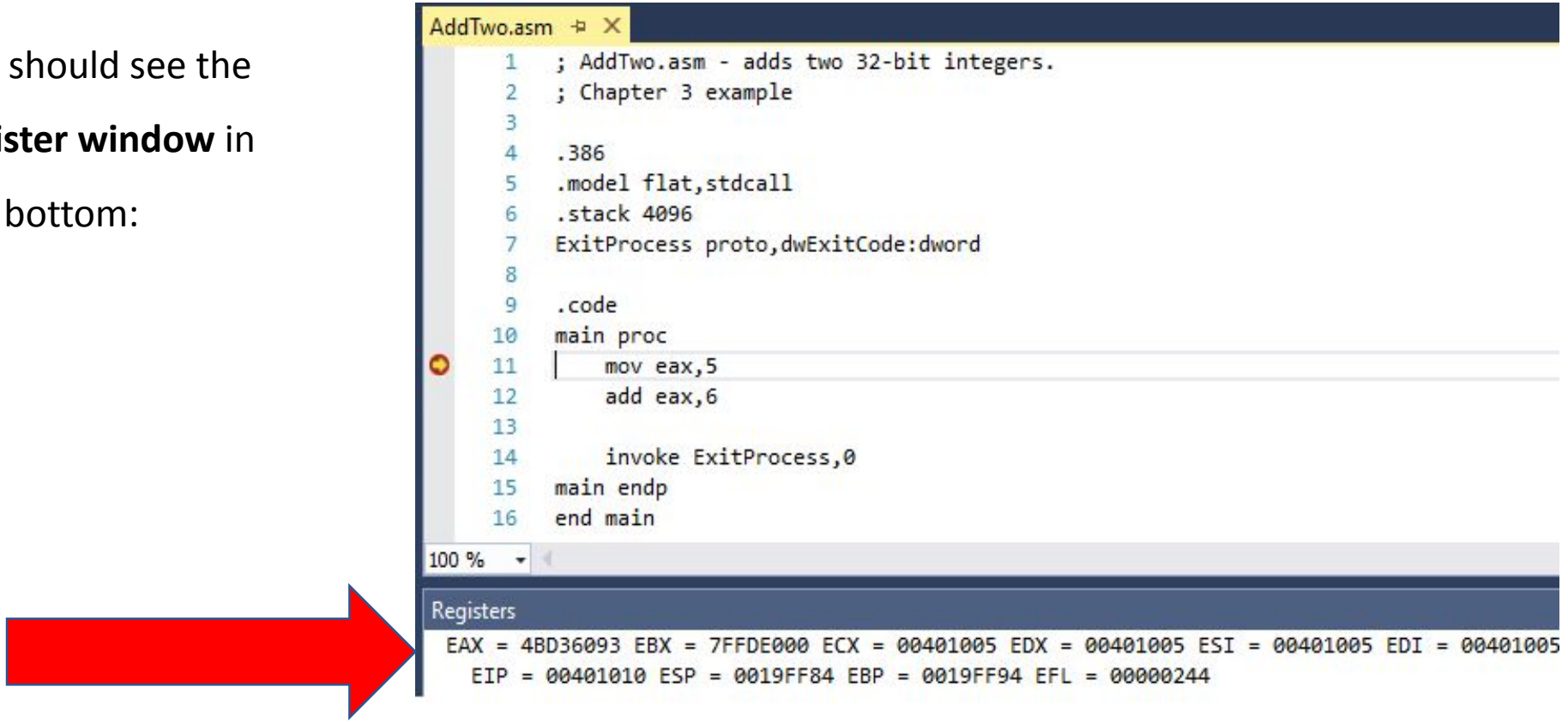
# Debug the code

- Select **Start Debugging** from the **Debug menu**.



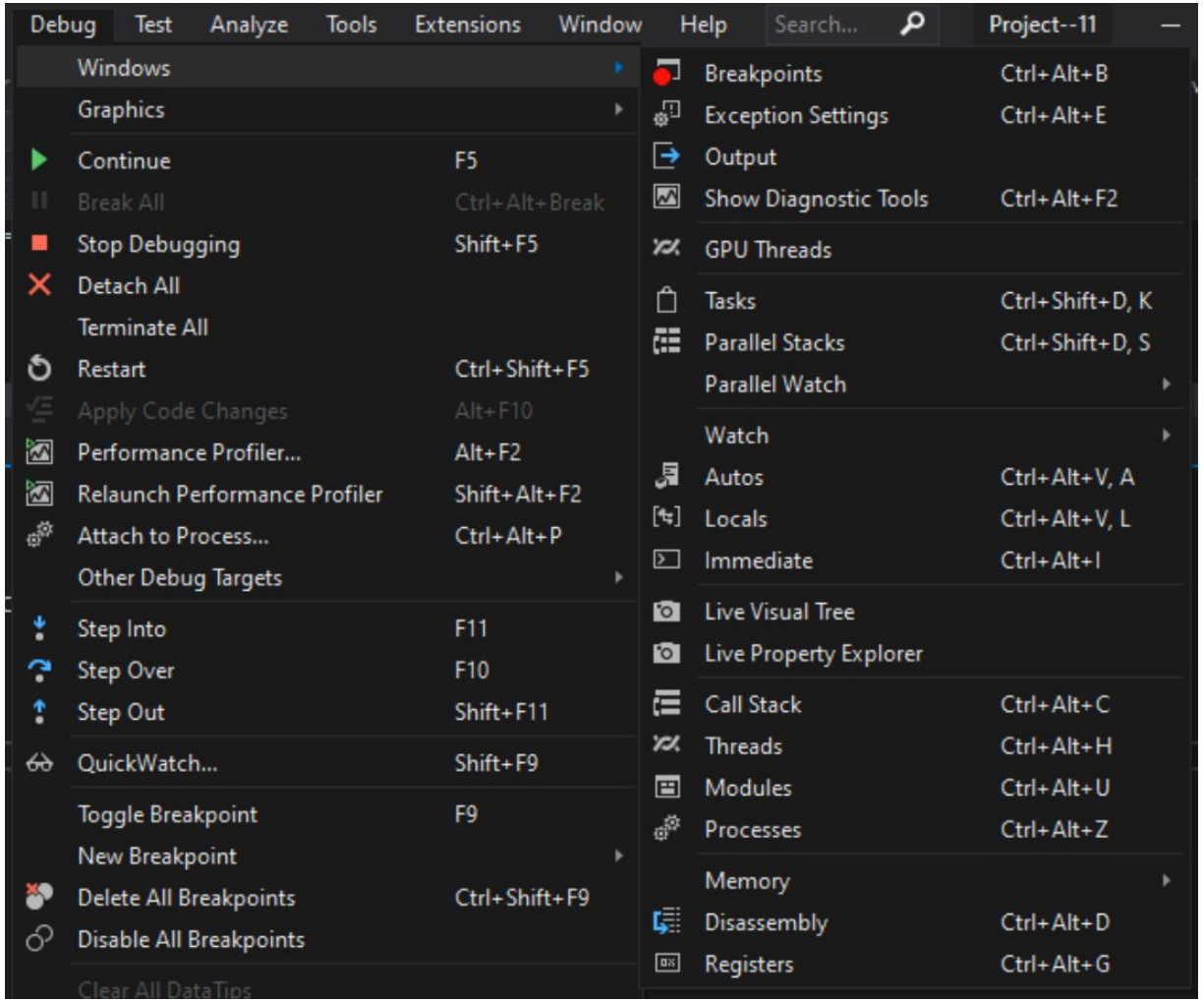
# Debug the code

- You should see the **register window** in the bottom:



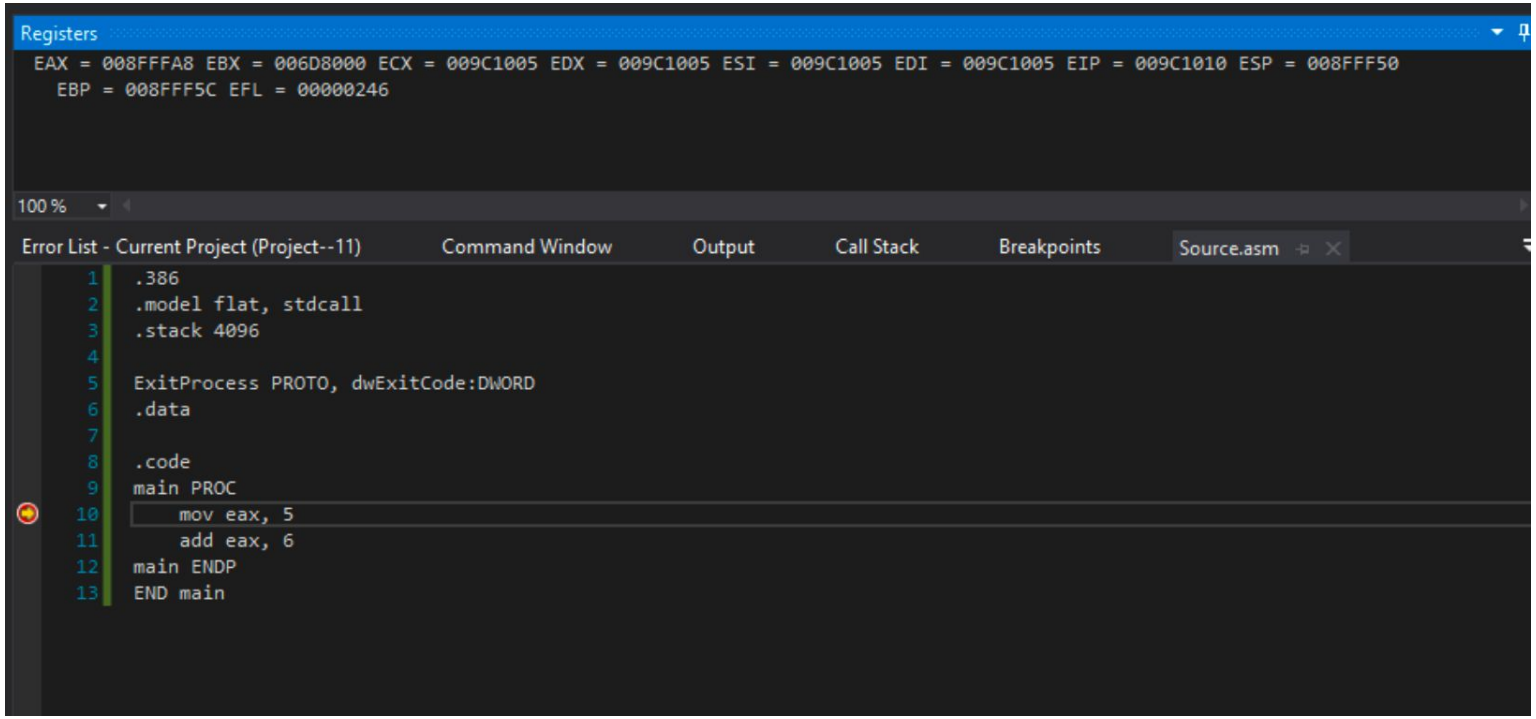
# Debug the code

- IF you don’t see the register window
- Go to
- **Debug->Windows->Registers**



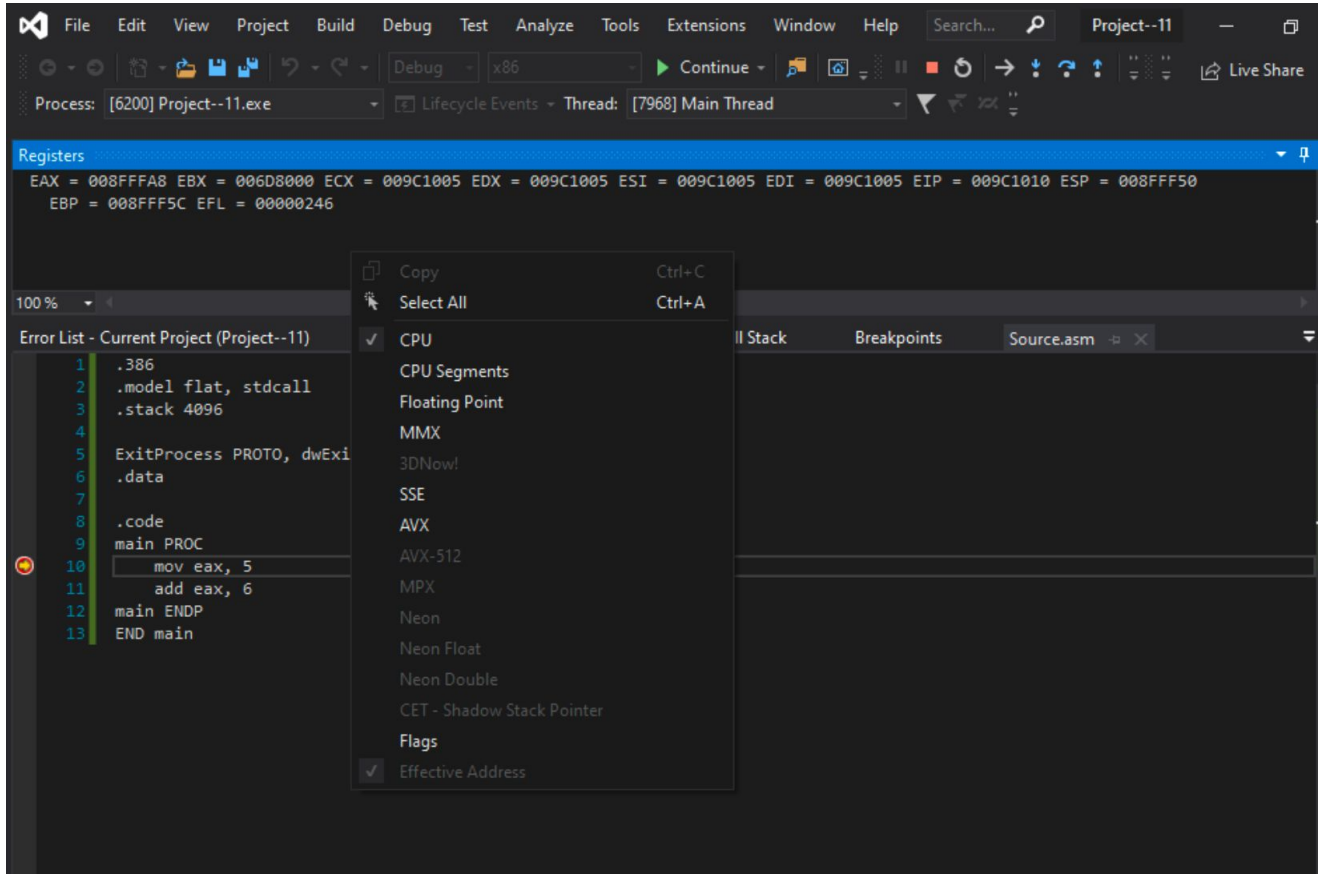
# Debug the code

- The register window should appear during the debugging



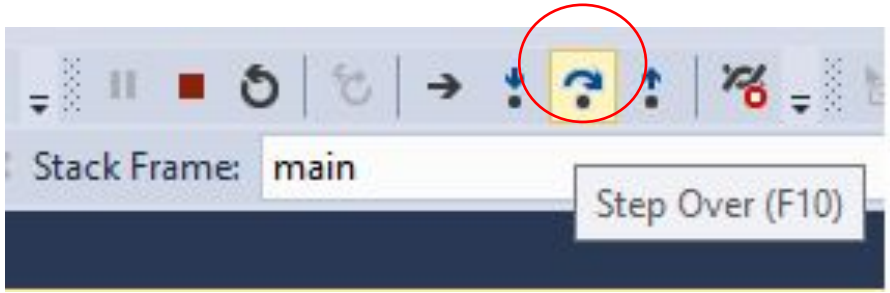
# Debug the code

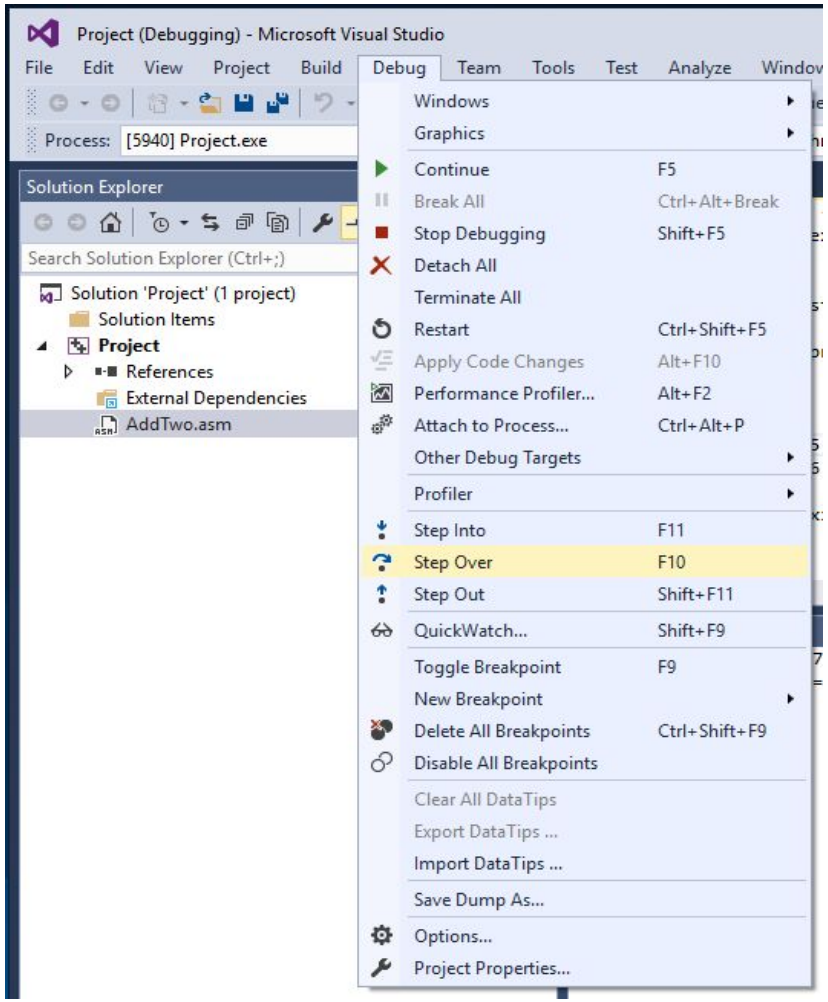
- To see the EFLAGs
- **Right click on the register window and select “Flags”**



# Debug the code

- Select **Step Over** from the **Debug menu**.
  - Depending on how Visual Studio was configured,
  - Either the Fn+F10 function key or the Shift+F8 keys will execute the **Step Over command**.
  - You can also use the button to stepover:

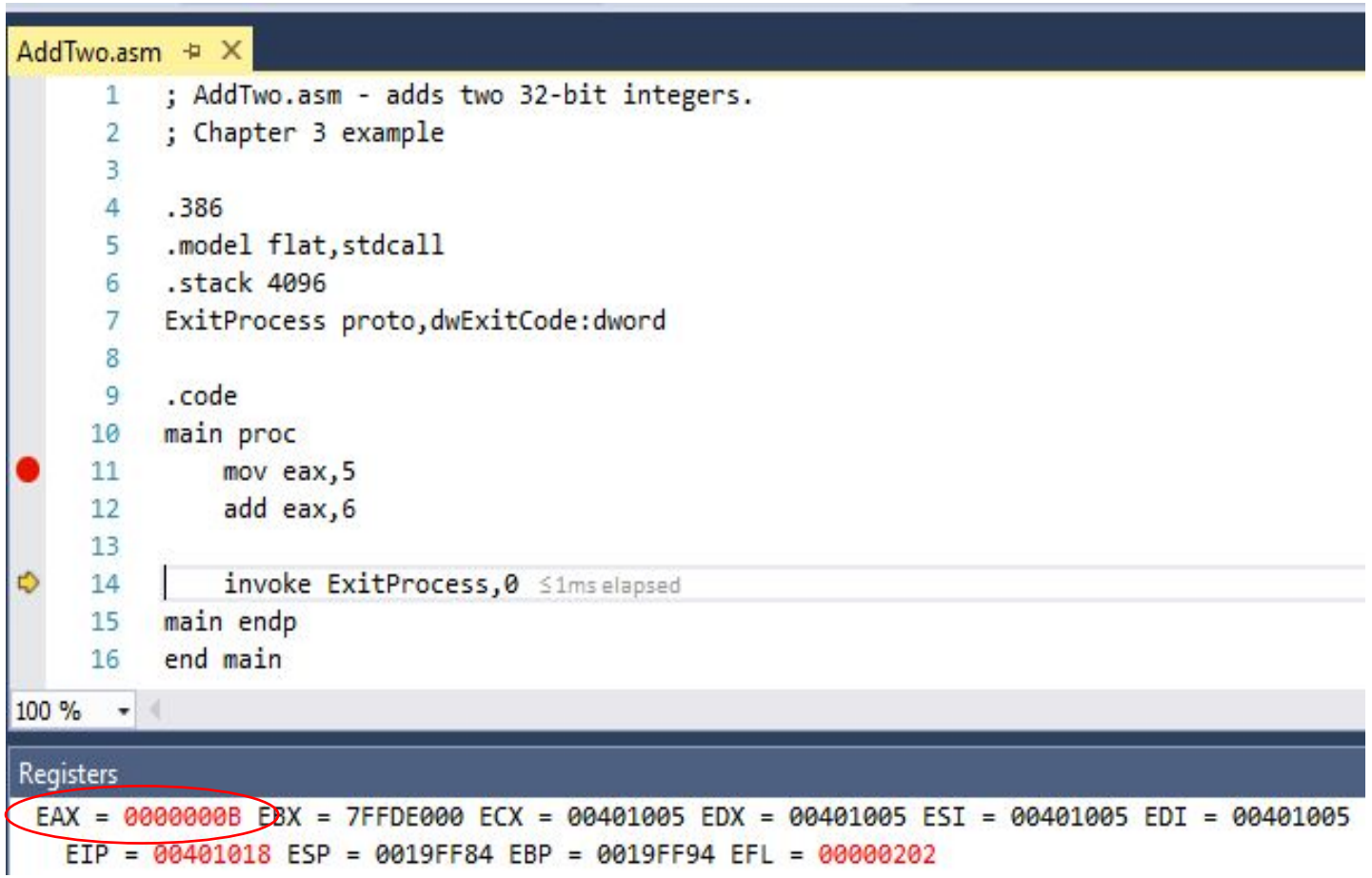



- After you reach the “invoke ExistProcess,0”,
  - Do not hit step over

# Debug the code

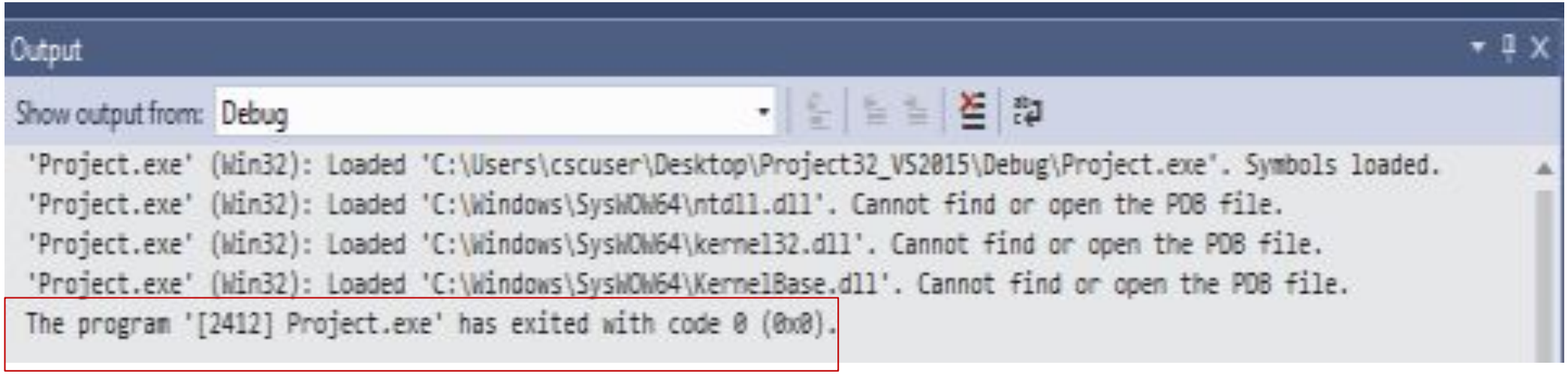
- After you reach the "invoke ExistProcess,0"
- Look at the **eax** register content and verify that its content is 11 (Which is **B**?).



# Debug the code

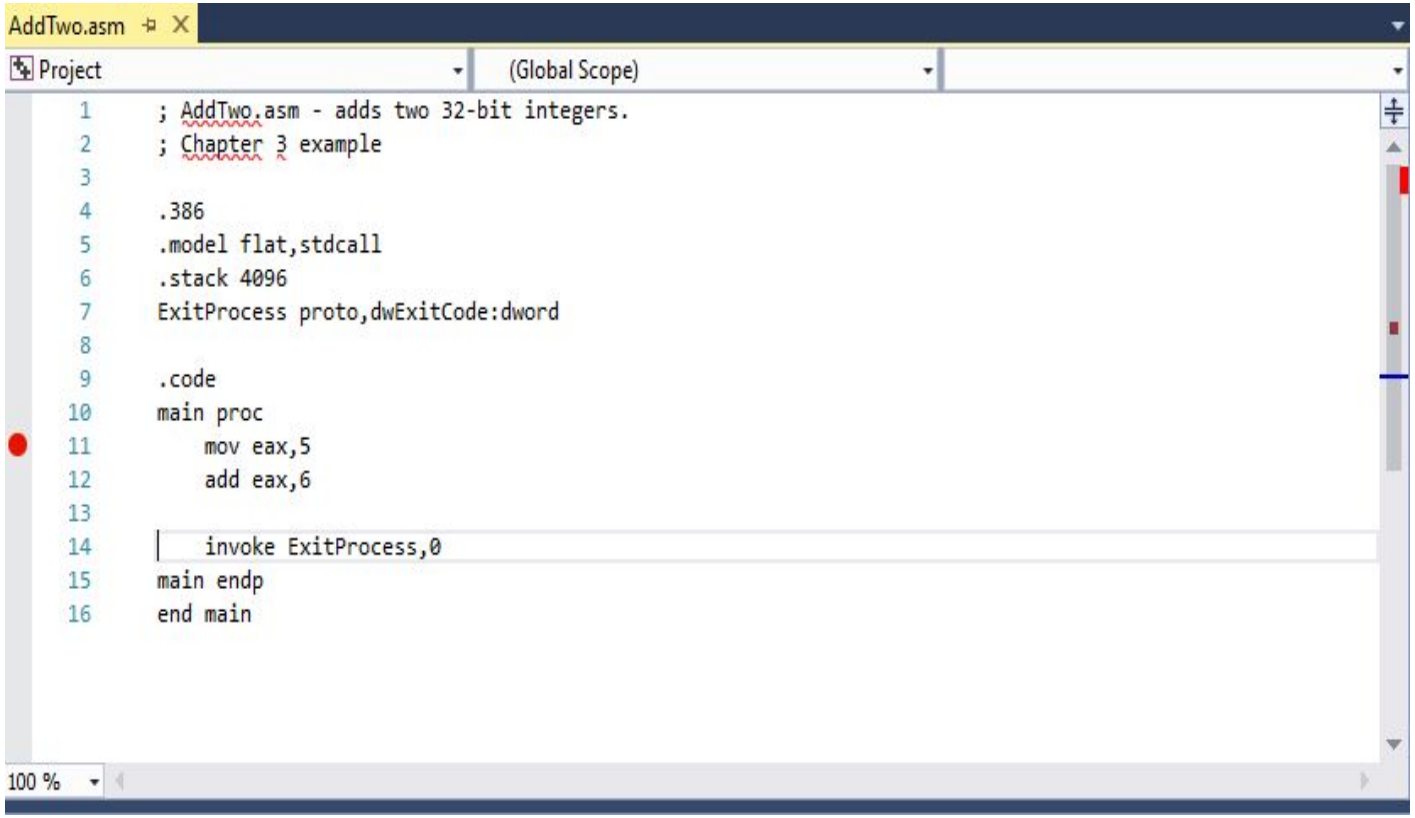
- When you hit step over, the program will end, as there is nothing to execute after:

  “invoke ExistProcess,0”



# Debug the code

- **Another way** to start a debugging session is
  - **set a breakpoint** on a program statement by clicking the mouse in **the vertical gray bar** just to the left of the code window.
    - A **large red dot** will mark the breakpoint location.
    - Then you can run the program by selecting **Start Debugging** from the **Debug menu**.




If you try to set a breakpoint on a **non-executable line**, Visual Studio will just move the breakpoint forward to **the next executable line** when you run the program.

# Some Practice Problems

Don't need to turn-in these problems

# Examples

- What is the Most significant bit of the following binary number?
- 1000011010

- Solution: 1

# Examples

- What is the minimum number of binary bits to represent a decimal number 435644?

Solution:

(1) Convert the decimal number to binary: 1101010010110111100

(2) Count the number of bits: 19

# Examples

- What is the minimum number of binary bits to represent the hexadecimal number 6A445?

Solution :

(1) Convert the Hexadecimal number to binary:

0110 1010 0100 0100 0101

(2) Drop any leading zeros from the left side of the number:

110 1010 0100 0100 0101

(3) Count the number of bits: 19 bits

# Examples

- What is the 8-bit binary representation of the following decimal number?

- 43

Solution:

(1) Convert 43 into binary : 101011

(2) Make the number 8-bit by adding 2 leading zeros: 0010 1011

(3) Perform 2's complement on 0010 1011

(3.1) Flip the bits: 1101 0100

(3.2) add 1 to it: 1101 0100 + 1 = 1101 0101

# Examples

- Perform the following hexadecimal subtraction using 2's complement.
- A15F – 6ABC

Solution:

(1)Compute the 2's complement of 6ABC:

(1.1) Reverse all the digits (subtract each digit from 15)

```
  15  15  15  15
(-)   6   A   B   C
  ---------------
   9   5   4   3
```

# Examples

- (1.2) add 1 to it: 9543+1 = 9544

- Add A15F + 9544

Carry: 1 0 0 1

A 1 5 F

9 5 4 4

3 6 A 3

$F + 4 = 19; \frac{19}{16} = 1, rem\ 3$

$1 + 5 + 4 = 10; 10\ is\ A\ in\ Hex$

$0 + 10 + 9 = 19; \frac{19}{16} = 1, rem\ 3$

Ignore the last carry.

# Examples

- What is the decimal representation of following signed numbers?
- 10110111

Solution: MSB is 1, so the number is negative

(1) Perform a 2's complement: 1011 0111

(1.1) flip the bits : 0100 1000

(1.2) add 2 to it: 0100 1000 + 1 = 0100 1001

(2) Convert the number into decimal: 73

(3) Sign bit was 1, so the number is -73

# Examples

- How many selector bits required for a four input multiplexer?

Solution:

A multiplexer uses selector bits to select specific input and let that input available to the output.

When a multiplexer has two inputs, it can enumerate the inputs as 0 and 1.

When a multiplexer has 4 inputs, it needs two bits to enumerate them.

Selector bits - 00 – input 1
01 – input 2
10 – input 3
11 – input 4

# Lab 2(b)

Submit these Math Problems to iCollege

# Lab 2(b) : Submission

- Solve the Problems provided in slide 41 to 42.
- You can do your work in a text editor (Microsoft word, open office, etc.)
- Or you can do it in a piece of paper, then scan or take a picture of the paper.
- Convert them into pdf and submit in the icollege.

# Lab 2(b) Problem 1

- Design a 8-bit full adder. Draw the block diagram. [Hint: Lecture]

# Lab 2(b) Problem 2

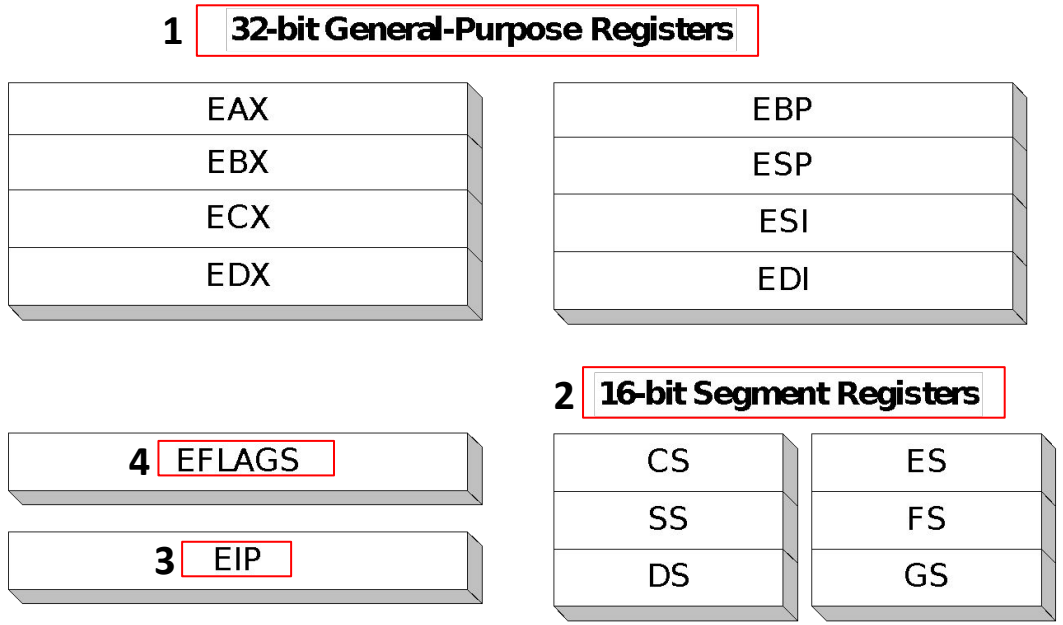
- Draw the circuit for the following Boolean expression:
- P = (X and Y) or (not X or Z)  [Hint: Lecture]

# Registers and Memory

A review

# Registers

- **Registers** are **storage locations inside the processor.**
- A register **can be accessed more quickly than a memory location .**
- **Different registers serve different purposes.**
- Some of them are described below:



# General-Purpose Registers (8 registers)

- **There are <u>eight</u> general purpose registers**

**1) EAX –**

- All major calculations take place in EAX,
- making it similar to a dedicated **accumulator register**.

**2) EDX –**

- The data register is the an extension to the accumulator.
- It is most useful for storing data related to the accumulator's current calculation.

# General-Purpose Registers

- **There are <u>eight</u> general purpose registers**

  **3) ECX –**

  - Like the variable **i** in high-level languages, the **count register** is the **universal loop counter**.

  **4) EBX –**

  - In 16-bit mode, the base register **was useful** as a pointer.
  - Now, it is **completely free for extra storage space**.

# General-Purpose Registers

- **There are <u>eight</u> general purpose registers**

**5) ESP –**

- **ESP** is the sacred stack pointer.
- With the important **PUSH**, **POP**, **CALL**, and **RET** instructions requiring it's value,
  - **there is never a good reason to use the stack pointer for anything else**.

**6) EBP –**

- In functions that **store parameters or variables on the stack**,
  - the **base pointer** <u>holds the location of the current stack frame</u>.
- **In other situations**, however, **EBP** is **a free data-storage register**.

# General-Purpose Registers

- **There are <u>eight</u> general purpose registers**

  7) **EDI –**

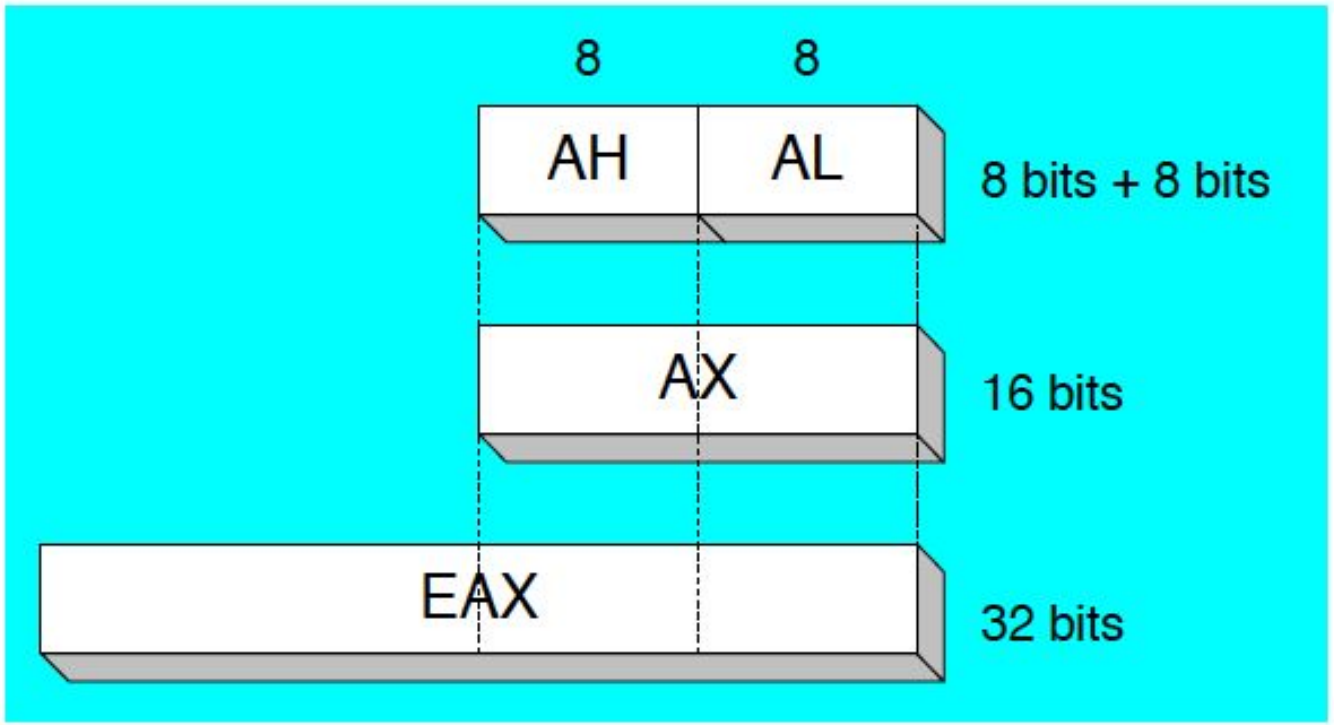
     - **Every loop** must store its result somewhere,
     - and the **destination index** points to that place.

  8) **ESI –**

     - In **loops** that process data,
     - the **source index** holds the location of the input data stream.

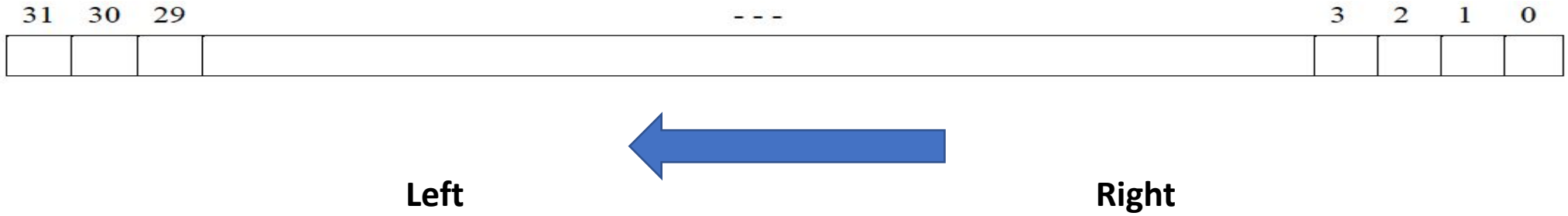
# General-Purpose Registers

- **Accessing** Parts of Registers



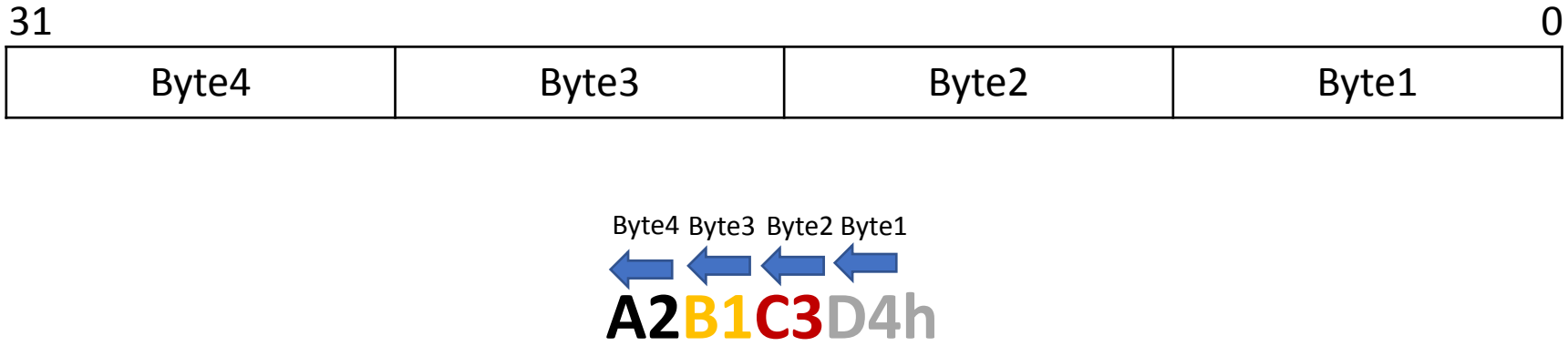
# General-Purpose Registers

- **Bits are stored in any registers right to left**
  - **Ex: 32-bit Register** (referring to bits storage not bytes)



# General-Purpose Registers

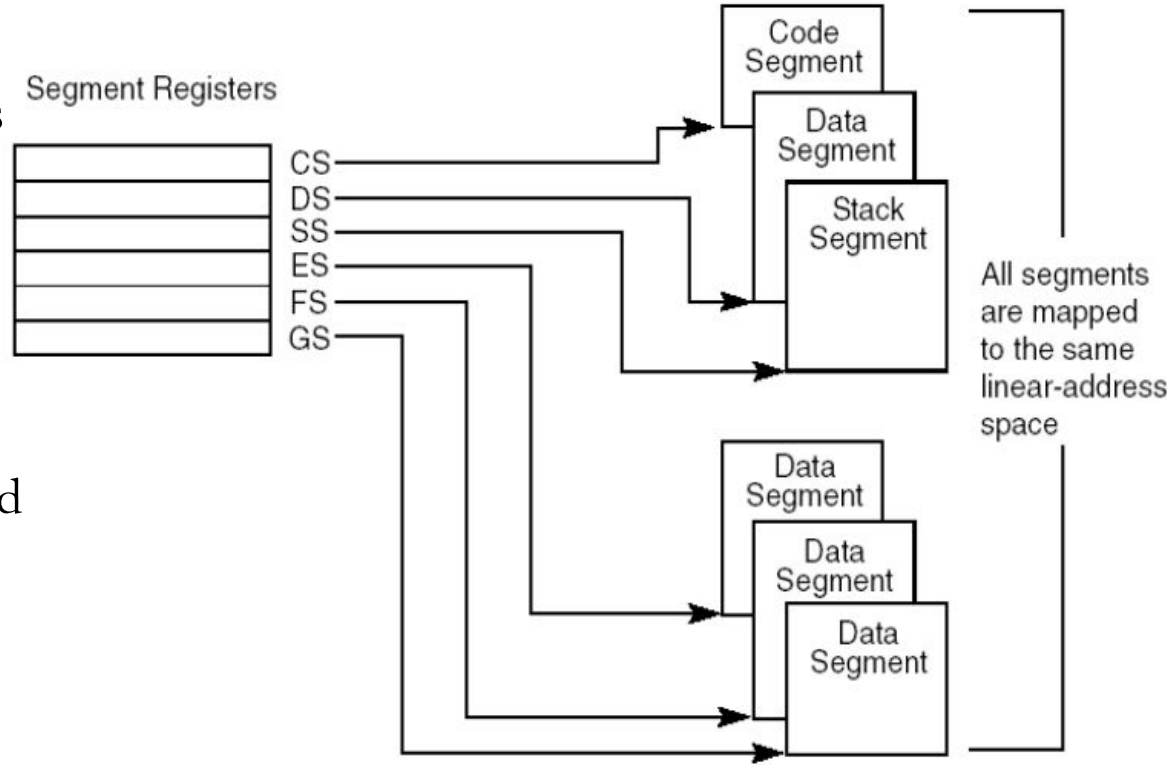
- **Bytes are stored right to left too**



# Segment Registers

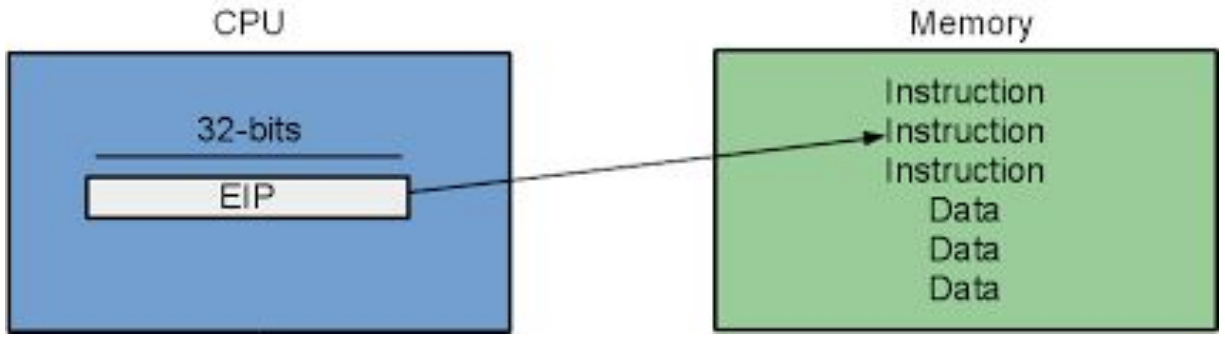
- **There are six segment registers**

1) **CS – code segment:** hold program instructions
2) **DS – data segment:** hold variables
3) **SS – stack segment:** holds local function variables and function parameters.
4) **ES, FS, GS - additional segments:** can be used in a similar way as the other segment registers.



# Instruction Pointer Register

- **EIP** – instruction pointer (also called **program counter)**:
  - contains the address of the **next instruction to be executed** .

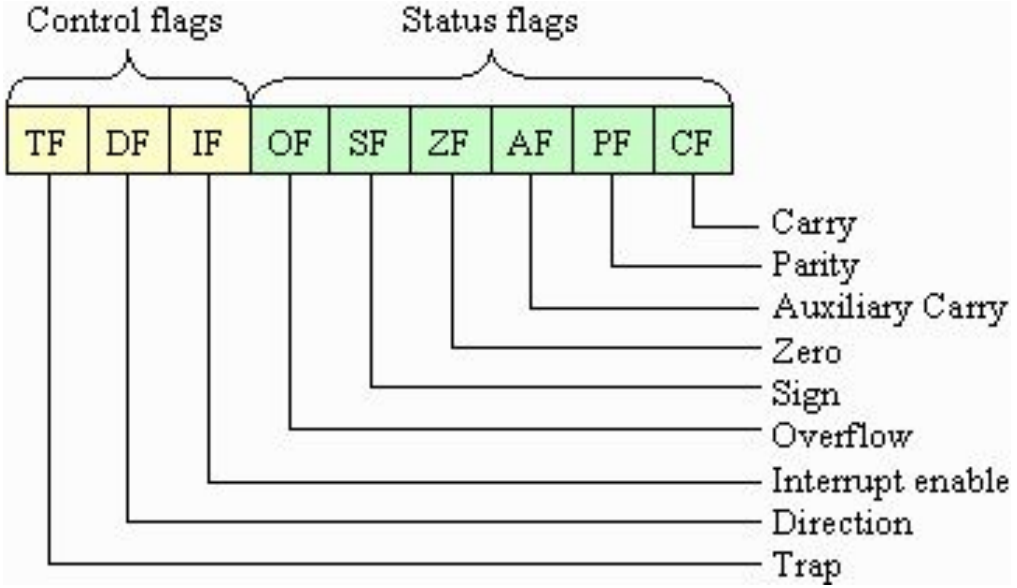



**It is also known as PC (Program Counter)**

# EFLAGS Register

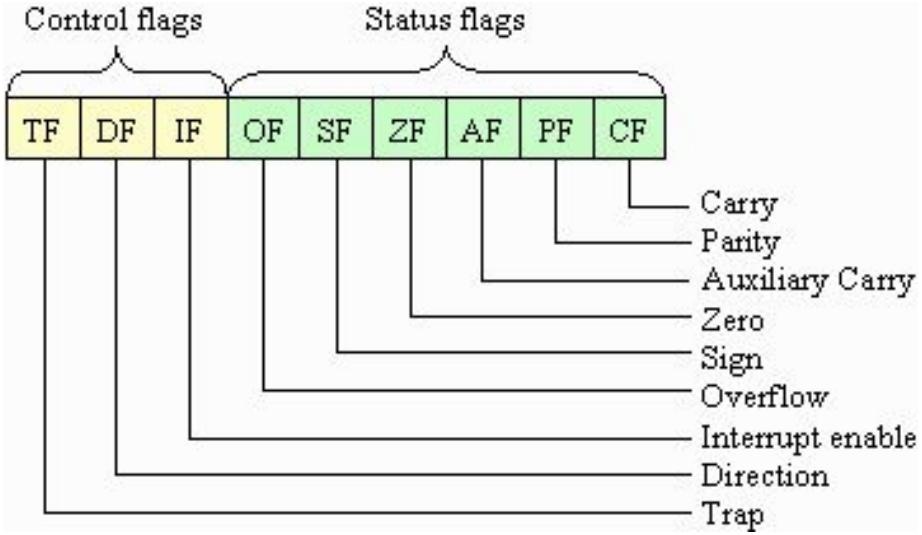
- **EFLAGS-** a register consists of **individual binary bits** that
  - control the **operation** of the CPU or
  - reflect **the outcome** of some CPU **operation**.

- Thus, we have **status** and **control** flags
  - Each flag is a single binary bit



# EFLAGS Register

- **Status flags** record certain information about the most recent **arithmetic** or **logical** operation.
  - **Carry**
    - unsigned arithmetic out of range
  - **Overflow**
    - signed arithmetic out of range
  - **Sign**
    - result is negative
  - **Zero**
    - result is zero




A flag is **set** when it equals 1;
it is **clear** (or reset) when it equals 0.

**Note**: **Control flags** are out of the scope of this class

# Some Practice Examples

Don't need to turn-in these problems

# Practice Problems

**1. Which flag is set when the result of an unsigned arithmetic operation is too large to fit into the destination?**

**Carry**

**2. Which flag is set when the result of a signed arithmetic operation is either too large or too small to fit into the destination?**

**Overflow**

**3. Which flag is set when an arithmetic or logical operation generates a negative result?**

**Sign**

# Practice Examples

**4. Show the EDX register and the size and position of the DH, DL, and DX within it.**

# Lab 2(c)

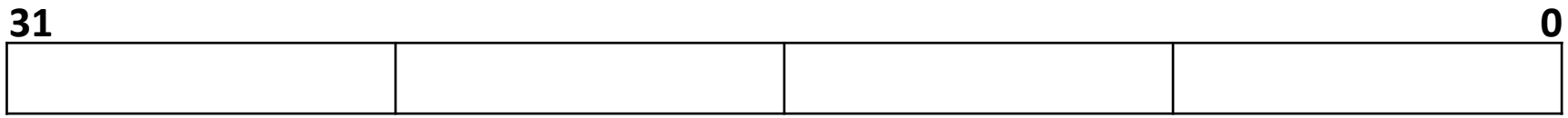
Submit these Problems

# Lab 2(c) : Submission

- Solve the Problems provided in slide 61 to 62.
- You can do your work in a text editor (Microsoft word, open office, etc.)
- Or you can do it in a piece of paper, then scan or take a picture of the paper.
- Convert them into pdf and submit in the iCollege.

# Lab 2(c) Problems

**2. Store the following value in EAX register: 12784569h**




**4 bytes**

# Lab 2(c) Problems

**6.** For each **add instruction in this exercise**, assume that **EAX** contains the given contents before the instruction is executed.

- Give the contents of **EAX** as well as the values of the **CF**, **OF**, **SF**, **ZF** after the instruction is executed.
- All numbers are in hex. (Hint: add eax, 40 will add 40 to the contents of register eax and stores the result back in eax)

| Contents of EAX (Before) | Instruction | Contents of EAX (After) | CF | OF | SF | ZF |
|---|---|---|---|---|---|---|
| 00000040 | add eax, 40 | | | | | |
| FFFFFF40 | add eax, 40 | | | | | |
| 00000040 | add eax, -40 | | | | | |

Assume that numbers are signed integers