NYU K12 STEM Internet of Things 2019

WELCOME

NYU TANDON SCHOOL OF ENGINEERING

Center for K12 STEM Education

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NYU TANDON SCHOOL OF ENGINEERING

K12 STEM Mission

- Access and opportunity
- Design and deliver high-quality, innovative teaching and learning programs for teachers and students
- Connect to faculty research
- Support and develop our students
- Create in-depth STEM education partnerships

TUTOR DETAILS

- **Contact Details:**

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CLASS RULES

- ASK AWAY ANYTHING.
- Explore what interests you , ask for extra material.
- Instructors will be your best friends in getting through this course.
- Accept Challenges , Try , Fail , Don’t give up , TRY AGAIN.
- Maintain professional attitude during class , deviant behavior will be recorded and reported.
- Attendance will be recorded and reported.
- We will keep track of your progress through grades on your labs and you will be awarded a grade letter at the end of course.

CLASS STRUCTURE

- Class Hours : Discussions on Concepts , Demonstrations
- Lab Hours : Practice through in-class assignments.
- In-Case a project is not completed in class , it is to be submitted next day at the start of the class.
- Submission Instructions TBD.
  - 9AM-12PM → Class Hours
  - 1PM-4PM → Lab Hours

Internet Of Things

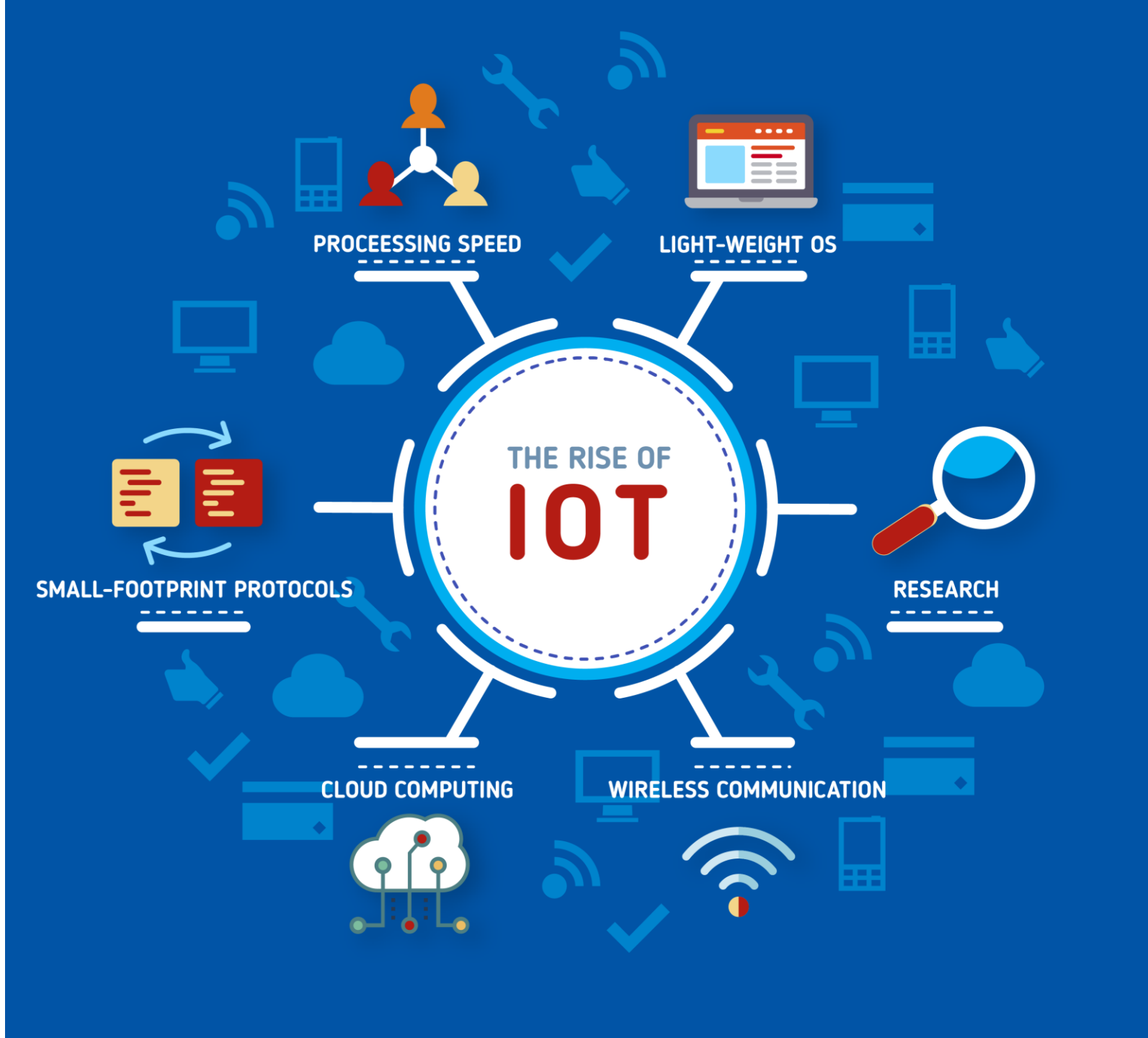
What are Embedded Systems?

- An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is **embedded** as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today.
- Anything that uses a microprocessor but isn't a general-purpose computer

  Smartphones, Set-top boxes ,Televisions ,Video Games ,Refrigerators ,Cars ,Planes ,Elevators ,Remote Controls ,Alarm Systems
- The user "sees" a smart (*special-purpose*) system as opposed to the computer inside the systems
  - "how does it do that?"
  - "it has a computer inside of it"
  - "oh, BTW, it does not or cannot run Windows or MacOS"
- The end-user typically does not or cannot modify or upgrade the internals

Why Is IoT Significant?

- The **Internet of things** (**IoT**) is the extension of Internet connectivity into physical devices and everyday objects.
- Embedded Systems have evolved into a new discipline called IoT.
- IoT emphasizes on creating networks of large number of smaller embedded devices which can be remotely monitored and controlled.
- IoT is now also extending to Personal Mobile Devices , where researchers are using huge numbers of interconnected PMDs to extract parallel computing without the need of dedicated hardware.
- IoT is also crucial in big data applications ,such as city planning , architecture , Departmental Stores , etc.



Embedded Systems Scope

Automotive systems

- Perhaps designing and developing “drive-by-wire” systems
- Self-driving vehicles

Telecommunications

Medical Devices

Consumer electronics

- Cellular phones, MP3 devices, integrated cellular/tablet
- Set-top box and HDTV
- Home and Internet appliances/ IOT
- Your refrigerator will be on the internet more than you are!

Defense and weapons systems

Process control

- Gasoline processing, chemical refinement

Automated manufacturing

- Supervisory Control and Data Acquisition (SCADA)

Space communications

- Satellite communications

Why are Embedded Systems Different?

Four General Categories of Embedded Systems

1. General Computing
   - Applications similar to desktop computing, but in an embeddedpackage
   - Video games, set-top boxes, wearable computers, automatic tellers
   - Tablets, Phablets
2. Control Systems
   - Closed loop feedback control of real-time system
   - Vehicle engines, chemical processes, nuclear power, flight control
3. Signal Processing
   - Computations involving large data streams
   - Radar, Sonar, Video compression
4. Communication & Networking

   Switching and information transmission

   Telephone system, Internet

   Wireless everything- IoT

Real-Time Embedded Systems

- These systems are designed to react to real-time stimulus , either external or internal.
- Precise timing and accuracy are required.

Typical Embedded Systems Constraints

- Small Size, Low Weight
  - Handheld electronics
  - Transportation applications weight costs money
- Low Power
  - Battery power for 8+ hours (laptops often last only 2 hours)
  - Limited cooling may limit power even if AC power available
- Harsh environment
  - Heat, vibration, shock
  - Power fluctuations, RF interference, lightning
  - Water, corrosion, physical abuse
- Safety critical operation
  - Must function correctly
  - Must not function incorrectly
- Extreme cost sensitivity
  - $0.05 adds up over 1,000,000 units

Embedded Systems Designer Skill Set

- Appreciation for multidisciplinary nature of design
  - Both hardware & software skills
  - Understanding of engineering beyond digital logic
  - Ability to take project from specification through production
- Communication and Teamwork skills
  - Work with other disciplines, manufacturing, marketing
  - Work with customers to understand the real problem being solved
  - Make a good presentation; even better – write “trade rag” articles
- And, by the way, technical skills too…..
  - Low-level: Microcontrollers, FPGA/ASIC, assembly language, A/D, D/A
  - High-Level: Object oriented design, C/C++, Real Time Operating Systems
  - Meta-level: Creative solutions to highly constrained problems
  - Likely in the future: Unified Modeling Language, embedded networks

Intro To Programming

```c
#include <stdio.h>
#include <stdlib.h>

int main(void) {
    printf("!!!Hello World!!!"); /* prints !!!Hello World!!! */
    return 0;
}
```

Hello World

Data types

- Used by compiler to determine what kind of data is being stored.
- Data can be a number, word, character, etc.

Data types Numbers

- **Storing integers**

  Syntax: int variableName

  Eg. int number = 10;

  Max Value: 2,147,483,647

- **Storing a large number**

  Syntax: long variableName

  long bigNumber = 9999999999999;

- **Storing decimals**

  Syntax: float variableName

  Eg. float marks = 89.5;

  Precision: 6 to 9 digits

- **Storing higher precision number**

  Syntax: double variableName

  Eg. double pi = 3.1415926535;

Data types
Words/Characters

- Storing characters

  Syntax: *char variableName*

  Eg.char alphabet = “A”;

- *Storing string*

  Syntax: *char variableName[]*

  Eg. char name[50] = “IoT Camp”;

Data types
Boolean

- Boolean data types are used to represent the truth values of a logic.
- It can have 2 values, either *true* or *false.*
- To include this data type, a library has to be added.

  #include <stdbool.h>
- Storing a Boolean

  Syntax: *bool variableName*

  Eg. bool isPlaying = true;

Printing on console

- Syntax: printf("*statement*",identifierValue);
- Different identifiers:
  - d – integers
  - x – hexadecimal
  - s – string
  - c - character
  - f - floating numbers
- Eg: char name[50] = "IoT";

  int year = 2019;

  printf("Welcome to Summer %s %d camp.", name, year);

  Output: `Welcome to Summer IoT 2019 camp.`
- Formatting the output:
  - \n – new line
  - \t – four horizontal spaces

- Eg: printf("Sr.no. \t Name \n 1. \t Jack");

  Output:

```
Sr.no.    Name
 1.       Jack
```

Taking input
from user

- **Syntax: scanf(“*identifier*”, &variableName);**
- Eg: int number;

  scanf(“%d”, &number);
- Important point:

  While using a string to take an input DON’T use “&” i.e.

  char name[50];

  scanf(“%s”, name); // No & before name

```c

#include <stdio.h>
#include <stdlib.h>

int main(void) {
    setvbuf(stdout, NULL, _IONBF, 0);
    char name[50];
    printf("Enter your name: ");
    scanf("%s",name);
    printf("Hello %s", name);
    return 0;
}

```

Problems Tasks Console Properties

<terminated> (exit value: 0) helloWorld.exe [C/C++ Application

```
Enter your name: Monish
Hello Monish
```

Hello you

Comments

- Commenting a code is always a good practice.
- It'll help you as well as others to understand the code.
- Single line comment: `//Single line comment`
- Multiline comment:

```
/*
 * Multi line comment
 * for something long
 *
 */
```

Mathematical Operations

Operations	Operator	Syntax
Addition	+	number1 + number2
Subtraction	-	number1 - number2
Multiplication	*	number1 * number2
Division	/	number1 / number2
Remainder	%	number1 % number2

Important point:

- In division, the result of the operation will be the quotient only i.e. it will not give the decimal value.

  Eg. int number1 = 15;
  int number2 = 10;
  printf("%f",(number1 / number2));
  Output: 1.000000 instead of 1.5

- To obtain decimal value one of the variable has to be a float.

  Eg. float number1 = 15;
  int number2 = 10;
  printf("%f",(number1 / number2));
  Output: 1.50000

Switch case

- **Syntax: switch(variable)**

```
{
    case value:
        // do something
        break;
    case value2:
        // do something else
        break;
    default:
        // if none of the above case satisfy then do something else
        break;
}
```

Switch case

- **Syntax: switch(variable)**

```
{
    case value:
        // do something
        break;
    case value2:
        // do something else
        break;
    default:
        // if none of the above case satisfy then do something else
        break;
}
```

- Eg. int number = 1;

```
switch(number)
{
    case 0:
    printf("Case 0 selected");
    break;
    case 1:
    printf("Case 1 selected");
    break;
    default:
    printf("Wrong selection");
    break;
}
```

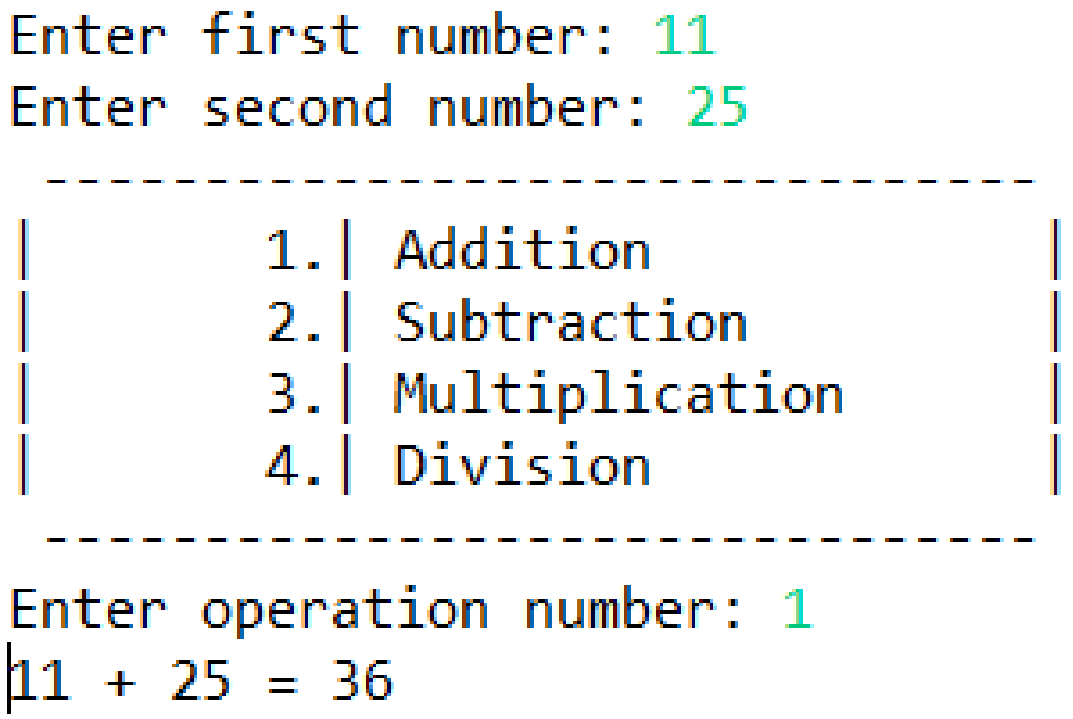
```c
#include <stdio.h>
#include <stdlib.h>


int main()
{
  char alphabet;
  printf("Select a character: ");
  scanf("%c", &alphabet);
  switch(alphabet)
  {
    case 'A':
    printf("You selected apples\n");
    break;
    case 'B':
    printf("You selected bananas\n");
    break;
    case 'G':
    printf("You selected grapes\n");
    break;
    case 'O':
    printf("You selected oranges\n");
    break;
    default:
    printf("No fruit selected\n");
    break;
  }
  return 0;
}
```

Switch case

Calculator

Design a calculator that performs the following operations:



Calculator

```c
int main(void) {
    setvbuf(stdout, NULL, _IONBF, 0);
    int firstNumber, secondNumber, operation;
    printf("Enter first number: ");
    scanf("%d", &firstNumber);
    printf("Enter second number: ");
    scanf("%d", &secondNumber);
    printf(" ------------------------------\n");
    printf("|   1.| Addition        |\n");
    printf("|   2.| Subtraction     |\n");
    printf("|   3.| Multiplication  |\n");
    printf("|   4.| Division        |\n");
    printf(" ------------------------------\n");
    printf("Enter operation number: ");
    scanf("%d", &operation);
    // printf("\n");
    switch(operation)
    {
        case 1:
            printf("%d + %d = %d",firstNumber,secondNumber,(firstNumber + secondNumber));
            break;
        case 2:
            printf("%d - %d = %d",firstNumber,secondNumber,(firstNumber - secondNumber));
            break;
        case 3:
            printf("%d * %d = %d",firstNumber,secondNumber,(firstNumber * secondNumber));
            break;
        case 4:
            printf("%d / %d = %d",firstNumber,secondNumber,(firstNumber / secondNumber));
            break;
        default:
            printf("Invalid operation number");
            break;
    }
    printf("\n");
    return 0;
}
```