ME 168 (COMPUTER PROGRAMMING FOR ENGINEERS)

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Course Outline

- Course Objectives
  - To describe and explain some basic terminology used in computer programming
  - To write and run computer programs in MATLAB
  - To develop, compile and run code in C/C++
- Contact Hours
  - 2 hrs theory
  - 1 hr practicals

Contact Hours

- Kumasi Campus
  - MECH 1
    - Theory (Fridays, 8:00 – 10:00 am)
    - Lab (Mondays, 10:30 am – 3:00 pm)
  - AERO 1
    - Theory (Tuesdays, 8:00 – 10:00 am)
    - Lab (Tuesdays, 3:30 pm – 5:30 pm)
- Obuasi Campus (MECH 1)
  - Theory (Thursdays, 8:00 – 10:00 am)
  - Lab (Thursdays, 10:00 – 11:00 am)

Course Outline

- Course Content
  - Computer Programming Fundamentals
  - Computer Software
  - MATLAB Programming
  - C/C++, Object Oriented Programming

- Assessment
  - Quizzes, Assignments, Mid-Semester, Final Exams

Assessment

- Quizzes, Assignments ⟵ S1 = 30%
- Attendance ⟵
- Mid Semester Exams (S2 = 30%)
- End of Semester Exams (S3 = 70%)
- Final Score = (S1 + S2)/2 + S3

Class Regulations

- Be punctual (No lateness beyond 10 minutes)
- No use of mobile phones in class
- Decent conduct and we all ride into the sunset to live happily ever after (HEA)

References

- Chapra, S.C., *Applied Numerical Methods with MATLAB for Engineers and Scientists*, 3rd Int. Ed., 2012
- Nakamura, S., *Numerical Analysis and Graphic Visualization with MATLAB*, Prentice Hall Inc. 1996
- Any C/C++ Programming Book

Computer Programming

Relevant Terminology (Review)

- Computer Programming:

  The process of creating a computer program

- Computer Program:

  A set of instructions that can be executed by the computer to perform a specific task

- Computer Software

  A set of computer programs

How Do Computers Store Data?

- There are many types of data a computer needs to store or operate on, e.g.,
  - Text, numbers, images, sound, videos, programs, instructions, etc.,

- The data are first moved or loaded into memory before they are fetched by the CPU for processing

How Do Computers Store Data?

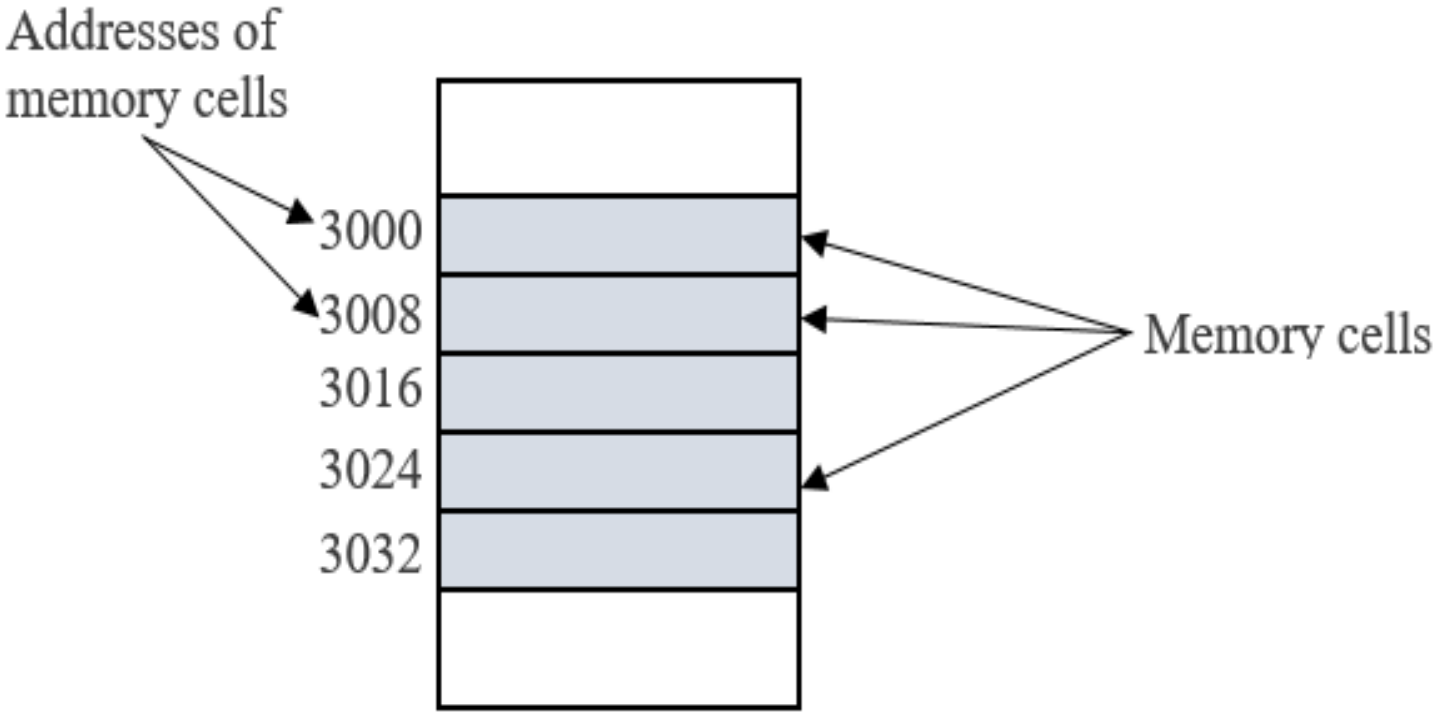
- The information/data in memory is stored as a series of switches (set ON/OFF)
- Each switch exists in two states: ON or OFF. Other representations are TRUE / FALSE or HIGH / LOW
  - If the switch is ON it's value is 1 (T or H)
  - If the switch is OFF it's value is 0 (F or L)
  - These two-state ON/OFF system 1 and 0 is called a binary number system

Bits, Nibbles and Bytes

- Each 0 or 1 in the binary system is called a **bit** (binary digit)
- A bit is the smallest possible unit of data a computer can recognize or use
- Bits are usually grouped together to store data, e.g.,
  - A group of 4 bits is called a **nibble**
  - 8 bits can be grouped together to form a **byte**
  - Other groupings are possible depending on register size (e.g., 32 bits or 64 bits)

Layout of Computer Memory

- A computer's memory consists of an ordered sequence of **bytes**
- Every byte in memory has a unique address



Storage of Numbers

- Numbers are stored as a series of bits
  - Example: How will the computer store the number 42?

- For a every grouping of bits, there is a fixed number of distinct numbers that can be represented in memory
  - This can be obtained by finding all of the distinct bit patterns that may be formed by the bits

Storage of Numbers

- How many different patterns with n bits?

Number of bits	Different Patterns
1	0, 1
2	00, 01, 10, 11
3	000, 001, 010, 011, 100, 101,110, 111

- Therefore, in general,
  - 1 bit yields 2 patterns
  - 2 bits yields 4 patterns
  - 3 bits yields 8 patterns

Storage of Numbers

- Mathematically,
  - 1 bit – 2 patterns
  - 2 bits – 4
  - 3 bits – 8
  - 4 bits – 16
  - 5 bits – 32
  - 6 bits – 64
  - 7 bits – 128
  - 8 bits – 256
  - n bits yields 2^n different patterns

Storage of Numbers

- One Byte – 256 Bit Patterns
  - E.g., 00000000, 00000001, 00000010, etc.
  - Converting the base two numbers to decimal yields values between 0 and 255
  - Thus, a byte can store numbers in the range 0 to 255
- How do you calculate the decimal values?
  - By number bases arithmetic

Binary to Decimal Conversion

Recall, any integral number may be written as

$$(d_{n-1}d_{n-2}\ldots d_2d_1d_0)_B$$

where *B* is the base or radix and d_i is the ith digit

- The decimal (base 10) equivalent of each digit is given by $d_i \times B^i$
- Thus, for *B* = 2, we have

$$(d_{n-1}d_{n-2}\ldots d_2d_1d_0)_2 = d_{n-1} \times 2^{n-1} + d_{n-2} \times 2^{n-2} + \cdots + d_2 \times 2^2 + d_1 \times 2^1 + d_0 \times 2^0$$

Binary to Decimal Conversion

$$(d_{n-1}d_{n-2}\ldots d_2d_1d_0)_2 = d_{n-1}\times 2^{n-1} + d_{n-2} \times 2^{n-2} + \cdots + d_2 \times 2^2 + d_1 \times 2^1 + d_0 \times 2^0$$

- By the above formula

  $00_2 = 0_{10}$; $01_2 = 1_{10}$;$10_2 = 2_{10}$; $11_2 = 3_{10}$

- This implies that 2 bits can be used to store or encode the numbers 0, 1, 2 and 3.
- 3 bits can be used to encode the numbers 0, 1, 2, 3, 4, 5, 6, 7.

Quiz 1

1) What are the different bit patterns than can be formed with n = 4 bits?
2) Evaluate the corresponding decimal numbers for your answers in question (1).
3) What is the largest number that can be encoded by n = 16 bits?