
Tutorial 1: Introduction to Computer Systems

1. Give an example on how a computer system may be used in the following industry.
 - a) Food and beverage industry
 - b) Banking industry
 - c) Education industry
2. You have formed a study group with 3 members in a team. Your team has started to prepare the tutorial questions using computer prior to tutorial class.
 - a) Identify **TWO (2)** examples of input devices, **TWO (2)** examples of output devices and **TWO (2)** examples of communication devices to facilitate your tutorial answer preparation. Justify your answer.
 - b) Explain the **FOUR (4)** key functions of a computer system in facilitating your tutorial answer preparation.
3. You are planning to purchase a new laptop computer. While surveying the specification of laptop computers available in the market, you come across the specifications below. Answer the following questions accordingly.

New Latitude 5530 Laptop

- 12th Gen. Intel® Core™ i7-1255U (10 Core, 12 MB Cache, 12 Threads, up to 4.70 GHz, vPro® Essentials)
- Windows 11 Home
- 16-in. display Full HD (1920x1200)
- 512 GB, M.2, PCIe NVMe, SSD, Class 35
- 16 GB, 1 x 16 GB, DDR4, 3200 MHz

[Extracted from www.dell.com.my]

- a) State the speed of the processor.
 - b) State the capacity of the Random Access Memory.
 - c) State the name of the operating system.
4. Differentiate the types of networks below in terms of their characteristic and give an example for each.
 - a) Local Area Network (LAN)
 - b) Metropolitan Area Network (MAN)
 - c) Wide Area Network (WAN)

5. Given the following diagram.

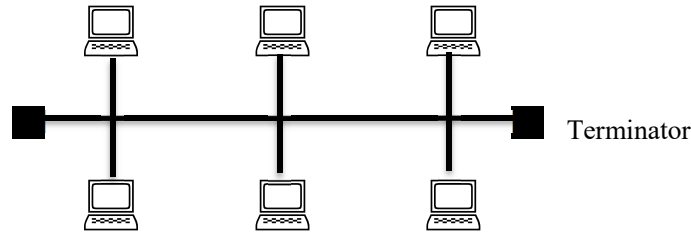


Figure 1: Computer Network Topology

- a) What is the network topology implemented as shown in Figure 1?
 - b) Give **TWO (2)** key characteristics of this implementation.
 - c) Discuss **TWO (2)** advantages and **TWO (2)** disadvantages of this implementation.
6. You were asked to implement a network system for your hostel-mates. Currently, you have a total of 5 hostel-mates, including you, with a laptop computer for each. All of you share one printer. The implementation of the network system shall allow all hostel-mates to access to the network and share the resources such as printer and files. You and your hostel-mates aim for a low-cost form of local area network topology for this project.
- a) Suggest the most appropriate type of network topology to the project. Justify your answer.
 - b) Based on your answer given in Q6 a), draw the layout of your suggested network topology accordingly.
7. Given the following scenario, suggest the most appropriate type of network architecture for each of them. Support your answer with justification.
- a) A university's online attendance system. The total users using this system is estimated to be around 10,000 users.
 - b) A departmental file sharing system. The purpose of this network is to allow each department in the company to share their files easily with each other.
 - c) An online banking system. It shall be accessible by both the customers and the employees of the bank.
8. "A recent retail survey has revealed that as many as 22 million consumers in Malaysia are digital consumers."
[Extracted from *The Edge*, 20 Oct 2021]

Will you participate in online shopping? Why or why now?

Tutorial 2: Numbering Systems and Bitwise Logical Operation

(A) Numbering Systems

1. Perform the following conversions. You are required to show your working steps clearly.
 - a) Convert $3D7_{16}$ to binary, octal and decimal numbers respectively.
 - b) Convert 1100010100100001_2 to octal, decimal and hexadecimal numbers respectively.
 - c) Convert 7098_{10} to binary, octal and hexadecimal numbers respectively.
 - d) Convert 13612_8 to binary, decimal and hexadecimal numbers respectively.
 - e) Convert 210102_3 to decimal numbers.
 - f) Convert 105_{10} to base-5 number.
2. Given the following expressions. If the expression is logical, perform the operation and show your working steps clearly. If the expression is illogical, state the reason.
 - a) $101101101_2 + 10011011_2 + 10010011_2$
 - b) $1FF9H_{16} + AC_{16}$
 - c) $7702_8 - 577_8$
 - d) $2A6_{12} - 2A_{12}$
 - e) $1101_2 \times 1011_2 \times 11_2$
 - f) $3175_5 \times 4_5$
 - g) $H7_{16} \times 7_{16}$
 - h) $1110001_2 - 1011_2 * 11_2$

(B) Signed and Unsigned Numbers

1. Given the binary integer 11001100_2 in an 8-bit system and represented in two's complement signed number notation. Convert it into the following data formats respectively.
 - a) Signed decimal value.
 - b) Unsigned decimal value.
2. Assuming that an 8-bit system is applied.

$$\begin{array}{r} (-27_{10}) \\ + (-58_{10}) \\ \hline \end{array}$$

- a) Perform the operation using Two's complement method.

- b) Verify your answer by showing your answer in signed decimal value.
 - c) Comment on the validity of your answer.
 - d) Does overflow or/and carry occur?
3. Assuming an 8-bit system is involved.

$$-75_{10} - 25_{10}$$

- a) Solve the above operation using Two's Complement method.
- b) Verify your answer in signed decimal value.
- c) Then, comment on the validity of your answer.
- d) Differentiate between a carry flag and an overflow flag. Complete the table below.

	Carry flag	Overflow flag
Definition		
Occur in signed or unsigned number?		
How to detect?		
Example		
Based on your answer obtained in Q2 a), does carry or/and overflow occur?		

Table 1: Carry flag vs. Overflow flag

(C) Floating Point Numbers

1. Perform the following operations.
(If the expression is logical, show your working steps clearly. If the expression is illogical, state the reason.)
 - a) Convert $B.AC_{16}$ to base-8 number.
 - b) Convert 56.7_{10} to base-5 number.
 - c) Convert 67.89_8 to base-2 number.
 - d) $110.11_2 + 111.111_2$.
2. Given that excess-80 notation is applied. The implied decimal point is at the beginning of the mantissa. A 4 is used to represent a positive number and an 8 is used to represent a negative number. Convert the SEEMMMMM 48484848 to decimal number.
3. Given the floating-point decimal numbers as shown below. Assume that the exponent is stored in excess-50 with the implied decimal point at the beginning of the mantissa. A "1" in the sign position is used to indicate a negative number and a "2" in the sign position is used to indicate a positive number.

$$\begin{aligned} &(+2.2222_{10}) \\ &(-0.2468_{10}) \end{aligned}$$

- a) Convert these two numbers into SEEMMMMM format.
 - b) Refer to your answer obtained from part a), calculate the difference between these two numbers. Show the result in both SEEMMMMM notation and scientific notation.
 - c) Refer to your answer obtained from part a), multiply these two numbers. Show the result in both SEEMMMMM notation and scientific notation.
4. The following decimal numbers are stored in excess-50 floating point format. A “1” is used to represent a negative sign, and a “5” for positive sign.
- a) Add these two numbers. Present your result in standard decimal sign-and-magnitude notation.

55020311
15375321

- b) Multiply these two numbers. Present your result in standard decimal sign-and-magnitude notation.

15176323
15485496

- c) Find the difference of these two numbers. Present your result in standard decimal sign-and-magnitude notation.

55152295
15256608

5. Convert the binary number 11011.0011011_2 into IEEE 754 single precision format using excess-127 notation. *(You are required to show your conversion steps clearly.)*
6. Assuming that excess-127 is applied, convert the decimal floating-point number below into IEEE754 single precision notation. *(You are required to show your working steps clearly.)*

- 15.25₁₀

7. Assuming that excess-127 is applied, convert the decimal IEEE754 single precision notation below into binary floating-point number. *(You are required to show your working steps clearly.)*

$1100000101101101000000000000000_2$

9. A fraction number expressed in decimal format is shown as below.

$-(\frac{5}{16})$

Given that:

- The “1” in the sign position represent a negative number while the “0” in the sign position represent a positive number.

- The implied binary point is on the right of the first bit of the mantissa.
- a) Convert the decimal fraction number given in Question 1 b) into a binary number.
 - b) Considering that the excess-127 is applied, convert this fraction number into IEEE-754 single precision format. *(You are required to show your working steps clearly.)*
 - c) Considering that the excess-1023 is applied, convert this fraction number into IEEE-754 double precision format. *(You are required to show your working steps clearly.)*

(D) Bitwise Logical Operations

1. Given that **X** contains **6BH**, **Y** contains **45H** and **Z** contains **17H**. Perform the following bitwise logical operations independently. Show your final answers in *hexadecimal* number. *(You are required to show your working steps clearly.)*
 - a) $W = X + Z$
 - b) $W = (X \cdot Y)' \oplus Z$
2. Given **A = 36₁₆**, **B = 9A₁₆** and **C = BB₁₆**, perform the following unrelated operations respectively. Show your final answers in *hexadecimal* number. *(You are required to show your working steps clearly.)*
 - a) $A \cdot B$
 - b) $B + C'$
 - c) $A + (B \oplus C)$
3. Given that **W**, **X**, **Y** and **Z** are 8-bit numbers in two's complement representation. Assuming that **W** contains 01010000₂, **X** contains 11110000₂ and **Y** contains 10100101₂. Perform the following bitwise logical operation to compute the value for **Z**. *(You are required to show your working steps clearly.)*
 - a) $Z = W \text{ OR } (X \text{ AND } Y')$. Show your final answer in hexadecimal format. Then, identify the result of sign flag at the end of the operation.
 - b) $Z = W \text{ XOR } (X' \text{ XOR } Y)$. Show your final answer in hexadecimal format. Then, identify the result of sign flag at the end of the operation.

Tutorial 3: Computer Architecture

1. In the computer machine cycle, a processor repeats a set of **FOUR (4)** basic steps for every instruction for processing. With the aid of a diagram, elaborate the steps involved in a machine cycle.
2. Assuming that LMC model is applied. Suppose that the following instructions are found at the given location in memory:

Program counter: 20
Value in memory location 20: 560 (LOAD)
Value in memory location 21: 161 (ADD)
Value in memory location 22: 360 (STORE)
:
Value in memory location 60: 422
Value in memory location 61: 008

Show the changes of contents in IR, PC, MAR, MDR and A during the execution of Instruction 20, 21 and 22.

3. Given the content of memory listed as below.

Program Counter: 340
Value stored in memory location 337: FA_{16}
Value stored in memory location 338: BB_{16}
Value stored in memory location 339: 00_{16}
Value stored in memory location 340: 2337 (Load)
Value stored in memory location 341: 5338 (Subtract)
Value stored in memory location 342: 1339 (Store)

During the operation of a Central Processing Unit (CPU), the Instruction Pointer (IR), Program Counter (PC), Memory Address Register (MAR), Memory Data Register (MDR) and Accumulator (A) are actively involved in the Little Man Computer (LMC) model.

- a) State the function of IR, PC, MAR, MDR and A respectively.
 - b) Show the changes in the content of each register mentioned during the execution of *instruction 341*.
 - c) Illustrate how the operation of LMC could be applied in a student's daily life.
4. With the Little Man Computer, explain the **FIVE (5)** steps of how the instruction MUL 50 is executed in the CPU. Given the Program Counter (PC) is now **21**. The contents of location 21 and location 50 are **MUL 50** and **04H** respectively.
 5. Differentiate between a point-to-point bus and a multipoint bus in terms of their relationship between sender and received, types of bus lines involved and diagram.

6.

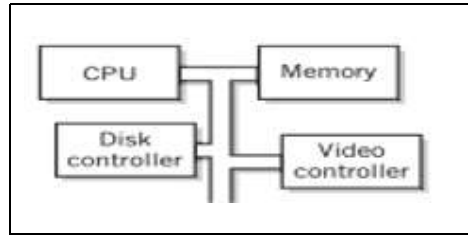


Figure 2: A computer bus configuration.

Answer the following questions by examining the Figure 2 above.

- a) Identify and explain the bus configuration implemented.
 - b) Give an advantage and a disadvantage of implementing this bus configuration.
6. Most modern computers provide a large number of general-purpose registers and very few memory-access instructions.
- a) What is the name of the computer processor architecture mentioned?
 - b) Discuss **THREE (3)** advantages of such processor architecture.

Tutorial 4: Memory

1. In the context of computer architecture, how many bit can be stored in a paragraph?
2. Distinguish between a Random-Access Memory (RAM) and a register in term of their capacity, data storage and reference methods.
3. Given the following data items, draw a diagram on a block of consecutive memory with 8 bits for each memory location to indicate how the following data items could be stored in memory, starts from offset address 0150H.
 - a) A 1-byte item named VAR1 containing “A”.
 - b) A 2-byte item named VAR2 containing a decimal value 2023.
 - c) A 4-byte item named VAR3 containing 202305, 1024H.
 - d) A 8-byte item named VAR4 containing 983D.
4. Determine the value **for Overflow Flag (OF), Sign Flag (SF), Zero Flag (ZF) and Carry Flag (CF)** respectively after each of the following related instruction has been executed. Complete the table below. Show your final answer in Hexadecimal number.

	Instructions	Working (in Binary)	OF	SF	ZF	CF
a)	MOV AX, B014H					
b)	ADD AX, B014H					
c)	XOR AX, 6028H					

Table 2: Computer registers

5. Based on the diagram given below, calculate the absolute address for the next instruction to be executed. *(You are required to show your working steps clearly.)*

SI: 2AA3 ₁₆	DS:2789 ₁₆
IP: 1705 ₁₆	CS:2788 ₁₆
SP: 2020 ₁₆	SS:2787 ₁₆

Figure 3: Memory addresses

6. Assume that the shaded area in the figure shows a memory segment which stores program executable instructions. The 2BC80H is the starting address of the segment while the location X holds the specific instruction at the displacement FFFDH.

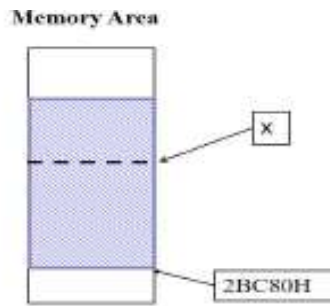


Figure 4: Computer memory

- a) Identify the name of the memory segment as highlighted in the shaded area.
 - b) Identify the registers used to store the segment's starting address and offset address for the shaded area.
 - c) Determine the address of location X in the form of Segment:Offset addressing scheme.
 - d) Find the absolute address of location X and show your answer in 20-bit format. *(You are required to show your working steps clearly.)*
7. Perform the following calculations and show your answers in hexadecimal format. Draw a diagram to indicate how these answers could be stored in the AX register and memory respectively. *(You are required to show your working steps clearly.)*
- a) $73_8 + 25_8$.
 - b) $1111_2 \times 111_2 \times 11_2$.
- 8.
- a) What is a cache memory?
 - b) How does a cache memory work?
 - c) What could be the impact of a cache miss?
9. Given that the memory is partitioned as P1 through P5 with the partition size of 370KB, 256KB, 120KB, 50KB and 400KB and the jobs labelled as J1 through J4 with job size of 75KB, 125KB, 398KB and 225KB respectively.
- a) Show how the jobs could be allocated in the memory when the following memory allocation algorithms is applied respectively.
 - i) First fit memory allocation algorithm.
 - ii) Best fit memory allocation algorithm.
 - iii) Worst fit memory allocation algorithm.

Use the following table format to show the working of your answer.

Memory partition	Memory partition size	Job	Job size	Internal fragmentation
Total:				

- b) Which memory allocation algorithm makes the best use of memory space? Justify your answer.
10. Given that the memory is partitioned as P1 through P5 with the partition size of 600KB, 200KB, 100KB, 400KB and 300KB and the jobs labelled as J1 through J4 with job size of 250KB, 350KB, 50KB and 550KB respectively. The following memory allocation is implemented.

Memory partition	Job allocation
P1	J4
P2	
P3	J3
P4	J2
P5	J1

Table 3: List of memory partition.

- a) Identify the job to be allocation into the memory partition named P1 in the First fit, the Best fit and the Worst fit memory allocation algorithm respectively.
- b) Based on the job allocation given in Table 3, identify the name of the memory allocation algorithm implemented.
- c) Based on the job allocation given in Table 3, show your working to compute the total internal fragmentation generated.

Tutorial 5: I/O Facilities

1. List and explain **THREE (3)** key components involved in the CPU-I/O devices communication.
2. A graphic card is an example of an I/O controller. I/O controllers have two interfaces. What are the **TWO (2)** interfaces of a graphic card connected to? What is their core function respectively?
3. Considering an interrupt occurs when a user connects her Universal Serial Bus (USB) flash drive to the USB port of her laptop computer.
 - a) With reference to the scenario given, identify the sender and receiver of the computer interrupt.
 - b) With reference to the scenario given, determine the purpose of the interrupt sent.
 - c) In the context of interrupt handling, provide a real-life example to illustrate on how would you handle multiple interrupts during your assignment report preparation period.
4. Explain why a programmed I/O does not work very well when the I/O device used is a hard disk drive or a graphics display?
5. Explain why Direct Memory Access (DMA) is not suitable to facilitate the data transfer from a keyboard.
6. How does a computer system determine the interrupting device?
7. a) Given the following information, draw a timeline to depict how a CPU handles multiple interrupts.

Process	Arrival Time (ns)	CPU / Processing Time (ns)	Priority
Program W	0	5	4
Interrupt X	2	3	2
Interrupt Y	3	2	1 (Highest Priority)
Interrupt Z	5	4	3

Table 4: List of processes.

- b) Which process spent the longest waiting time? Comment on your answer.

Tutorial 6: System Software

1. Define operating system. Give **TWO (2)** examples of operating systems used for desktop computer and **TWO (2)** examples of operating systems used for mobile devices.
2. Do you think an operating system is mandatory in every computer system? Why or why not?
3. List and explain **THREE (3)** key functions of an operating system. Give example(s) to support your answer.
4. Based on the scenario given below, suggest the most appropriate type of operating system to facilitate the operation respectively. Then justify your answer.
 - a) A clerk is assigned to print the bills and mail these bills to the customers on a monthly basis.
 - b) A multi-function laser printer which offers the features such as print, scan, fax, email, smart-card reader, connection to digital camera and so on.
 - c) Windows 8 that makes it possible to run the same application on both a low power tablet or kiosk and a high-end desktop or laptop.
 - d) Fuzzy logic system used by automatic rice cooker helps to ensure the rice is properly cooked with a variety of customized cooking options.
 - e) Information kiosk in shopping center that inform the visitors about interesting offers and allow the visitors to search for the shops by criteria such as shop name, shop category, floor plan for the shopping center with optimal guidance to the shops.

Tutorial 7: Processor Management

1. What are the major items found in a Process Control Block (PCB)?
2. During the process execution operation, the process changes state. The state of a process is defined by the current activity of that process. With the aid of a diagram, explain how a process may switch from a state to another.
3. How does context switch work? Give **TWO (2)** advantages and **TWO (2)** disadvantages of context switch.
4. In the context of processor management, differentiate between a preemptive policy and a non-preemptive scheduling policy in terms of their characteristics and algorithms involved.
5. Consider the following set of processes.

Process	Arrival Time (ns)	CPU / Processing Time (ns)	Priority
A	0	3	5
B	2	4	2
C	3	2	4
D	5	2	1 (Highest Priority)
E	8	5	3

Table 5: List of processes.

You are required to draw a timeline Gantt chart for each of the following algorithms. Then, calculate the *Average Waiting Time* and *Average Turnaround Time* for each of the algorithms. (Ignore context switching time and natural wait).

- a) First Come First Serve scheduling (FCFS)
 - b) Shortest Job First (SJF)
 - c) Priority Scheduling (PS) - Non-preemptive
 - d) Priority Scheduling (PS) - Preemptive
 - e) Shortest Remaining Time scheduling (SRT)
 - f) Round Robin scheduling (RR) (Assuming the quantum given is 3 time slices.)
6. Consider the following set of processes

Process	Arrival Time	CPU Cycle
A	0	3
B	2	5
C	4	2
D	6	1
E	8	4

Table 6: List of processes.

- a) In the recent meeting, you were assigned to look into the design of the process scheduling model. Suggest **TWO (2)** factors to be taken into consideration in selecting the most appropriate process scheduling algorithm.
- b) Draw a timeline Gantt chart for Shortest Job First (SJF) algorithm and Shortest Remaining Time (SRT) algorithm respectively. Then, comment on your answer.

7. Given the following set of processes as shown below.

Process	Arrival Time (ns)	CPU / Processing Time (ns)
A	0	4
B	1	5
C	3	3
D	5	1
E	7	2

Table 7: List of processes.

Your project team has decided to implement a Round Robin process scheduling algorithm to the system. However, the implementation is pending due to the team has yet to decide the quantum size.

To facilitate the decision making, draw a timeline Gantt chart for Round Robin scheduling algorithm (RR) based on the following quantum sizes respectively. Then, calculate the *Average Turnaround Time* and *Average Waiting Time* for each of the algorithms and comment on your answer obtained accordingly.

- (a) A quantum size of 2 time slices.
 - (b) A quantum size of 3 time slices.
8. It is said that the Round Robin scheduling algorithm is one of the most appropriate to be implemented for an interactive system. Do you agree? Justify your answer.

Tutorial 8: Virtual Memory

1. Virtual Memory can be implemented through demand paging and segmentation schemes. Compare these two implementation schemes in terms of their characteristics.
2. List **THREE (3)** advantages and **THREE (3)** disadvantages of Virtual Memory.
3. Given that *Company X* has implemented virtual memory with the following characteristics.
 - Allow internal fragmentation but disallow external fragmentation.
 - Programs are divided into equal size.
 - Using page map tables.
 - a) Identify the implementation method in *Company X*.
 - b) In your opinion, what could be the **TWO (2)** main reasons that lead the *Company X*'s decision to implement virtual memory using the implementation method as you mentioned in **part a)** above? Support your answer with the advantages.
4. Assuming that **THREE (3)** page frames are allocated. Given the following sequence of program requests.

2 7 5 2 3 2 4 7

 - a) Which page would be the *FIRST* page that swapped out by the First-in First-out algorithm?
 - b) Which page would be the *FIRST* page that swapped out by the Least Recent Used algorithm?
 - c) Which page replacement algorithm is more efficient? Justify your answer.
5. Given the following page sequence, perform the page fault trace analysis and calculate the percentage of page faults that occurred in Least Recent Used (LRU) algorithm, for a **THREE (3)** page frames implementation and a **FOUR (4)** page frames implementation respectively.

3, 1, 1, 2, 4, 5, 5, 4, 8, 2
6. Suppose a particular program has **THREE (3)** page frames allocated to it and they are initially empty. Given the page size at 100 bytes each and the virtual address as below. This program sends the page request in the following orders.

102 324 397 532 643 443 623 554 743 488

 - a) Compute the page number accordingly.
 - b) Perform the page fault trace analysis and calculate the percentage of page faults that occurred in First-in First-Out (FIFO) algorithm and Least Recent Used (LRU) algorithm respectively.