



Do not award half marks.

In all cases give credit for appropriate alternative answers.

Question 1 (Compulsory)

- (a) When returning from a subroutine call, what happens to both the stack pointer and program counter? [2]

The return instruction is implemented by popping the stack and transferring the return address to the PC:

| | | |
|-----------------------|---|----------|
| PC <- M[SP] | Transfer return address to the PC | [1 mark] |
| SP <- SP+1 | Free top of stack by incrementing stack pointer {for when the stack grows downwards in memory} | [1 mark] |

- (b) Given the size of main memory is 29 and there are 500 Opcodes available for use, what would be the total word length given a 3-Address instruction format? [4]

**500 opcodes require 9 bits (500 is closest to 29); 9 bits for each address;
total word length = 4*9 = 36 bits. [4 marks]**

- (c) Write a sequence of instructions (a program) for a microprocessor using 2-address instructions to compute the following assignment: $X := (A - B) / (C - D)$. [3]

**SUB A, B [1 mark for both subtractions]
SUB C, D
DIV A, C [1 mark for the division]
MOV X, A [1 mark for correct final assignment]**

- (d) List two advantages and two disadvantages of Indirect addressing method. [4]

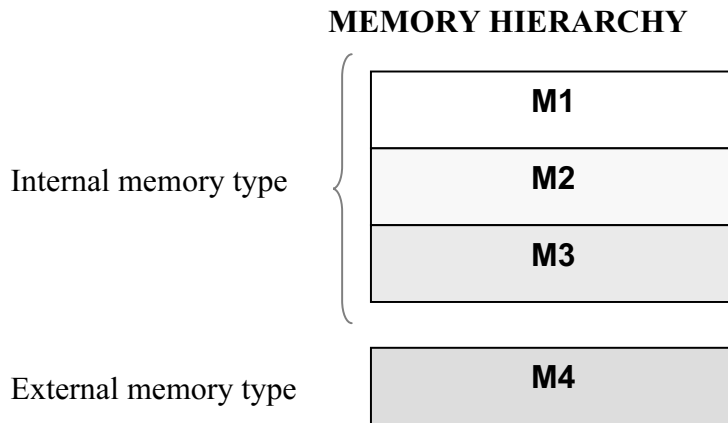
Advantages [2 marks]

- **Good for maintaining pointers**
- **Effective address and data can be changed**
- **Large address space**
- **Large address range**

Disadvantage [2 marks]

- **Two additional memory reference required**
- **Slow**

- (e) A typical computer system displays several layers of memory shown in the diagram below. Consider M1 to represent the CPU registers and M2 to represent the cache:



Identify what is represented by M3. Briefly explain the transfer capacity between M3 and M4.

[2]

Main Memory [1], Page is transferred [1].

- (f) Assume that $A=10$, and then consider the given operation:

$A \leftarrow 3 + A$
 $B \leftarrow 4 * A$

When these operations are performed in parallel, what would be the result of B? [2]

B \leftarrow 4 * A
B \leftarrow 4 * 10 [1]
B \leftarrow 40 [1]

- (g) List three possible solutions to overcome the bandwidth problem in LANs. [3]

Install a faster network technology such as: ATM, FDDI or fast Ethernet.

[1 mark]

Segment the network into smaller parts using bridges and routers. [1 mark]

LAN switching. [1 mark]

- (h) Briefly describe two replacement algorithms, which may be used to choose the block to be replaced. [4]

Any three of the following:

For the correct name award one mark each, and for a suitable explanation award one mark each.

Least recently-used (LRU) [1] replace the block which has been in the cache longest without being referenced. [1]

First-in-first-out [1] replace the block, which has been in the cache the longest. [1]

- (i) Memory can be classified into internal and external memory. Give two types of external memory. [2]

One mark for each of the following, maximum 2 marks:

Magnetic disk.

Magnetic tape.

Optical disk.

Award credit for other sensible answers.

- (j) What are network protocols? Give two examples for network protocols. [4]

Network protocols are standards that allow computers to communicate.

[2 marks]

Examples include:

TCP/IP [1 mark]

FTTP [1 mark]

HTTP [1 mark]

SMTP [1 mark]

Award credit for any other acceptable protocols, maximum 2 marks.

Do not award half marks.

In all cases give credit for appropriate alternative answers.

Question 2

- (a) What is a subroutine? What are the benefits of using subroutines? [4]

A subroutine is a set of instructions, arranged and executed in sequence [1 mark], which performs a specific task, and can be called from several places in the program. [1 mark]

Benefits: Either two of the four solutions below or other relevant points, maximum two marks:

Saves on storage. [1 mark]

Modular. [1 mark]

Global usage. [1 mark]

Aids debugging. [1 mark]

- (b) One approach to passing parameters to subroutines is to use registers to store the parameter values, after first saving the register contents of the calling program on the stack. What is the main advantage of this scheme? Provide one disadvantage? [2]

Advantage: register access is very fast. [1 mark]

Disadvantage: the number of parameters is limited by the number of registers available. [1 mark]

- (c) Describe the steps involved in the execution of a subroutine call when a stack is used for parameter passing. [6]

Award up to six marks for expressing the sequence of events given below, or other relevant points. Solutions can be provided either in textual form, or as equations showing the effect on various registers, or using diagrams:

Subroutine call specifies start address. [1]

Calling program state (registers) saved on stack, along with the program counter. [1]

Parameter list location and parameter list length stored on stack or parameters all stored on stack (if only a few parameters). [1]

Program counter is loaded with subroutine start address, so control jumps to subroutine. [1]

Parameters are loaded by getting data or address from stack, and instructions of subroutine are executed. [1]

At the end of the subroutine, the return address (calling program's program counter) is popped from stack and control returns to calling program. [1]

- (d) A subroutine call and an interrupt behave in a similar fashion. List *one* way in which they are similar, and two ways in which they differ. [3]

Similarities include:

In both cases, the program counter and registers must be stored for later continuation of execution. [1 mark]

Differences include, award maximum of 2 marks:

Interrupt initiated by internal/external signal whereas a subroutine initiated through execution of instruction. [1 mark]

The address of the interrupt is determined by hardware whereas the address of a subroutine is fixed. [1 mark]

In an Interrupt the contents of the PC, the processor registers and the PSW are pushed/stored onto a stack. Whereas in a Subroutine call only the contents of the PC and the processor registers are pushed/stored onto a stack. [1 mark]

Do not award half marks.

In all cases give credit for appropriate alternative answers.

Question 3

- (a) Describe with the aid of a diagram how paging works and also explain how paging is related to virtual memory. [6]

Award one mark to each of the points given below (up to a maximum of two marks for any two acceptable points), and award two marks for a correct diagram:

A process is divided into a number of equal size pages. [1]

A page is a fixed length block that can be assigned to fixed regions of physical memory called page frames. [1]

The size of page = size of page frame. [1]

Mapping between the pages and page frames are done by the O/S. [1]

An incoming page can be assigned to any available page frame. [1]

A page table is used to keep a list of all pages and their corresponding mapping to main memory. [1]

Paging is related to virtual memory:

Demand paging makes use of virtual memory. [1] This is the ability to bring blocks of data into and out of memory as and when required, and gives the perception that main memory is several times larger than it actually is. [1]

- (b) Explain what is meant by Direct Memory Access. Why is DMA superior to the other I/O techniques? [3]

DMA involves having an extra module on the system bus and the I/O operation is delegated to the DMA module. [1]

DMA is a technique that does not interrupt the CPU and functions on cycle stealing. [1]

In the DMA technique the CPU is only involved at the beginning and end of the data transfer. [1]

- (c) A 'hit' is the term given to a successful detection of data within the cache. Name the term given to an unsuccessful search for data within the cache. What actions must be carried out when a hit does not occur? [3]

A miss is the term given to an unsuccessful search for a block of data in the cache. [1]

When a miss occurs the CPU must fetch the required data from the main memory. [1]

A copy of the fetched data is placed in the cache memory. [1]

- (d) Why are cache replacement algorithms needed? How may they have a significant impact on performance? [3]

When a new block is brought into the cache, one of the existing blocks must be replaced. [1] An algorithm must be used to determine which block should be replaced. [1] The block to be replaced should be the least likely to be needed. Otherwise blocks will need to be regularly fetched and overwritten giving poor performance. [1]

Do not award half marks.

In all cases give credit for appropriate alternative answers.

Question 4

- (a) The operation ADD ACC, MEM uses the ALU to add the value stored in the accumulator to the value that is stored in the memory location specified in the instruction. The final result is placed in the accumulator. Show the steps of the execution cycle on the operation. [4]

IR
decoding circuitry
MEM MAR [1 mark]
MAR address bus
Read control line is asserted [1 mark]
[MEM] data bus MBR
MBR AX1 [1 mark]
AX = Acc + AX1 [1 mark]

- (b) What is the importance of a Program Status Word (PSW) or Status Register (SR)? Apart from the PSW, list any two registers that are used in computer systems. [3]

Any two from the following for a maximum of two marks:

Program Status Word (PSW) or Status Register (SR) is the operating system register that is used to check the status of a program or external device. [1 mark]

It is used to check whether the devices are ready to do the job or not, and if it is not then the PSW will contain an error flag. [1]

The CPU also uses the PSW to read data from an I/O device. The CPU checks the relevant flags of the PSW to ensure that the I/O device is ready. If it is, then the I/O module will read the data. [1]

Other Registers include:

Any two from the following for one mark:

**Memory Address Register (MAR)
Memory Buffer Register (MBR)
Instruction Register (IR)
Program counter (PC)
Accumulator (AC)
Base Register (BX)
Index Register (SI)**

Also award credit for other acceptable answers.

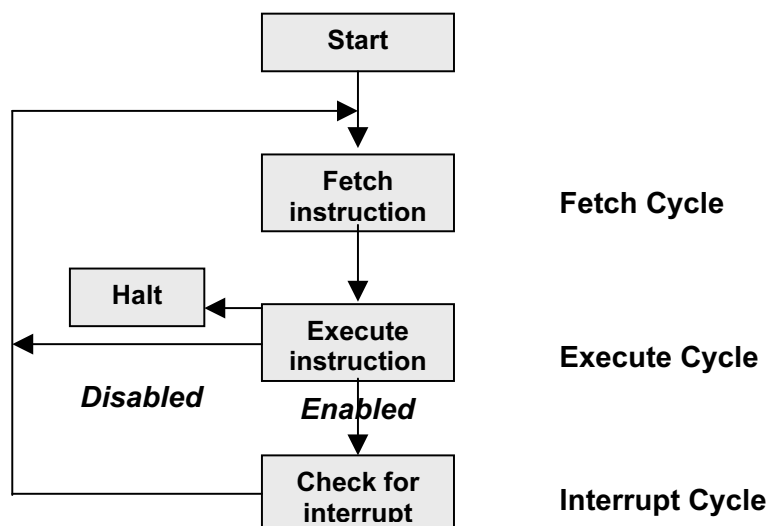
- (c) With the aid of a diagram, briefly explain how the effective address is determined using displacement addressing. [4]

There are 2 fields that contain addressing information:
The implicit field refers to the special purpose register.
The explicit field contains additional addressing
Information is added into the special purpose register to give the effective address.
Students can provide either relative, base or indexed addressing as an example of displacement addressing.
For instance, in base addressing students should clearly show:
Special register is the base register. [1]
Base field provides the storage address of a segment of the program. [1]
Offset field provides displacement from segment. [1]
To set the effective address, the given offset is added with the base register. [1]
Accordingly award marks for both relative and indexed addressing.

- (d) With the aid of a diagram, show how the fetch-execute cycle incorporates a check for interrupts. [4]

Award marks for the features indicated. Allow credit for alternative valid answers.

Four marks for a completely correct diagram. Any diagram, which is not complete should be awarded partial marks.



Do not award half marks.

In all cases give credit for appropriate alternative answers.

Question 5

- (a) Explain, how forwarding and filtering of packets are achieved in LAN switches? [3]

Switches normally have higher port counts and divide the network into several dedicated channels parallel to each other. [1]

These multiple independent data paths increase the throughput capacity of a switch. [1]. Switches are self-configuring and they can reduce the network downtime. [1]

If a segment is attached to a port of a switch then CSMA/CD is used for media access in that segment. [1]

The source and destination medium access control (MAC) address of an incoming frame is retrieved, and if the frame is to be forwarded then it is sent to the destination port. [1]

Award a maximum of 3 marks.

- (b) Explain in detail the differences between a Token Ring and an Ethernet LAN. [4]

Ethernet strikes a good balance between speed, cost and ease of installation whereas a token ring is difficult to install. [1]

Ethernet can transmit messages in a bi-directional manner while in a token ring messages are transferred in a uni-directional manner. [1]

Ethernet uses a broadcast mode to transmit messages whereas in a token ring data is passed along the ring and is viewed by each device. [1]

Ethernet networks use CSMA/CD for collision detection whereas a token ring does not use any protocol for collision detection. [1]

- (c) Apart from the convenience of easy access to Internet services, what other technical features does WAP offer? Illustrate your answer by discussing any two features in detail.

[4]

Award one mark for any correct feature listed and one mark each for correct explanation on the listed feature.

WAP utilizes Internet standards such as XML, user datagram protocol (UDP) and Internet Protocol (IP) [1]. Many of the protocols are based on Internet standards such as HTTP and TLS but have been optimized for the unique constraints of the wireless environment [1].

Internet standards such as HTML, HTTP, TLS and TCP are inefficient over mobile networks [1]. Standard HTML content cannot be effectively displayed on small size screens of pocket size mobile phones and pages [1].

WAP utilizes binary transmission for greater compression of data and is optimized for long latency and low bandwidth [1]. WAP sessions cope with intermittent coverage and can operate over a wide variety of wireless transports [1].

The lightweight WAP stack is designed to minimize the required bandwidth [1] and maximize the number of wireless network types that can deliver WAP content [1].

WAP is based on a scalable-layered architecture [1], each layer can develop independently of others [1].

- (d) Explain at least 2 benefits offered by WAP to Operators, Content Providers and End Users. [4]

Any two points from the below; allow credit for alternative valid answers:

Benefits for Operators:

WAP decreases churn, cut costs and increases the subscriber base both by improving existing services, such as interfaces to voice mail, and prepaid systems. [1]

WAP facilitates unlimited range of new value added services and applications such as account management and billing inquiries. [1]

New applications can be introduced without the need for additional infrastructure or modifications to the phone. [1]

WAP is an interoperable framework, enabling the provision of end to end turnkey solutions which will create competitive advantages, build customer loyalty and increase revenue. [1]

Benefits for content providers:

WAP will enable content and application developers to utilize WML. This will enable services to be written and developed within an operator's network quickly and easily. [1]

WAP is a global and interoperable open standard, content providers have immediate access to a wealth of potential customers who will seek such applications to enhance the service offerings. [1]

Mobile customers are becoming more hungry to receive increased functionality and value added from their mobile devices and WAP opens the door for this untapped market. [1]

Benefits for end users:

End users will benefit from easy, secure access to relevant Internet information and services such as unified messaging, banking and entertainment through their mobile devices.

Intranet information such as corporate databases can also be accessed via WAP.[1]

Users will have significant freedom of choice when selecting mobile terminals and applications they support. [1]

Users will be able to receive and request information in a controlled, fast and low cost environment. [1]

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