



2003 Computing

Advanced Higher

Finalised Marking Instructions

SECTION I – Software Development and Computing Project

1. (a)

Activity	Meaning	What is involved?
Feasibility study	An investigation of the problem to see whether the problem is worth solving.	<ul style="list-style-type: none"> Assessing the technical, economic and legal feasibility to see if a solution is worth doing Consider alternative approaches to proceeding with the task
System investigation	A careful look at the current system to see how it actually works.	<ul style="list-style-type: none"> A number of techniques are used to investigate the current system This will include questionnaires, searches of documentation, interviews, observation, etc
Operational requirements specification	This describes the proposed system clearly in a form that will be understood by designers and client.	<ul style="list-style-type: none"> The ORS will form a legally binding contract It will be the basis of what goes next so must be clearly stated.

Marks : 1 mark for the meaning of each term and 2 marks for a full description of what is involved at each stage. Up to 9 marks. Allow flexibility between aspects where a candidate has given a more extensive answer in one area over another.

- (b) A system specification is a document which states the way that the problem must be solved whereas a requirements specification states what is required by the solution.

Marks : 2 marks for a clear description of the difference between the two documents.

- (c) To ensure that the client is satisfied with the final system the system designers should do the following:

- validate software to ensure compliance with the operational requirement specification. This can be done by ensuring the client is happy with progress, creating a prototype and allowing the client to comment on it, etc.
- deliver to budget and on time to comply with contractual obligations.

Marks : eg 2 marks for each bullet well described, up to 4 marks.

- (d) Factors included ought to be the following or similar. Examples should be related to the scenario.

Factor	Description	Example
User familiarity	the interface should use terms and concepts drawn from the experience of the user.	Menu options which use terms similar to task (such as New Client in the database, etc).
Consistency	comparable operations should be activated in the same way	The accounts package and client database should have similar menu structure, toolbars, etc.
Recoverability	The interface should allow the user to recover from errors.	Provision of an UNDO feature or Confirmation of destructive action when deleting an account

Marks : 1 mark for description of each principle and one mark for each example. Up to 6 marks. Allow other, well explained ideas including "on line help".

- (e) To ensure the program is maintainable the designers should:

- ensure documentation is clearly written and allows the programming team to clearly understand the design
- ensure the software is designed to be modular. The requirements should be written in such a way as to encourage this feature by the programming team.
- choose a software development environment which encourages a disciplined approach to the development.
- use meaningful variable and procedure names throughout the design

Marks : 1 mark for each bullet up to 3 marks.

- (f)

Personnel	Role	Activities
Programming team	Component testing and system testing	Use test data constructed earlier to ensure all components work with appropriate constraints. Once the sub-systems have been integrated the whole system must be tested to ensure no errors exist and that each of the modules works together.
Client staff	Use the new system to carry out sample tasks	Tasks are carried out by staff to ensure that the new system does what is required of it.
Project Leader	Communication between client and programming team.	The interface between the client and the programmers must clearly communicate between the two.

Marks : 1 mark for each role and activity up to 6 marks.

2. (a) Four appropriate questions should be described:

- clients : How many clients are there and what details must be stored in the database? It is important to determine the amount of backing storage that will be required for backing storage.
- communications – What sort of data and resource sharing is required? The form of network infrastructure will be determined based on an understanding of the types of collaborative tasks that will be undertaken.
- accounts features – What specific features are required and what features in the current package are not actually used? Although the client has stated that the current accounts package has many useful features it is vital to understand specifically which features need to be implemented.
- user interface – Who will be using the system and what level of IT knowledge will they have? The client has highlighted the desire to update the user interface. It is important to know about the current user experience to be able to implement an appropriate upgrade.
- other questions could include aspects of time, costs or training.

Marks : 1 mark for a description of each question and one mark for appropriate discussion, up to 8 marks.

- (b) (i) The initial requirements statement produced by the client is not a technical document. It is based on what the client sees as their need for a new accountancy system. The ORS, however, is a formal document written in technical language which describes the characteristics of the proposed system.

Marks : 1 mark for a clear description of the difference between the statement and the ORS.

- (b) (ii) The steps which lead to the ORS are as follows:

- a feasibility study is carried out which involves finding out whether the problem is worth solving or not. This will involve looking at technical, economic and legal feasibility. Alternative solutions are considered before moving on to the next stage.
- a system Investigation is carried out. Once the proposal has been agreed with the client the information must be gathered by interviewing staff, observing staff at work distributing questionnaires and examining sources of documentation. In the context of the accountancy firm the admin staff, accountants, etc would be interviewed. The use of the current software and hardware would be observed in relation to the preparation of a company's accounts or as part of the ongoing work of updating client records.
- the Operational Requirements Specification is written. The information is organised in the ORS so that it can be viewed appropriately by the client and the designers. This will form the contract so must be clear and unambiguous. The accountants will have to agree with this before moving to the next stage.

Marks :2 marks should be awarded for each stage: 1 mark for the definition and one for the context within which it is placed (up to total of 6 marks)

- (c) (i) There are a number of design methodologies that could adequately be used to design the detailed logic of the solution. Typically, candidates are likely to select a methodology with which they are very familiar such as pseudocode.

Pseudocode uses English like words and phrases to allow the designer to break down the problem into smaller and smaller chunks. The aim is to design the solution without the restrictions of a particular language but with the definition of common structures such as sequence, selection and repetition.

Marks : 2 marks for a clear description of an appropriate methodology. Reduce marks if description lacks clarity.

- (ii) An appropriate example of a pseudocode algorithm might be doing a simple linear search for a particular client record in the database.

```

Set index to 1
Set name_to_be_found
Set found to FALSE
DO
    IF record.name(index)=name_to_be_found THEN
        Found = TRUE
    END IF
    Index=index+1
LOOP until index =max OR found = TRUE

```

} 1 for syntax

} 1 for loop

} 1 for "if"

- 1 for conditions

Marks : Up to 5 marks for a clear description related to the context of the accountancy system. Reduce marks if there is a lack of clarity or a clear mistake in the use of the methodology, or if the example is not very appropriate to the context.

- (d) (i) To ensure module independence the programmer should:
- a highly independent module will have as little interaction with other modules as possible. In other words it will have a simple interface when viewed by other parts of the program structure. Local variables should be used as much as possible, but the parameter lists should be simple, perhaps using a record structure rather than a list of single variables.
 - each module should carry out one function or task wherever possible. This is easier to develop and understand by others when it comes to system integration and later with maintenance.

Marks : 2 mark for each clearly described feature, up to 4 marks. The candidate may refer to cohesion and coupling. If their answer is in these terms then full marks should be awarded for a well written description of these terms in relation to highly independent modules.

- (ii) The problems which may arise if modules are not highly independent are:
- if global variables are used then it can be hard to trace where the contents of a variable are actually being altered so error tracing can be a complex and error prone task.
 - modules which perform more than one function can be difficult to observe. It is not clear what is happening in what module, leading to difficulties in debugging and maintenance.
 - as most projects are developed by teams it is vital that other members of the team are able to integrate modules easily. If modules are not highly independent then this task becomes far harder.
 - secondary effects caused as a result of modifying one module will be difficult to deal with if more than one function is carried out in a module.

Marks : 1 mark for each problem identified and 1 mark for description, up to 4 marks. Allow flexibility between points.

SECTION II Part A – Artificial Intelligence

3. (a) (i) Two methods used to represent knowledge domains from the following:

- search trees – a tree structure where the possible states which can be produced from the level above are represented on a single lower level.
- logic – a formal mathematical representation used to define the reasoning process.
- semantic nets – objects which belong to a larger class can inherit the properties of that class without the need to list all the properties for every object.
- frames –very similar to the way we organise information in broad conceptual structures.
- etc

Marks : 1 mark for each method, a labelled diagram may be used to aid the description, up to 2 marks. Award 0 marks for naming only. The question asks for a description.

(ii)

Representation	Strengths	Weaknesses
Search trees	<ul style="list-style-type: none"> • Good pictorial representation of search paths • Clear development of links to objects from initial state 	<ul style="list-style-type: none"> • Difficult to use with knowledge that doesn't have obvious start and goal states • Can be difficult to translate into Prolog.
Logic	<ul style="list-style-type: none"> • Can be converted into Prolog very easily. • Good, efficient representation 	<ul style="list-style-type: none"> • No pictorial representation • Symbols are very mathematical
Semantic nets	<ul style="list-style-type: none"> • Common properties are only represented once • Searches follow paths through network 	<ul style="list-style-type: none"> • Diagrams can become large and difficult to follow
Frames	<ul style="list-style-type: none"> • Good for structured domain of knowledge • Efficient for complex knowledge 	<ul style="list-style-type: none"> • Difficult to convert to Prolog

Marks : 1 mark for each strength or weakness, up to 4 marks.

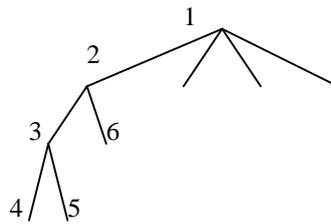
Note : if the candidate gives too much detail in (i.) then marks from part (ii) may be applied

- (b) (i) Exhaustive searching involves a systematic technique which tries to find a solution to a problem by looking at all possible solutions.

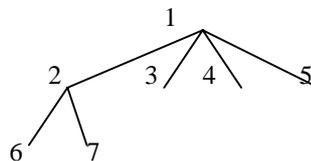
Heuristic searching uses rules of thumb or knowledge about the state space to limit the process of searching. This will then eliminate a lot of wasted searching.

Marks : 2 marks for a clear description of each type of searching. Up to 4 marks.

- (ii) Depth first search – starts at the root of the tree and works down each branch considering each node until it reaches a terminal node. If this is not a goal then it goes back up and tries the next available path



Breadth first search – starts at the root of the tree and searches all possible nodes at that level. It then moves to the next level if all the nodes at the previous level and have been searched.



Marks : 1 mark for each description and 1 mark for clear illustration. Up to 4 marks. Maximum of 1 if just a diagram

- (ii) A combinatorial explosion is a common problem related to exhaustive search techniques such as depth first and breadth first. The number of possible solutions which need to be checked in all but the simplest of problems becomes highly unmanageable.

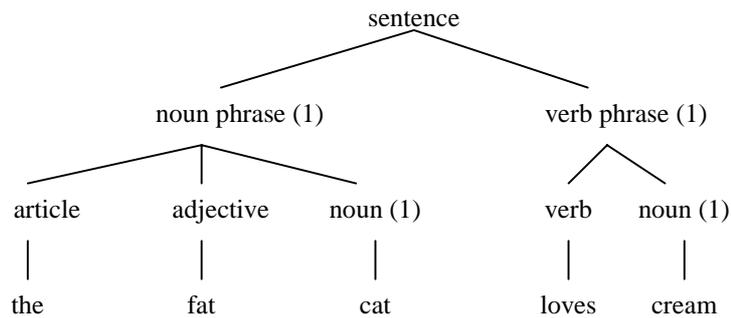
Marks : 2 marks for a clear description – must include the idea of "exploding"

- (c) (i) Problems associated with nlp:

- language is often imprecise or incomplete
- ambiguity is common due to one word having more than one meaning.
- ambiguity as a result of different interpretations of the same sentence.
- size of vocabulary
- etc

Marks : 1 mark for each problem, up to 2 marks

(c) (i)



Marks : *The exact terms are not required in the candidate response. The term “article” may be referred to as “determiner”.*

(d) (i) The main stages involved in creating an expert system are:

- knowledge acquisition –this will involve gathering relevant detailed information about the system to be developed.
- knowledge representation – this stage involves representing the acquired knowledge using an appropriate software tool such as an expert system shell.
- system validation – this will involve testing the system, identifying problems and comparing the human expert’s advice with that produced by the expert system.

Marks : *1 mark for description of each stage, up to 3 marks*

(ii) forward chaining involves reasoning forward from the given facts using appropriate rules to create more facts until the desired outcome is reached. A car mechanic will look at the problem with the car not starting on a snowy day and then reason forward to look at a possible cause such as damp getting into the cables and spark plugs.

backward chaining involves reasoning backward from the desired end point to determine what starting facts are required and then to see if these facts exist. If the mechanic can’t decide what the problem with the car is then he will use tests to see what problems are evident and then work back the way to find more facts to support the theory that the cables are getting damp.

Marks : *1 mark for each description and 1 mark for each illustration. Up to 4 marks*

(iii) Criteria which could be used when choosing between forward and backward chaining :

- is there a small amount of initial data from which we want to get a solution? In a situation such as this forward chaining would provide a considerable amount of information based on a small amount of initial data.
- is the problem a diagnostic one? Backward chaining is good for this as it starts by forming a hypothesis and then trying to prove it.

Marks : 1 mark for each criterion, up to 2 marks

(e) (i) advantage – where the knowledge engineer finds it hard to be 100% sure about a prediction a certainty factor can be used to give an idea of how sure he / she is.
disadvantage – certainty factors can be hard to define.

Marks : 1 mark for each. Up to 2 marks

(ii) Certainty factors can be implemented in Intermodeller by means of an integer in the range of –100 to +100 which can be attached to any rule to indicate the confidence in the validity of the rule.

Marks : 2 marks for a clear description of certainty factors for the named expert system shell.

4. (a) (i) ([J,Q,K], [], []) \longrightarrow ([Q,K],[J], [])

Marks : 1 mark for correct transformation

(ii) ([], [], [J,Q,K])

Marks : 1 mark for correct goal state

(iii) ([K], [], [J,Q]) \longrightarrow ([J,K], [], [Q])

([K], [], [J,Q]) \longrightarrow ([K], [J], [Q])

([K], [], [J,Q]) \longrightarrow ([], [K],[J,Q])

Marks : 1 mark for each transformation correctly defined, up to 3 marks

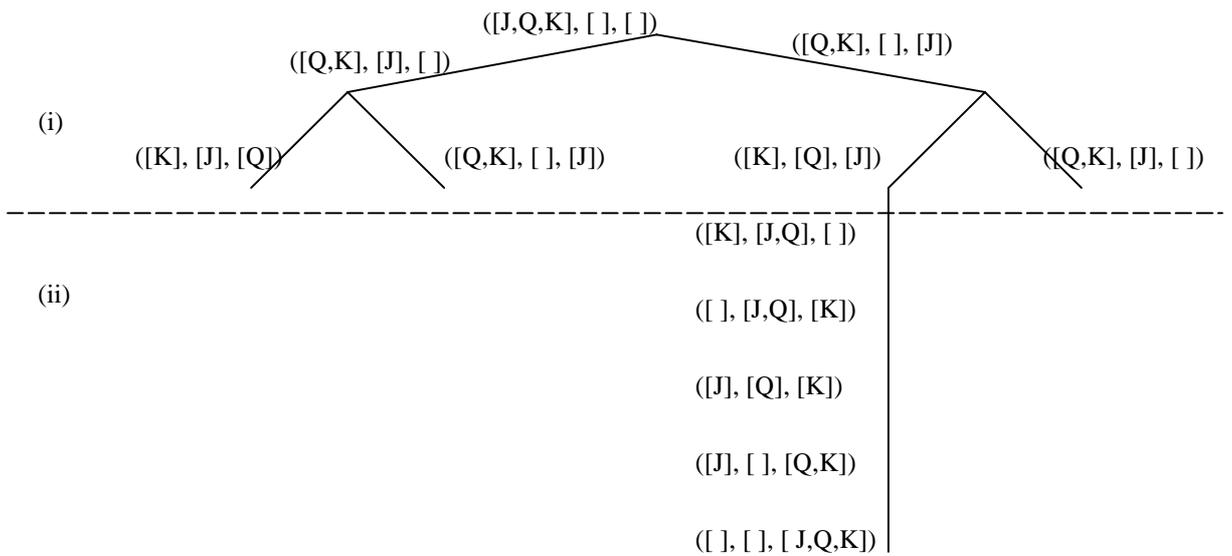
(iv)

Functionality	Does it do what it is meant to do? Does it solve the problem? Could it have been solved more readily in another way?
Quality of solution	Is the solution efficient? Is the solution valid? How long does it take using breadth / depth first?
Possible Enhancements	How could the solution be improved or generalised?
Possible consequences	What moral / ethical implications arise out of solving such an AI problem? Are there any legal implications of such problems?

Marks : 2 marks for each clear description of a relevant criteria. Up to 6 marks

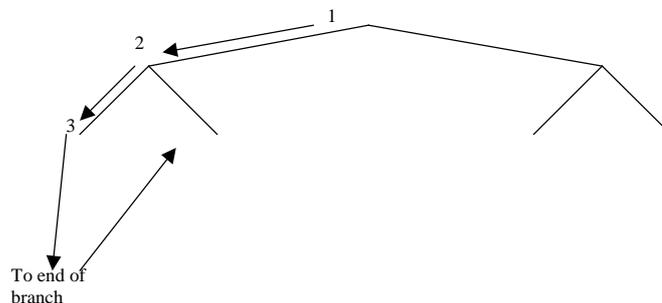
Note that the candidate response must be criteria to evaluate the solution

(b) (i) & (ii)



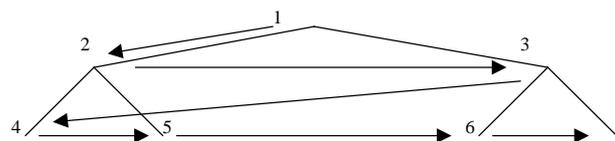
Marks : 1 mark for correct syntax
1 mark for correct first level
2 marks for correct second level
2 marks for final branch completed
Up to max 6 marks

(b) (iii) Depth first search:



A correct answer will indicate that each branch is searched exhaustively before going on to the next one. The search tree drawn does not extend as far as a goal state so this should be indicated on the diagram.

Breadth first search



Note that a correct answer for the breadth first search will indicate that each level is searched exhaustively before moving on to the next level down.

Marks : 2 marks for each search strategy labelled corrected and fully, up to 4 marks

- (c) (i) For example hill climbing could be described as follows: one move is selected and the rest are not considered again. An evaluation function is used to give each node a weighting.

Marks : 2 marks for a clear description of any appropriate heuristic

- (c) (ii) A heuristic technique ought to find a solution more quickly but may not find the best solution. An exhaustive technique, on the other hand, ought to find the best solution but it may take a lot longer to find it. Could respond in terms of processor time and memory usage.

Marks : 3 marks for a clear description

- (d) (i) Image analysis involves the computer defining and locating objects. The values of adjacent pixels are compared and so edges are detected. A sketch is then produced of the object by the computer.

Image recognition involves classifying objects into categories. This is the only stage of the process that requires AI as it uses search techniques.

Marks : award 1 mark for giving both names. Award 2 marks for each description

- (ii) Pattern matching in computer vision can be described as follows:

- an object is described using a mathematical representation
- templates of known shapes and patterns are stored in the same mathematical format
- the object is compared with the stored templates
- the best match is found and used.

Marks : 4 marks for a clear and full description

5. (a) Valid factors:

- can the knowledge be analysed and formalised into an expert system?
- quantity of knowledge – is the knowledge domain reasonably small?
- is there an easily accessible human expert?
- does the demand justify the development cost?
- can the knowledge be clearly defined to allow validation?
- cost – does the cost justify the development?

Marks : 1 mark for each valid factor, up to 4 marks

(b) valid justifications:

- the knowledge can be formalised well for example IF the animal is not breathing THEN it is dead
- quantity of knowledge is far too high but could be restricted to a small range of animals
- the number of human experts is limited but they are available for the project
- cost may not be justified as there will be a fairly limited client group
- diagnosis is not always clear cut so validation may be difficult.

Marks : 5 marks, the answer should be in terms of the factors outlined in part a. 1 mark is awarded for each valid justification and 1 mark for the final recommendation. Accept “yes” or “no” as the overall recommendation as long as justification is appropriate.

(c) Appropriate reasons:

To determine the feasibility of the system
To demonstrate the HCI
Small financial commitment if test is unsuccessful.

Marks : 1 mark for each of 3 reasons

- (d) (i) Example instructions based on Intermodeller, but any appropriate Expert System Shell may be used (e.g. Flex, Primex, etc)

Knowledge representation language

A number of different representations are possible which allow different classes of problem to be represented. This includes rules, tables, decision trees, etc. Symptoms for animal diseases may be classified quite straightforwardly using a table format.

Inference strategy

The main representations use depth first backward chaining. For example, top level goals are derived from the left hand side of advice rules. Undefined conditions are interpreted as questions for which dialogues are generated automatically. Loop detection is provided so that "BLEEDING IF BLEEDING" does not cause the system to hang.

Explanations

These are based on rule and goal tracing. How explanations, offered with advice conclusions, list the instantiated conditions of the rule that validated the conclusion. "Why?" as well as "how?".

Debugging

This is not provided with Intermodeller and is likely to cause problems in the above example as the size of the knowledge base will be large unless the scope and boundaries are defined very narrowly.

Marks : 2 marks for each area well described, remove marks if context not clearly given. up to 8 marks.

- (ii) Implementation of the vet system can be done as follows (based on the shell described above):

- the different possible representations will allow the knowledge engineer a great deal of flexibility in implementing the system. For example tables could be used for symptoms, trees would allow a graphical approach to the classification, etc.
- the lack of effective debugging features will be a major drawback of using this shell to develop the system as it will be difficult to trace errors without visually watching the inference strategy taking place.

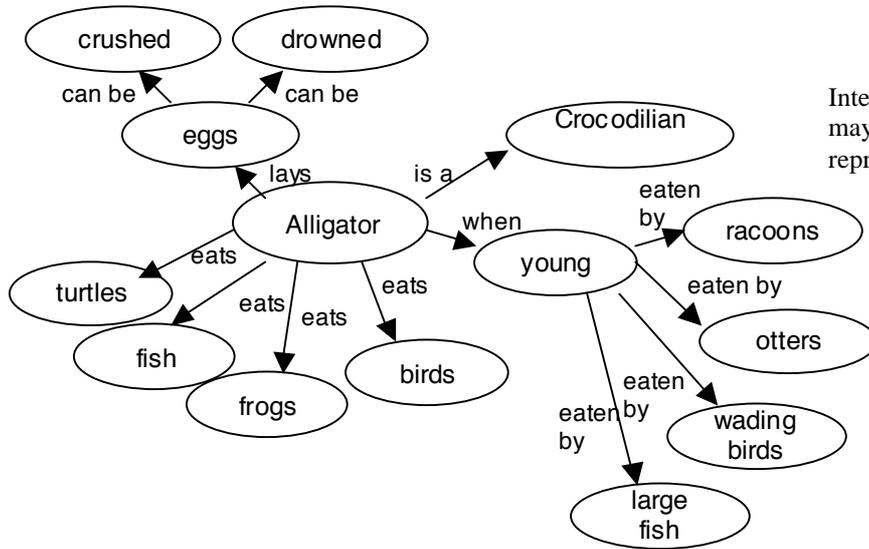
Marks : 4 marks for a clearly stated answer

- (e) Validation of the system will involve:

- comparing the results produced with the decisions made by the vet whilst diagnosing particular diseases.
- allowing non experts to use the system under supervision to see whether the advice given is sensible and can be applied by them. In this case the non-experts will be a vet who is not trained to deal with the rare breeds. They will be able to use the advice which is given and will be able to evaluate its usefulness.

Marks : 1 mark for each criterion and 1 mark each application, up to 4 marks.

- (f) (i) Below is an appropriate semantic net for the information.



Interpretation by candidate may result in different representation.

5 marks for a clearly labelled diagram as follows:

1 mark for the central node

2 marks for appropriate naming of links

2 marks for appropriate outside nodes

Note that the diagram may not use the same syntax as shown above.

- (f) (ii) A number of representations could be used for example frames. Frames allow the information to be represented in a style which uses data structures consisting of slots that are filled with specific instances of data. The values stored in certain slots can be pointers to other frames which brings in the idea of inheritance.

Marks : 2 marks for a clear description. For example, if frames is described then the idea of the structure and the idea of inheritance ought to be included for 2 marks.

Section II Part B – Computer Systems

6. (a) (i) Clock speed – refers to the number of pulses per second generated by an oscillator. The CPU requires a fixed number of clock pulses or clock cycles to execute each instruction. Obviously the faster a processor runs, the more instructions it can execute in a given time period. Consideration should also be given to the number of cycles it takes to execute an instruction.

Processors with the same clock speed will not necessarily perform equally due to other aspects of their architecture and doubling the clock speed of any processor will not necessarily double the performance.

Marks : 2 marks for full description or any two relevant points

- (ii) Registers – the processor's registers are used to control instructions being executed, to handle addressing of memory and to provide arithmetic capability. Some processors have segment registers for addressing an area of memory.

Increasing the size of registers has the effect of increasing the amount of data that can be handled or manipulated in one go.

The use of multiple registers rather than a single accumulator can save memory accesses and take advantage of faster speeds inside the processor. This can also reduce the number of memory references created by variables at run time.

Multiple registers make it possible to carry out several instructions at the same time i.e. in parallel.

Marks : 2 marks for full description or any two relevant points

- (iii) Cache memory – the access time of memory is the time it takes to release memory contents for use, therefore speed of memory affects performance. Cache is a small, fast memory which is linked to main memory. Cache will hold a copy of some blocks of main memory and when the CPU attempts to access a word, it will look first in the cache memory and if it finds the data there, it does not have to do the more time consuming reading of data from larger memory. Programs contain instructions eg. loops, procedures, which are accessed regularly and thus are suitable for inclusion in the cache memory. Access from cache is faster than main memory.

Other – RAM can be thought of as cache memory as all of RAM's contents come from disk. A disk cache is usually a reserved area of RAM where a copy of the most recently accessed data is stored.

Marks : 2 marks for full description or any two relevant points. If only one is given then a high degree of detail is required.

- (b) (i) RISC processor [*Reduced Instruction Set Computer*], uses a minimal instruction set, emphasising the instructions used most often and optimising them for the fastest possible execution. CISC uses complex instruction sets and addressing modes. In RISC, most instructions execute in a single clock cycle. Software for RISC processors must handle more operations than traditional CISC [*Complex Instruction Set Computer*] processors, but RISC processors have advantages in applications that benefit from faster instruction execution, such as engineering and graphics workstations and parallel-processing systems. They are also less costly to design, test, and manufacture. In the mid-1990s RISC processors began to be used in personal computers instead of the CISC processors that had been used since the introduction of the microprocessor.

Summary:

RISC	<ul style="list-style-type: none"> • simple design, cheap to produce • hardwired • instructions execute in a single cycle 	CISC	<ul style="list-style-type: none"> • complex design, expensive to produce. • Microprogrammed • some instructions need many cycles.
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Other points:

Instructions which can access memory are of the LOAD/STORE type. i.e. ADD and SUB are not possible.

Every instruction is of the same length.

Hardware implementation. i.e. not microcoded.

O/S and applications are easier to develop (less instructions).

RISC is based on research evidence that 20% of instructions do 80% of the work.

Each instruction type that a computer must perform requires additional transistors and circuitry (cost) – larger set of instructions make the processor more complicated and slower in operation.

RISC processor has less supervisor circuits which are needed to detect resource conflicts. These circuits slow down the processor.

RISC chips are generally faster than CISC processors, such as the Pentium. For software developers, however, clock speed isn't the only quality by which they judge a computer system. The performance of any given RISC processor is closely tied to compiler and, more precisely, to optimisation technology. That's why companies who sell chips also build RISC compilers specifically for those chips.

Marks : 2 marks for performance gains of RISC, 2 marks for comparison/contrast.

- (ii) MIPS (Millions of instruction per second) – gives the rate at which a processor executes instructions. i.e. how many low-level machine instructions a processor can execute in 1 second. Since different instructions have different execution times, some average taken over all instructions had to be used. The average should be weighted towards the most frequently executed instructions. It is used for carrying out integer operations only and for scientific work the equivalent performance was MFLOPS (Millions of floating point operations per second). As architecture has become more complex, MIPS & MFLOPS have become inadequate as a measure of performance, but MIPS is the only measure which can be used over the whole range of processors.

Often rendered by hackers as “Meaningless Indication of Processor Speed”.

Marks : 2 marks for full description of limitations (1 for what measures are, 1 for how they are ineffective)

- (iii) More important measure is the throughput, (the amount of work a computer can do in a given time), in terms of results. This involves using a benchmark suite of programs, which are run and the execution times noted. Such a suite of programs will try to include programs which test various aspects of the efficiency of the machine. A popular set of benchmarks that are used is the SPEC92 benchmark suite. Benchmarks are available to compare computers in a particular environment eg. commercial office environment
It should be noted that the benchmark should be suited to the application area. SPEC92 is an integer/fp test involving 18 tests which should be run on workstations with at least 32 MB RAM – useful in scientific and engineering application but not in context of games.

Other possible answers – response time, memory bandwidth.

Marks : 2 marks for full description of suitable alternative

- (c) (i) The assembly language program has to be changed into machine code. There is a one to one relationship between assembly code and machine code instructions. The assembler, which is often part of the systems software and specific to a type of computer, will carry out this process.

OR

The translation of the source program will produce an equivalent machine readable and understandable sequence of instructions that can be executed by the processor.

OR

This is to translate the source code into relocatable machine code, meaning a set of machine instructions that can be loaded at various locations in memory.

Marks : 1 mark for full description

- (ii) On the first pass the assembler may encounter a reference (eg. a subroutine) which is in a later segment. During the second pass it will be able to calculate the offset to the forward reference and complete the coding.

Assemblers typically make 2 or more passes through a source program in order to resolve forward references to addresses not yet encountered in the program. During the first pass, the assembler constructs a symbol table of name and labels and their relative locations (offsets) within the segment.

During pass 2, using the information in the symbol table, i.e. the length and relative position of each data field and instruction, the assembler can complete the object code for each instruction.

The candidate may make mention of the symbol table.

Other – Once a full pass over the program has been made, the assembler knows which symbols will be on page zero, so it can go over the program again selecting the appropriate addressing mode for instructions. This makes certain instructions shorter.

Marks : 1 mark for address reference/symbol table, 1 mark for object code/addressing mode

- (iii) To generate code which is as small as possible
to generate code that runs as fast as possible
because there are no HLL's available for the processor
to enable the programmer to control the hardware of the computer directly.

Marks : 2 marks for any two relevant points

- (d) (i) The effect of a bitwise OR on any two bits is for any 2 zeros, the outcome is zero; 0 0 = 0, any two ones equals one, 1 1 = 1, one zero and one one equals 1, 1 0 = 1 and 0 1 = 1. With 1100 and 1001 the outcome would be 1101.

Marks : 1 mark for explanation of bitwise OR, 1 mark for outcome – out of 2.

- (ii) This is achieved by setting bit 5 (bits being numbered from 0 – 7 from right to left) of the appropriate register. In an upper case character, bit 5 will always be set to **zero**. The corresponding lower case character is identical except that bit 5 is set to **one**. A bitwise OR is applied with a mask, in binary, of 00100000 (bit 5 set to 1). Each bit of the source operand (ASCII character) is compared with the corresponding bit of the destination operand (mask). The result will be 1, if either the source bit or the destination bit is set to 1. If both bits are set to 1 or both bits are set to 0, then the result will be 0.

ie	source	01000001	A	source	01100001	a
	destination	00100000	mask	destination	00100000	mask
	result	01100001	a	result	01100001	a

Marks : 1 mark for setting bit, 1 mark for OR, 1 mark for mask, 1 mark for result

(e) (i)

organising and viewing directories	
windows	Directories and sub-directories (folders) can be created both out with and within applications. In the OS, you can either click, in the active window, on File, then New, then Folder and enter the name for the folder or right click and click on New, then Folder and enter the name for the folder. In an application there is usually an icon available in the Save As window, which will allow you by clicking on it, to create and name a new folder (in current drive or folder). The contents of any folder can be viewed by double clicking on the folder icon. To move a folder – click on folder and drag to new location.
Unix	Files are stored in directories, which are arranged in a tree and the top directory is denoted by “/”. To change directory use the command cd, eg. cd directory. To create a new directory use the command mkdir, eg. mkdir wpfiles. To list files in the current working directory use the command ls, eg. ls wpfiles
Mac	The OS takes advantage of the human spatial memory - icons and windows always stay where you left them. The metaphor of the finder desktop is a direct reflection of the filesystem - files on the desktop are actually in a directory /Desktop. The Mac OS actually gets you closer to the filesystem (than Windows) so that it doesn't need "wizards" to simplify it for you, because the filestructure is logical and clear down to the system level.
Installing and uninstalling	
Windows	Insert the CD and wait for installation to start automatically (autorun). If not then use the Control panel (via settings on the Start menu) and double click the add/remove programs icon. This will give you the option to install or uninstall any selected program. Find the program in the listing and click on it. It will install / uninstall all the files associated with that program. Follow the prompts which in most cases involve clicking the Yes option.
Unix	Most applications for Unix will come with a script that can be used to install the program and related files. The script routine can usually be activated by typing - /install You will have to provide details of the directory where you will place the files and subdirectories. There is usually a similar uninstall command - /uninstall.
Mac	Double click the Installer and choose the drive for installation. And click the appropriate options. To uninstall, drag the program to the trash can. You may have to do the same to extensions and preferences in the Systems folder.
Resource sharing	
Windows (2000)	Right click on the object that you want to share, eg. File, folder, printer, etc. Choose the sharing option and select to share this object. Assuming a network connection or physical link, the object can be used or accessed by logging on to the host computer. One method is to click start, click Run and type \\sn987001 - where sn987001 is the identity of the host computer. You will now be able to access the shared items.
Unix	Designed as a multi-user system – built to run networks and allow sharing of resources (plus supervision). Users can allocated to groups which have access to various resources, eg. allow designated files to be shared.
Mac	File sharing has been possible with peer to peer networks on Apple systems since the earliest versions of the operating system. This allows folders to be shared requiring a log in before access to particular resources is possible.

Marks : 2 marks for each feature from a recognised OS, up to 6 marks

(e) (ii)

Applications support	
MSDOS	DOS applications are given a virtual machine. There is little or no support for applications and the interface was dependent on the specific application.
Windows	Most applications for PC's are written for Windows (due to market dominance). Microsoft, who produced Windows, have also written many good applications, eg. Excel, Word. Applications for Windows make use of the API (application programming interface), which means that applications tend to look much the same and work the same way. The menus and dialog boxes come from the API rather than from the application developer.
Mac	Support can depend on the developer's community. MAC OS X has led to a 100% growth in this area, including UNIX and JAVA programmers. Software developers such as Adobe, MS, Corel, Macromedia, MathWorks, Oracle and Sysbase have doubled their applications for Mac OS X.
Unix	There is a wide range of free and commercial software available for Unix. Commercial applications from Corel, Island Software, Star and a host of other producers are available covering all application areas. Unix can also run on Windows, Mac and other operating systems. Popular programming languages such as C++, Perl, Java, etc. are all readily available for Unix.
Customising the user interface	
MSDOS	Use the file display command in the options menu to alter how files are displayed. Use commands in the TREE menu to control the level of directory structure that can be displayed. Use commands in CONFIG.SYS, for example to change date and time. Use the ANSISYS device driver to control the appearance of the screen, by issuing ANSI escape sequences. These can be set up in a text file and activated using the "type" command.
Windows	Comes with GUI that provides a full WIMP environment. Use of options in the control panel menu to customise desktop pattern, change screen displays, alter sound levels, alter mouse tracking speed, etc. Use of View menu to alter display of folders and files. Use of appearance tab in display properties to change window schemes and system fonts.
Mac	Use of options in the control panel menu to customise desktop pattern, change screen displays, alter sound levels, alter mouse tracking speed, etc. Use of View menu to alter display of folders and files. Use of appearance utility to manipulate windows and system fonts.
Unix	Provides a command line interface with a selection of shells. Each shell has its set of commands. Commands can be typed in directly. The shell acts as a command interpreter, executing the command, if possible, or issuing an error message if not. A graphical user interface such as MOTIF is now available which would suit novice users

Marks : 1 mark for each feature for each of two operating systems, up to 4 marks

Section II Part B – Computer Systems

7. (a) (i) Immediate addressing - LODX #N, CMPA #6 (anything with a # in the operand)
Direct addressing - STOA V, LODA P (anything with a letter only in the operand)

Marks : 1 mark for each example, up to two marks

- (ii) immediate addressing - the operand contains the actual value that has to be processed. eg. load # 23 : 23 is loaded

direct (or absolute) addressing - the operand specifies a memory location which contains the value to be processed. eg load \$800 - contents of memory location 800 are loaded.

Immediate : operand – data; direct (or absolute): operand – memory address

Marks : 1 mark for description of immediate, 1 mark for description of direct (or absolute), 1 mark for difference

- (iii) The index register is set to zero and will then count how many times the number 6 can be deducted from V (number placed in the accumulator). If the value of the comparison with the accumulator is GT then it will loop back to the label, if it is LT then it will stop the loop and jump to label2. If it is equal then the remainder (in the accumulator) is set to zero and x-register is incremented. At Lab 2, the value in the accumulator is stored in memory location P and the contents of the x-register are stored in memory location Q. The program is dividing (repeated subtraction) by 6 and stores the number of times divisible by 6 in P and the remainder in Q.

Marks : up to 6 marks for clear and full answer; 2 marks for register set-up and use, 2 marks for flow of program indicating branches (loops), 2 marks for final memory location values and purpose of program

- (iv) 2

Marks : 1 mark for correct answer

- (v) Whether there was a remainder or not (i.e. original number divisible by 6 or not) the final answer would contain no remainder. (1 mark) Also the x-register would not be incremented thus giving the wrong answer. (1 mark) The remainder would be set to the current value in the accumulator. (1 mark)

Marks : 3 marks as indicated

- (b) Fetch from memory -
- | | |
|--|--------|
| Step 1 PC (IR) contents transferred to MAR (set up address bus) | 1 mark |
| Step 2 activate a READ operation on control line | |
| OR address decoder accesses the store location addressed | 1 mark |
| Step 3 data transferred to Instruction Register (via MDR) | 1 mark |
| Step 4 PC incremented (and the instruction decoded (and executed)) | 1 mark |

Marks : 4 marks as indicated

- (c) The control unit directs the operation of other units by providing timing and control signals. Its main role is to execute programs. To achieve this it contains the necessary logic to interpret instructions and to execute them, i.e fetch and execute.

**Marks : 2 marks – 2 points or full description of fetch / execute
1 mark – 1 point or limited description**

- (d) (i) 6502, 8080 – 8 bits, 8086 – 16 bits etc.

Marks : 1 mark for correct answer

- (ii) accumulator – is the register in which intermediate results are stored. Without accumulator, it would be necessary to write the result of each calculation to memory and read it back again,
Or memory address register(mar) – is the register that contains the address of a register to fetch or store from or to the computer storage.
Or memory data register(mdr) – is the register that contains the contents of a register to fetch or store from or to computer storage.(Also called memory buffer register)
Or any other suitable register

Marks : 2 marks - name & detailed description (1 mark - name & simple description)

- (iii) specific – x86 family, 486 to Pentium
Data path increased 32bit – 64 bit, doubling the amount of info pulled from memory on each fetch.
Superscalar architecture – 2 datapaths that allow processor to complete more than one instruction per clock cycle.
Introduction of MMX instructions – special 64 bit functions that allowed better number crunching speed.
Increased clock speed – 66MHz – 233MHz, which increases performance, in terms of the number of cycles /second.

general - pipelining allows several instructions to be at different stages of processing; pipelining means that one instruction can complete execution in every clock cycle; superscalar architecture provides extra pipeline(s) - more than 1 instruction/cycle;
cache memory reduces time taken to exchange data between memory & processor;
incorporation of floating point and multimedia instructions into processor instruction set;
higher clock speeds improve performance;
increased data bus widths allow higher data transfer rates

**Marks : 1 mark for each of above points (or any other suitable) up to 4 points.
Half the marks if the answer is not specific.**

- (e) (i) Multitasking – is a method by which multiple tasks may execute, apparently simultaneously, on a single computer processor.

Marks : 1 mark for suitable description

- (ii) The memory problems the OS must deal with are –
Memory must be divided into parts, eg. partitions, segments, pages.
It has to allocate memory to programs and keep programs apart from each other.
Each task or process is allocated memory by the scheduler.
It needs to protect programs from one another so that data from one process does not overwrite another process.
It has to deal with hardware interrupts by ‘pre-empting’ a running process to give control to the OS, and then to restore the pre-empted process.

Marks : 1 mark for each of 3 points from division of memory, memory allocation, memory protection, scheduling of process, etc. A good candidate may make mention of base limit addressing.

- (f) Windows - recover a deleted file, that has been emptied from the Recycle Bin:

Restart in MS-DOS mode.

CD to the directory from which the file went to the Recycle Bin.

Issue the undocumented MS-DOS command LOCK,

Issue the command UNDELETE *myfile* and follow the instructions. If no disk writes have occurred since the accidental deletion of your file, UNDELETE will successfully recover it.

Issue the command UNLOCK.

Issue the command EXIT. Your computer will reboot and return to Windows mode.

Marks : 1 mark for name of operating system if correctly linked to description, 2 marks for full description, 1 mark for limited description. 0 marks for utility software.

Section II Part B – Computer Systems

8. (a) Memory model – any suitable model. Key points-usable memory, addressing, protection or organisation.

The choice of size for the main (physical) memory is partly determined by the addressing methods used and the cost of memory components. Addressing such as the Win32 memory model allows 2^{32} (4GB) of virtual addressing space. The memory size will be determined and it is usual for computers to have the potential for later memory expansion. A decision must be taken about memory organisation, i.e. where the users' programs, the operating system and the BIOS are to be stored.

Users' programs need to be physically isolated from each other and also from system components.

Another consideration is whether or not to allocate sections of memory to the screen display, program code and variables.

Memory can be organised into pages or segments

Marks : 1 mark for each of 3 relevant points, up to 3 marks. Allow for a diagram of a memory map.

- (b) Virtual memory

advantages –

- initially dealt with the problem of programs that were too big to fit into memory to be executed. It enlarges the address space, the set of addresses a program can utilise.
- As the process or program can be divided into parts, only the active process has to be in memory. i.e. the code that is currently being executed.

disadvantages –

- the use of virtual memory makes things more complicated. The complexity tends to slow things down and can, in certain circumstances, make them grind to a halt (thrashing).
- Virtual memory relies on disk-access, to enable sections of code to be swapped between disk and main memory, which is relatively slow.

Marks : 2 marks for advantage, 2 marks for disadvantage, up to 4 marks. Must be a full description for full marks.

- (c) The operation (double clicking the file) would be entered through the GUI or the command language interpreter, which would interpret the command and activate the file manager to carry out certain tasks. This would involve retrieving two files – the WP application file, which has to be activated and the document or data file. For both files the file manager has to carry out certain tasks. The list of tasks that the file manager has to perform are:-
1. check file exists
 2. check that the user has permission to read file
 3. use the file ID to find the sector, track and size of file
 4. pass the file size to the memory manager

The information required by the file manager would be stored in the File Allocation Table.

Once the memory manager receives the size of the file to be opened, it needs to work out whether there is enough memory available to load your file. The MM checks memory and if enough free space exists, it will send the sector and track numbers to the Input/Output manager. The I/O manager locates the file on the hard disk (by sector) and retrieves the information. File is then loaded and displayed.

The memory manager must also protect the memory area that the file uses, until it is finished.

Marks : 1 mark for initial command activates file manager, 4 x 1 for each task file manager performs, 1 mark for FAT or similar, 1 mark for memory allocation check, 1 mark for I/O task Total of 8 marks

- (d) (i) Early Mac O.S. and Windows 3x use non-pre-emptive / co-operative multitasking.
UNIX, Windows NT and OS2 use pre-emptive multitasking.

Marks : 1 mark for pre-emptive and name of OS, 1 mark for co-operative / non-pre-emptive and name of OS

- (ii) Co-operative – a type of multitasking in which the process currently controlling the CPU must offer control to other processes. It is called co-operative because all programs must co-operate for it to work. Each program can control the CPU for as long as it needs and if one program does not co-operate it will dominate the CPU. If a program is not using the CPU it can allow another program to use it temporarily.

Pre-emptive – forces applications to share the CPU whether they want to or not. In pre-emptive the O/S allocates time-slices to each program. The scheduler has the ability to suspend one process, at any point, and give another process a turn.

2 marks for describing pre-emptive, 2 marks for describing non-pre-emptive / co-operative. Total of 4 marks

- (e) (i) 3 states are –

Running – process runs until obliged to wait for Input/Output or pre-empted by the scheduler (to give another process a turn).

Blocked – if a process is waiting for Input/Output it is described as blocked, and stays in that condition until the Input/Output is over. When the Input/Output is finished, it passes into the ready state again.

Ready – if a process is pre-empted or when an Input/Output operation is finished, the process is ready for the processor. When its turn comes round again, it is shifted back into the running state of the scheduler.

Marks : 1 mark for description of each state. Total of 3 marks.

- (ii) Algorithms – round robin , Priority scheduling , FCFS , Shortest job first

Round robin – a scheduling algorithm in which processes are activated in a fixed cyclic order. Each process is assigned a processor time-slice . Those which cannot proceed because they are waiting for some event, eg. an I/O operation, simply return control to the scheduler. If the process is still running at the end of the time-slice , it is pre-empted and has to wait its turn again. It is a fair method , suitable to interactive systems . Time – slice about 1/10th of a second .

Priority – Each process is given a priority and the job with the highest priority is processed. In many systems , there is a queue of jobs for each level or priority and jobs within a certain priority are treated to round – robin scheduling . Low priority jobs can have their priorities raised if they have been waiting a long time .

Processes can be static or dynamic, where dynamic priorities are based on the processes' behaviour while in the system. One problem is starvation, where low priority processes are not given the opportunity to run.

Or suitable explanation of other types

Marks : 2 marks for round robin, 2 marks for comparison with one other algorithm

- (f) (i) A type of program error that requires that a program responsible for the error be shut down. Software applications communicate with operating systems and other applications through layers of code. The program will issue an error alert that communicates the problem across the layers. When an error is detected, the error is sent through the layers of code, one by one, until code is found that can handle the error. If no code has been included in any layer of the program to handle the specific error, the error alert will travel through all the layers, and the O/S recognises it as an unhandled error and shuts down the program. It may even shut down the O/S.

OR

Windows – does not cause the error, but has the exception-handling routine for that particular processor exception, eg. divide by zero, NMI interrupt, Invalid Opcode fault, which displays the error message.

Fatal (exception) errors are codes returned by the program because of a certain situations – access to an illegal instruction, invalid code accessed or the privilege level of an operation is invalid. When these situations arise, the processor returns

an exception to the OS, which in turn is handled as a fatal exception error message. Usually non-recoverable and you must shut down.

Marks : 1 mark for application – OS communication, 1 mark for error alert/code, 1 mark for error handling.

- (ii) Sources of error and correction (Windows) –
- Protection error caused by certain video adapters. Corrected by updating video adapter driver and re-starting.
 - Registry is damaged caused by antivirus program running at the same time. Restore backup of Windows registry.
 - Fatal exception error OE caused by faulty RAM chips. Replace RAM chips.
 - Page fault interrupt caused by access to virtual memory on a demand-paged basis and 'page' is missing or damaged. Re-start and re-install software.
 - Stack overflow usually caused by a device driver using more than allocated 4KB (or one page). Increase setting of MinSPs, eg. MinSPs = 4

Sources of error and correction (General) –

Program may issue a request that the O/S cannot honour, eg. reserve a block of memory for the program's use. Corrected by removing any other active process from memory. ie Restart with no other applications running at the same time.

Program tries to use an address out with the program's address space. Increase the amount of memory available to the process or user and re-start.

Marks : 2 marks for error sources, 2 marks for error corrections

SECTION II Part C – Data Communications

Answers and Marking Scheme

9. (a) **Information access:** When data was largely text based, access to information could be provided using other network application programs, eg e-mail to an answer to a question, file transfer to access a text document or remote access using telnet to query a database. However the world wide web (WWW) is the main information access system in use today. (Students may mention forerunners such as Gopher but this is not necessary to gain full marks). 1

Developed in 1989 as a web of linked documents, early browsers could only transfer text. Web pages are written using Hypertext Markup Language (HTML). Support for accessing graphics was soon added (early 1990s) and support for almost any kind of file can now provided by plug-ins and developments such as Java and XML means that the capabilities can continue to be extended. 1

The WWW uses a client-server mode of operation. The use of a Uniform Resource Locator (URL) which contains the protocol scheme, IP address, file pathname and file name means that information can be accessed using a range of other protocols eg. telnet and FTP. 1

Specific examples include Mosaic (the first browser capable of accessing graphics), Netscape and Internet Explorer (IE). The W3C organisation oversees the development of the web, but the browser programs typically do not fully support the current standard and offer proprietary extensions. This has undermined one of the original ideas behind the development of the web as a means of providing uniform, platform independent access, to a range of information types. 1

Marks: Both historical development and specific applications must be mentioned for full marks. A suggested breakdown of marks for the above answer is shown in the margin, but all six marks can be gained in a number of ways.

9. (a) **E-Mail:** This was one of the first Internet applications developed and remains one of the most important. On the Internet, sending messages is accomplished using Simple Mail Transfer Protocol (SMTP). Mail is normally delivered to a shared, always accessible mail server. The most popular method of accessing the messages is currently the Post Office Protocol (POP). 1

Originally text was entirely ASCII and SMTP specifies that all data has to be 7 bit ASCII characters. The Multipurpose Internet Mail Extensions (MIME) was developed to allow the transfer of other types of information such as graphics, sound and video. The MIME header includes details of the content type, which allow email applications to select an appropriate “player”. 1

Most current e-mail programs support the transparent transfer of files by attaching the file to the email. Older methods of transferring non-text data include Base 64 and Uuencoding. Examples of e-mail programs include Outlook and Eudora. As well as supporting the internationally agreed standards, some e-mail programs offer proprietary extensions, eg Outlook’s support of HTML email. Another recent development is web-mail: the ability to access mail using a web browser (eg Hotmail is operated almost exclusively through a web browser). 1

Marks: Both historical development and specific applications must be mentioned for full marks. Note: The sample answer deals almost exclusively with Internet email, but students can be given credit for describing other e-mail systems (eg FirstClass). A suggested breakdown of marks for the above answer is shown in the margin, but all six marks can be gained in a number of ways.

- (b) (i) An informal code of conduct governing the way emails are written and interpreted. Describes rules intended to help avoid causing offence unintentionally. 1

Important to know and understand because email lacks the clues present in face-to-face or telephone communications that help us interpret meaning and allow us to see the effect of our communication on listeners. Important if you want to avoid causing unintentional offence. 1

- (ii) All capitals, poor spelling, poor grammar, overuse of exclamation mark, personal details included, spamming the mailing list, ... 1

The senders message will be viewed with extreme anger by many of the recipients. (They have a life... and that life includes puppets.) It may be viewed as a message from someone deliberately trying to cause trouble (a Troll). Will probably result in some people trying to flame the sender. 1

Many other breaches of netiquette are in evidence. Two marks only if clear reference made to example message.

- (iii) Do unto others..., respect other peoples time and bandwidth, remember the “permanence” email and be careful about what you say about others, take time to respond calmly to messages, use smilies/emoticons, ... 2

Must be a clear explanation of two techniques for full marks. No marks if candidate simply states the opposite of the problems identified in part (ii) without further explanation.

(c) *Local cache:* Since the menu page contains a large number of graphics, it would make sense to store a copy of the files on the users hard disk. The users browser would not have to fetch the graphics from the remote server every time the user returns to the menu page and the page would be displayed more quickly. 3

Proxy server: A proxy server keeps copies of frequently accessed documents. The movie clips are held on servers all round the world, so holding copies of the popular pages more locally on a proxy server will speed up the delivery. 3

Other answers are possible, for example the video clips are in different formats, and so various “helper” programs may have to be identified and connected with the appropriate file types. Plug-ins may have to be downloaded and set up, for example QuickTime allows users to specify what sort of connection they are using which determines which version of a movie is sent. The user may choose to turn off the display of graphics in the browser to speed up the rendering of the pages. ...

1 mark is awarded for the identification of an appropriate parameter, 1 mark for a description of the parameter and 1 mark for an explanation of why adjusting it makes a difference.

(d) *Sample answer:*

(i) TCP/IP is defined by IETF (Internet Engineering Task Force). {...or possibly the Internet Advisory Board or the Internet Society. ☺} 2

1 mark if the protocol does not match the standards body.

(ii) TCP/IP is used by all computers connected to the Internet. It is probably the most important networking protocol in use today. It allows computers on different networks to communicate with each other. Every device on the network must have a unique IP address. The TCP protocol splits data to be transmitted into packets for transmission and re-assembles the data once it is received. The IP protocol facilitates the routing of the packets to their correct destination. 3

Many other answers are possible but the candidate response must make reference to a specific network system.

(e) *Sample answer:*

MIME (Multi-Purpose Internet Mail Extensions). An extension of the original Internet email protocol SMTP that lets people use the protocol to exchange different kinds of data files on the Internet. (SMTP only handled ASCII.) The content type of the data is inserted at the beginning by the server. The client then uses the content type in the MIME header to allow the selection of an appropriate player.

3

Many answers possible. Candidates should indicate an understanding of why encoding is necessary (i.e. email is set up to send text) for 1 mark. The remaining 2 marks should be awarded for a reasonably detailed description of the scheme. It would also be acceptable to give a briefer description of two schemes for 2 marks, eg. Uuencode or Base64.

(f) Candidate **must** refer to a specific program for full marks, preferably by naming the program, but it should at least be clear whether they are describing a GUI based or command driven program.

The following sequence should be clear:

1. the need to connect to the file server and identify yourself (they may describe anonymous FTP, but the convention of sending your email address as an ID should be described). 1 mark
2. navigation through the servers file system to the correct folder/directory. This may be expressed in terms of a URL or entering a path name, double clicking icons in a GUI based system, or issuing a series of change directory commands. 1 mark
3. initiating the transfer from the file server to the local machine, eg. GET, double click, or drag and drop. Ideally they should be aware of the need to specify the type of transfer (binary in this case) but this is often handled automatically by current programs and so may be omitted without losing marks. 1 mark.

3

10. (a) *Candidates may give unstructured descriptions of the network systems, so marks can be transferred freely between the roman numerated sections. However, no more than three marks should be given for each section.*

The following are suggestions for the areas that candidates may raise. Other solutions could be valid if described at a sufficient level of detail for AH.

(i) Topology

A bus topology is the most likely, probably Ethernet. This is suggested by the small number of stations (six doctors, the reception area and possibly one or two others). Also, the applications described do not demand particularly high performance (eg. No requirement for video conferencing). Finally, the small geographical extent of the network (all contained in the one building/practice) and the low cost of Ethernet networks also mean bus is a good choice.

3

(ii) Hardware

Clearly all devices attached to the network will need Ethernet connections (possibly already built into the PC). Cabling likely to be coaxial cable, Shielded Twisted Pair (STP) or Unshielded Twisted Pair (UTP). Other hardware described could include terminators and possibly a hub. Hardware for connecting LAN to the Internet should also be described - probably a router. *{Given the scenario described, a modem is not a sensible option and no credit should be given if that is all that is offered by a candidate.}* An awareness of security issues (given the sensitive nature of the data being transferred) may lead to discussion of gateways and firewalls. *{Perhaps not really hardware, but should be given credit if discussed appropriately.}*

3

(iii) Bandwidth

No specific hints given about the need for bandwidth, so a low bandwidth Ethernet (10Mbps ?) probably sufficient for the LAN inside the practice. The fact that six (or more) machines are potentially accessing the Internet simultaneously suggests that the Internet connection should be something like ISDN, ATM or possibly cable. This suggests a minimum bandwidth of say 128K, and preferably higher, for the external Internet connection. Local health board may have its own WAN.

3

(iv) Architecture

*It would be possible to argue convincingly for both peer-to-peer and client server, but security issues and the patient database probably give client server the edge for this application. Backup of the data is also easier in client server model. Accept either answer on its own or give the marks for a good comparison of the two. For the full 3 marks however, security issues **must** be discussed.*

3

- (b) Different levels of passwords/access for doctors, receptionists, nurses etc. (eg. receptionists cannot gain access to confidential patient records). *{Passwords alone, without discussion of levels of users, is not worth any marks}* Physical security (eg. File server/PCs in secure/staffed areas where they cannot be accessed by public). Firewall to prevent unauthorised external access. Encryption of data. Backup of data. Candidates may also discuss the integrity of the data, e.g. only one copy of patient information, limitations on who can update certain parts of patient record, etc.

Marks: 4 marks should be awarded for the discussion of issues related to in-surgery security.

4

- (c) (i) A remote access program allows a remote computer system (a host) to be controlled, through some sort of communication link, from a client system. The client machine will log in to the host and will then typically act as a dumb terminal controlling the operation of the host computer. The remote host carries out the processing requested by the client machine and then passes the results back through the communication link to the client machine. Allows users to make use of applications and data on a remote computer.

3

Note: not just file transfer

- (ii) Remote access:
Need for secure log in, with confidential ID and password *{worth a maximum of 1 mark no matter how fully described}*. Need for encryption of data during transmission. Perhaps only permitted if connection through some sort of virtual private network, or through an actual private network ie Health Board is her ISP. Perhaps restrictions placed on what can be accessed remotely and only partial access to the database may be possible.

A full 4 marks could be awarded for a student who argues (in sufficient detail) that remote access, through dial-up lines and an ISP, is inherently insecure and should not be permitted under any circumstances.

4

- (d) Wireless technology, eg. Bluetooth or Airport would allow connection to a network, but this would have to be coupled with some means of connecting to the Internet. This could be through a wireless bridge to the Internet based in the doctor's car but it is more likely that connection would be through a wireless modem or by connecting laptop to mobile phone. Connection to the mobile could also be wireless, eg. infra-red or Bluetooth.

A laptop would not be necessary if a WAP mobile is used. Typical mobile screens are small and mono, but larger, colour screens are appearing which make this application a more attractive proposition. Personal Digital Assistants (PDA) are another possibility. Hybrid PDA/mobile phones are available with Internet capabilities built in or they can work with a mobile phone to provide Internet access.

The equipment is lightweight, easily portable, relatively cheap and easily accessible. The doctor can quickly and easily check medical information, seek a second opinion without having to carry extensive (and bulky?) paper reference sources. Internet based information can be updated regularly, so the doctor has access to accurate information while still with the patient. Alternative diagnosis can therefore be checked while the doctor is there rather than followed up after the visit.

5

Students must describe the features of at least one technology and at least one benefit to gain the full five marks. Otherwise, the marks can be split over features and benefits at the markers discretion.

- (e) (i) Post Office Protocol (POP) was defined to allow computers that are not permanently connected to the Internet to access electronic mail. POP allows email for a user to be stored on a mail server. Emails are stored on this mail server until the user logs on to it (using an ID and password). Once authenticated, all the messages on the mail server for that user are downloaded to the users machine. Copies of the messages may be left on the mail server, but are typically deleted once the download has been successfully completed.

1

1

Note that protocols other than POP could be described but that SMTP is not appropriate in this situation.

- (ii) Using POP the only solution is to leave copies of messages on the mail server until they have been copied onto all the remote machines used by the user. This means that any message still stored on the mail server would be accessible from any other machine. The problem is that the user would have to be very careful to keep the messages on all the remote machines synchronised and to periodically delete or archive old messages from the mail server. The user could also end up with multiple copies of the same message. 5

An alternative solution is to use a different protocol, for example IMAP. This protocol overcomes the problem by maintaining the messages and archive of read messages on the mail server. The email programs on the remote machines communicate with the mail server by tagging messages as read, deleted, etc. The programs on the remote machines download new messages and update the “inbox” etc. as necessary to keep the view of the mailbox on all the machines synchronised. The main disadvantage of this protocol is that it is not supported by all email programs/mail systems.

Another possibility would be to move to a web based mail system such as Hotmail. All messages stay on the mail server at all times and the messages must be explicitly saved to the users local machine if this is required. This has the advantage of making the mail accessible to any machine with an Internet connection and a browser program. It can therefore be used even on public access machines, for example in an Internet café. A disadvantage is that the web interface can be clumsy to use.

*A description of all the solutions listed above is **not** required for the 5 marks. One solution suitably described is sufficient.*

11. (a) (i) All signals transmitted will deteriorate as the distance between nodes increases. A repeater is used to extend the length of the network. All data received by a repeater is retransmitted. In the scenario described, the repeater is used to extend the distance between the Comms Carrier and the laptops in the training hall. As long as the Comms Carrier is within range of the repeater, and the laptops are in the range of the repeater, the laptops can communicate with the file server on the Comms Carrier. 1
- Maximum of 1 mark if no reference is made in the answer to the scenario described in the question.* 1
- (ii) All the computers will require wireless-networking capability eg. Bluetooth or Airport. In addition the fileserver will require some sort of gateway (and firewall?) as well as the wireless hardware. 2
- 1 mark for wireless hardware, 1 mark for additional hardware required at the file server end. Allow flexibility to allow 2 marks for a good description of one.*
- (iii) Data on page = 8 000 + 12 000 + 1 420 000
= 1 440 000 bytes 1
- Nm of packts = 1 440 000 ÷ 1 200
= 1 200 packets 1
- Bytes transmtd = 1200 x 1250
= 1 500 000 bytes 1
- Bits transmitted = 1 500 000 x 8
= 12 000 000 bits 1
- Tr'nsmis's'n time = 12 000 000 ÷ 400 000
= 30 seconds 1
- (iv) Still require to send the same amount of data when the home page is requested, ie
- Bits transmitted = 12 000 000 bits 1
- The wireless network is likely to be set up to send data addressed to individual nodes as they request the information. So the same information will be requested and sent twenty times.
- Tr'nsmis's'n time = 12 000 000 x 20 ÷ 2 000 000
= 120 seconds = 2 minutes 1
- It may be possible to broadcast the data to all 20 laptops at the same time, but unless there was some extremely intelligent software at the file-server end, this is unlikely to happen. If a candidate simply misses out the "x 20" laptops part their answer is wrong. If a candidate offers an explanation involving broadcasting, markers will have to exercise their professional judgement.*

11. (a) (v) Unlikely because of various overheads not stated in the question, e.g. transmission errors and network collisions. 1

Could minimise waiting times by pre-caching the home page on the laptops so that they don't have to fetch from the remote server, or even the file server on the Comms Carrier. 1

Probably even better to reduce the size of the home page in the first place by compressing the graphics and video or eliminating the video altogether. If the video is necessary, perhaps a smaller alternative, e.g. a Flash animation, could be used instead. 1

Local caching may have an impact.

- (b) The network application works at the application level of the model. It handles the transmission and reception of data to/from the lower levels transparently - the user is probably not aware of what is happening at the lower levels.

The top three layers describe application oriented functions. The Application layer is the user application level, e.g. Telnet. The Presentation layer is concerned with the format of the data and the Session layer with dialog between two applications and controls the exchange of data. With Telnet, the distinction between these three layers is not clear cut, for example control characters (escape characters) can be embedded in the data stream.

The Transport and Network layers establishes the connection and handles routing and addressing. With Telnet the relevant protocols for these levels are TCP and IP.

The Data and Physical levels deal with the data transmission and the physical characteristics of this transmission. With telnet this will be defined by the type of Internet connection. For example, if Ethernet is used, Ethernet standards will specify packet size and composition etc. (Data level) and the Physical characteristics of the network connection, e.g. type of cable, voltage level etc.

Application		Network Applications such as ftp, telnet
Presentation		
Session		
Transport		TCP
Network		IP
Data link		Ethernet, Token Ring, FDDI, Modem
Physical		

ISO OSI diagram

There is not an exact fit between the ISO OSI model and current network applications. Applications may amalgamate (or by-pass) some of the models layers or create sub-layers.

The sample answer refers mostly to Telnet, but descriptions of other network applications are acceptable. 7

A straight description of the seven layers with no reference to a network application can gain a maximum of 4 marks.

- (c) Every IP address used by a device connected to the Internet must be unique. With Class B addresses, the first 16 bits identify a specific network and the remaining 16 bits specify a host within that network.

There are therefore 2^{16} possible host numbers for every network, but not every network uses every possible host number. Therefore, many potential IP addresses are “wasted”. 2

{In fact the first two binary digits of a Class B address are always “10”. The maximum for a Class B address is therefore approximately 16 000 x 65 000 - significantly less than 2^{32} even before taking account of “wasted” addresses.}

- (d) (i) The devices are not necessarily to be permanently connected to the Internet (“The devices will be able to be plugged and unplugged from the Internet at any time”). They could be installed in portable devices (a palm top computer is mentioned in the question). A static IP address would not be an efficient use of the finite (and increasingly scarce) number of IP addresses. Much better for the device to use Dynamic Host Configuration Protocol (DHCP) to obtain an address, or to select an address from a range of addresses offered from some other source. 1
1
1

The standard described in the question is a thinly disguised reference to Universal Plug and Play (UPnP). Students should be able to answer this from general knowledge of networking and addressing. If UPnP (or similar system) is mentioned specifically, markers should look for a greater level of detail in the answer before giving the full 3 marks.

- (ii) An obvious extension is to increase the number of bits used in the address, e.g. double the number of bits to 64. This would bring a huge increase in the number of available addresses. *{IPv6 has increased the number of bits per address.}*

Variable numbers of bits could be used to specify the network. This would allow the allocation of numbers to more networks, with fewer hosts on each network. This should reduce the number of “wasted” addresses. *{This is known as Classless Inter-Domain Routing (CIDR) and again IPv6 does this. An address described as 192.168.1.0/22 indicates that the first 22 bits specify the network.}*

Techniques such as Network Address Translation (NAT) allow whole networks to “hide” behind a single IP address. Internally, LAN can use one set of addresses, which are unique within that LAN, but may not be unique on the Internet. A NAT box (an IP gateway) uses a smaller set of unique addresses for external traffic and handles translation between the internal and external addresses.

Various answers are possible. At least one benefit must be described for candidates to gain full marks. 4

Again, markers should perhaps require more detail for full marks from candidates who are clearly familiar with CIDR and IPv6.

(iii) There are various benefits to these solutions. For example allocating more bits to an address means that some bits can be designated for other purposes, eg to specify security levels or signify priority. Classless systems reduce the size of routing tables. NAT techniques can be used to make individual PCs less vulnerable to electronic intruders.

1

(e) (i) *Sample answer:*

JPEG is a compression standard named after the body that defined it - the Joint Photographic Experts Group. It is a “lossy” compression system, ie some data is lost in the compression processes. However, the system is designed so that this loss should not create a noticeable loss of detail to the human eye.

2

Any other standard, briefly described, is acceptable.

(ii) *Sample answer:*

MPEG is a compression standard named after the body that defined it - the Motion Picture Experts Group. It is a “lossy” compression system for moving images.

2

Any other standard, briefly described, is acceptable.

Profile of Questions

Q1	Source Unit	KU	PS / AA
a.	1 a,	6	3
b.	1b	2	
c.	1b	4	
d.	1b, 2b		6
e.	1c	3	
f.	1c	3	3
TOTAL		18	12

Q2	Source Unit	KU	PS / AA
a	1a	4	4
b.i.	1a	1	
ii.	1a	3	3
c.i.	1b, 2	2	
c.ii.	1b, 2		5
d.i.	1 b	4	
ii.	1 b	4	
TOTAL		18	12

Q3	Source Unit	KU	PS / AA
a.i.	1a, 2a	2	
a.ii.	1a, 2a	4	
b.i.	2b	4	
b.ii.	2b	2	2
b.iii.	2b	2	
c.i.	1a, 2c	2	
c.ii.	2d		4
d.i.	3a	3	
d.ii.	3a	2	2
d.iii.	3b		2
e.i.	3a,b	2	
e.ii.	3a,b		2
TOTAL		23	12

Q4	Source Unit	KU	PS / AA
a.i.	1a		1
a.ii.	1a		1
a.iii.	1a		3
a.iv.	1c	6	
b.i.	2a		4
b.ii.	2a		2
b.iii.	2d		4
c.i.	2b	2	
c.ii.	2b	2	
c.iii.	2b	3	
d.i.	2c	2	3
d.ii.	2c	1	3
TOTAL		14	21

Q5	Source Unit	KU	PS / AA
a.	3a	4	
b.	3a		5
c.	3a	3	
d.i.	3a, b	4	4
d.ii.	3b		4
e.	3b		4
f.i.	3b		5
f.ii.	1a	2	
TOTAL		13	22

Q6	Source Unit	KU	PS / AA
ai	1	2	
aii	1	2	
aiii	1	2	
bi	1	2	2
bii	1	2	
biii	1		2
ci	2	1	
cii	2	2	
ciii	2	2	
di	2	2	
dii	2		4
ei	3	3	3
eii	3	2	2
TOTAL		22	13

Q7	Source Unit	KU	PS / AA
ai	2		2
aii	2		3
aiii	2		6
aiv	2		1
av	2		3
b	1	4	
c	1	2	
di	1	1	
dii	1	2	
diii	1		4
ei	3	1	
eii	3	3	3
TOTAL		13	22

Q8	Source Unit	KU	PS / AA
a	3a	3	
b	3b	2	2
c	3c		8
di	3a	2	
dii	3a	2	2
ei	3		3
e.ii.	3	2	2
f.i.		3	
f.ii	3		4
TOTAL		14	21

Q9	Source Unit	KU	PS / AA
a)	1a, 1b, 1d	10	2
b) (i)	3d	2	
b) (ii)	3d		2
b) (iii)	3d		2
c)	3d	2	4
d)	2a, 2c, 2d	4	1
e)	2a, 2c, 2d	2	1
f)	1c, 1d, 3b	1	2
TOTAL		21	14

Q10	Source Unit	KU	PS / AA
a) i - iv	2b, 2d	4	8
b)	1a, b		4
c) (I)	1c, 1d, 2c, 2d		3
c. (ii)	1c, 1d		4
d)	2c		5
e.i.		2	
e.ii.		5	
TOTAL		11	24

Q11	Source Unit	KU	PS / AA
a) i	2b	2	
a) ii	2b	2	
a) iii	1c, 1d, 2c 2d		5
a) iv	1c, 1d, 2c 2d		2
a) v	2c, 2d		3
b)	2a, 2d, 1c	4	3
c)	2c		2
d) i	2a, 2c		3
d) ii	2a, 2c		4
d.(iii)	2a, 2c		1
e) i	2a, 2c	2	
e) ii	2a, 2c	2	
TOTAL		12	23

[END OF MARKING INSTRUCTIONS]