

Comments John Gurd:

A total of 159 candidates sat this examination paper, which set one compulsory question plus two out of three optional questions. The average mark obtained was 60%.

Q1 was compulsory and all 159 candidates answered it, with an average mark of 12.33 out of 20. By far the most common way in which marks were lost was failure to provide an answer to some part of the question. In particular, few answers were presented for parts b) and e). The second most common way in which marks were lost was where an answer only partially addressed the set question.

Q2 was answered by 128 candidates, making it the most popular of the optional questions, with an average mark of 10.91 out of 20. Marks were lost where there was no attempt to explain what a term introduced by the set question meant. For example, few candidates explained what a context switch entailed in their answer to part b). Marks were also lost for answers that only partially addressed the set question. Many candidates lost a mark in part d) because they did not keep proper track of the contents of the ready queue when process A yields the CPU after step 12 (both B and C are ready, but C entered the queue one step earlier than B and so is at the front and should be scheduled first). Few candidates were able to answer part e) fully.

Q3 was answered by 70 candidates, making it the least popular of the optional questions, with an average mark of 11.97 out of 20.

Q4 was answered by 120 candidates with an average mark of 11.97 out of 20. There was some evidence that candidates were running out of time when answering the final parts of this question.

Richard Neville:

Please see the attached pdf.

Section A

1. Operating Systems

5 Short Questions RN

General Feedback Comments

The following general comments are suggested to make your reflection and feedback more readable/succinct and viable for a more general succinct meditation on what you could do to enhance your learning and may be adapt your revision methodology.

First, it is important to reflect on the last lecture RN presented to the cohort; at the end of that lecture a comprehensive set of steps and guidance was presented for revision that students have advised me that they utilise. This was derived from methods students have utilised to revise over the years. The sentiments and guidance in this revision was sometimes given in their own words [the students]; and their own reflection on what worked best for different situations. But, may be it is worth noting that sometimes there can be discrepancies between the student's view of what mark they should have attained and what they actually were awarded. Reflecting on this issue may be it is worth noting and quoting the specific feedback from a student with respect to using the [suggested] self-test (or self-assessment) methodology, they said:

“With regards to the self-assessment questions definitely allowed me to retain and recall large amounts of domain knowledge.

It was especially useful in shorter questions and proved more beneficial than simply re-reading notes in a repetitive manner.”

This is pertinent as without utilising a method like the self-assessment as well as undertaking a number of past exam papers one cannot self-access one's ability to pass the exam or access what mark one may obtain; and it is even more important when one goes into industry as without a good understanding of your own abilities how can you decide which courses to take, either those presented by the company that employs you or by external courses, and hence how can you evolve your personal skill set. You could also assesses where you feel you are in the **The Four stages of Learning (4SoL): or Do you know what you know?**, information on this [4SoL] will be placed on Blackboard 9 soon.

Good companies will encourage you to undertake CPD. Continuing professional development (CPD) or Continuing professional education (CPE) is the means by which people maintain their knowledge and skills related to their professional lives.

One could say that evolving your revision and exam skill at University is, in fact, a form of CPD.

A final point, before getting into the detailed feedback for each question, is to reflect or ask yourself questions such as:

Did I undertake past exam papers? [enough]

Did I undertake a past exam paper –timed? [to get used to the time constraint of a real exam]

Did I develop a self-test (or self-assessment)? and finally

Did you utilise the methodologies presented in RN's exam revision lecture?

One of the recurring points was the advice on diagrams does not seem to be have been noted by many students; hence we repeat it hear: Remember, good – honours grade answer – in the exam – for a question – to maximise marks – should – or you should think of adding A DIAGRAM or a set of diagrams; hence a basic layout of a question answer may be:

- 1) Textual answer;
- 2) Diagram supporting answer [or code snippet]; &
- 3) Full explanation of diagram...

This sort of answer will [may] maximise your marks...

- e) Direct memory access (DMA) is interrupt driven. Given that a processor writes to a disk, utilizing DMA, describe the four-step DMA process for writing data. (2 marks)

1.e

Bookwork (2 marks):

- e) Direct memory access (DMA) is interrupt driven. Given that a processor writes to a disk, utilizing DMA, describe the four-step DMA process for writing data. (2 marks)

The following points should be covered to some degree in the answer:

Answer should cover the 'basic points' and for higher marks put these basic points into context.

A processor writes to a disk; the process can be speeded up utilising direct memory access (DMA).

The 4-steps DMA process is:

- 1) Processor inform the disk DMA I/O - to write data by writing to a command register in the DMA I/O device;
- 2) DMA controller starts write process;
- 3) Process gets on with another work [process] until;

2 marks for an answer that describes and contextualises all four and gives the salient facts in a sensible way; and provides a well-defined set of brief descriptions of each;

1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): Lectures 15 Controlling Input and Output 2.

TOTAL marks (2 marks) [2]

Marker's feedback 1.e.

Pedagogic assessment [criterion]:

The question assesses lecture 17 learning objective 3; 3) Explain what is meant by direct memory access and how it is useful in I/O; as the terms 'direct memory access' are directly related to how a read or write access that does not use the processor is undertaken; using DMA.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to DMA: inform (DMA device to write), command register, (start) write, [processor does other work, finish [DMA], (signal with) interrupt...

Main differentiation that must be clearly evidenced in your answer is you list the four steps explicitly: the four steps must be clearly delineated; your description of each step must include terms like: inform [DMA (controller) to write data]; [DMA] starts [write process], [processor] gets on with other process; [DMA] finishes; [signal by] interrupting CPU.

The question's answer should clearly evidence knowledge of required salient facts relating to the steps involved; this was not done explicitly in some of the answers given – as the terminology (keywords and naming conventions) given above was not used. If the answers did not detail the differences [for each step] plainly as stated in the above (and in the Example answer); for example answer gives evidence of knowledge of required salient facts, full marks were not awarded.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- f) There are two major methods for implementing virtual memory; one is paged virtual memory. Explain the paged virtual memory procedure. (2 marks)

1.f

Bookwork (2 marks):

- f) There are two major methods for implementing virtual memory; one is paged virtual memory. Explain the paged virtual memory procedure. (2 marks)

The following points should be covered to some degree in the answer:

1. The processor generates a logical address;
2. The page number field is used by the MMU to look to see whether the page is in memory or not;
3. If it is in memory, a physical address is computed by replacing the page number with the page frame number of where the page can be found
4. Together with the offset this is used as a physical address to memory; and
5. If it is not in memory, the transfer is aborted (page fault) and the operating system will load the page from disk to memory.

2 marks for an answer that depicts all the salient facts in a sensible way; and correctly delineated and briefly described;

1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): Lecture 11: Virtual Memory (1).

TOTAL marks (2 marks) [4]

Marker's feedback 1.f.

Pedagogic assessment [criterion]:

Marker's feedback

The question assesses lecture 11 learning objectives 1, 2, & 3 [each to some degree]; Explain what is meant by a paged virtual memory system; Determine the structure of an address in a

paged virtual memory system; & Establish the outcome of memory references (specified by address) for a paged virtual memory system with a specific page table; as the terms ‘physical address,’ & ‘generating a physical memory address,’ are directly related to explaining how to calculate the physical page address and explicitly explain the process.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to calculating [looking up] the page frame number in the page table: page number, logical address, page table, page frame number, relative address [within the frame]. In the context of the process of generating the page frame [given the page number and relative address]: [processor] generate logical address, [check] page number [in memory], [if so] compute page frame [number], [if not] throw page fault, [then] load page [from memory].

Main differentiation that must be clearly evidenced in your answer is that: i) the diagram and text [diagrammatic and textual answer] states the correct page frame – meta data that would be helpful to you is the use of symbols: ‘p’ (page number), ‘o’ (page offset), ‘i’ (page iframe). The other [in respect to a full, concise description of the process] is to state all four steps utilising all [in the correct context] the correct terminology (keywords and naming conventions).

The question’s answer should clearly evidence knowledge of required salient facts relating to the calculation process of the page frame (and page offset) and the process; this was not done explicitly in some of the answers given. If the answers did not detail the differences plainly as stated in the above (and in the Example answer); e.g. answer gives evidence of knowledge of required salient facts, full marks were not awarded.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- g) Given a page table is to translate the page number and page offset (in the virtual memory) to a page frame and page offset (in the physical memory) and the partial view of the page table is:
- [...]
 [07, 00]
 [06, xx]
 [05, 03]
 [04, 02]
 [...]
 given [X, Y] = [page number, page offset].
- i) Calculate the page frames and page offsets given the page numbers and page offsets, to be sequentially translated, are: [07, 06] and [06, 01]; (1 mark)
- ii) Then state which page translation [07, 06] or [06, 01] caused a *page fault*; also briefly state what happens: “if the page is not in memory”. (1 mark)

1.g.

Application (2 marks).

Example answer:- The following points should be covered to some degree in the answer:

Note the short forms and symbols used in lectures were: 'p' (page number), 'o' (page offset), 'i' (page frame).

- i) State the page frames and page offsets given the page numbers and page offsets are: [07, 06] and [06, 01]:

[page number, page offset] -> [page frame, page offset]; [p, o]->[i, o]:

[07, 06] -> [00, 06]

[06, 01] -> [,] no page frame allocated to page number 06

(1 mark)

- ii) Then state which page translation [07, 06] or [06, 01] caused a *page fault*; also briefly state what happens: "if the page is not in memory":

Page number 06 causes a *page fault* as: [06, 01] -> [,] no page frame allocated to page number 06.

IF the page is not in memory THEN the transfer is aborted (page fault) and the operating system will load the page from disk to memory.

(1 mark)

2 marks for a totally correct part i & ii; and explicit concise explanation for second part of ii.

1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): 11; Memory Management (1).

TOTAL marks (2 marks) [6]

Marker's feedback 1.g.

Pedagogic assessment [criterion]:

Marker's feedback

The question assesses lecture 11 learning objectives 1, 2, & 3 [each to some degree]; Explain what is meant by a paged virtual memory system; Determine the structure of an address in a paged virtual memory system; & Establish the outcome of memory references (specified by address) for a paged virtual memory system with a specific page table; as the terms 'physical address,' & 'generating a physical memory address,' are directly related to explaining how to calculate the physical page address and explicitly explain the process.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: page, translation, fault, not, [in], memory, number, page, frame, allocated, transfer, aborted, operating, system, load, from, disk, memory.

Main differentiation that must be clearly evidenced in your answer is that: i) the diagram and text [diagrammatic and textual answer] states the correct page frame – meta data that would be helpful to you is the use of symbols: 'p' (page number), 'o' (page offset), 'i' (page frame).

The other [in respect to a full, concise description of the process] is to state all four steps

utilising all [in the correct context] the correct terminology (keywords and naming conventions).

The question's answer should clearly evidence knowledge of required salient facts relating to the calculation of the page frame (and page offset) and the process; this was not done explicitly in some of the answers given. If the answers did not detail the differences plainly as stated in the above (and in the Example answer); e.g. answer gives evidence of knowledge of required salient facts, full marks were not awarded.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- h) State how to avoid external fragmentation. Your answer should include a brief description of the solution and a diagram supporting your description – which explicitly covers the 'before' and 'after' scenarios. (2 marks)

1.h

Bookwork and Diagrammatic depiction (2 marks).

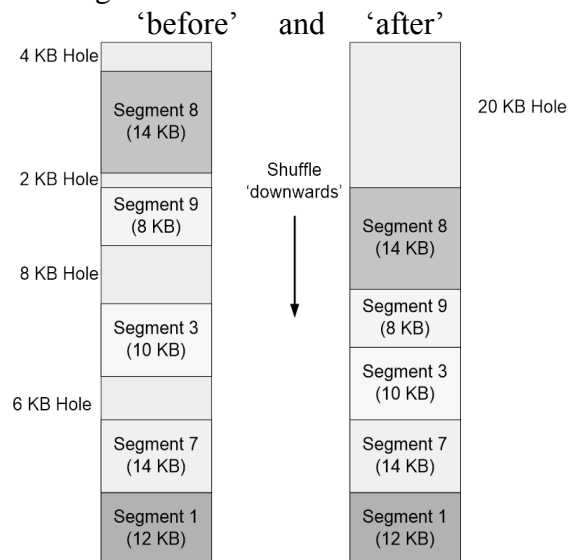
h) State how to avoid external fragmentation. Your answer should include a brief description of the solution and a diagram supporting your description – which explicitly covers the ‘before’ and ‘after’ scenarios. (2 marks)

Example answer:- The following points should be covered to some degree in the answer:

The process is termed shuffling.

Compact the memory by shuffling segments in memory to fill the holes.

External Fragmentation can occur, where memory space is wasted due to holes in the physical memory. Shuffling requires extensive copying of data and is excessively time consuming.



2 marks for a totally correct explicit delineation of the process using keywords in context – plus a complete – well drawn – and labelled diagram.

1 mark for some basic table (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): 12; Virtual Memory (2) Segmented Virtual Memory.

TOTAL marks (2 marks) [8]

Marker's feedback 1.h.

Pedagogic assessment [criterion]:

The question assesses lecture 12 learning objective [LO's]; General information related to Virtual Memory (2); Segmented Virtual Memory.

The question's answer should clearly evidence knowledge of required salient facts

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: Compact, memory, 'shuffling,' segments, fill holes.

Well done most of you were correct and did [correctly] ascertain that compaction [using shuffling] was the method utilised; if this was explained well [with correct terminology] full marks were awarded.

However, if the answer was fuzzy [either grammatically or in the technical sense], or not concise, and did not utilise the correct technical terminology marks would not have been awarded.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- i) What does the dirty bit indicate. State how it is utilised. (2 marks)

1.i

Bookwork (2 marks),

- i) What does the dirty bit indicate. State how it is utilised. (2 marks)

Example answer:- The following points should be covered to some degree in the answer:

The dirty bit indicates when the memory has been modified. The dirty bit is a status bit which marks the block that has been modified. Set if the page is written to (or dirty). The dirty is utilised when a page (or segment) is replaced – ejected or removed from physical memory – if it is set the page (or segment) must be written back to secondary memory (or hard disk) prior to its replacement. While if the dirty bit is clear (= “0”) the location can be overwritten – without a write back cycle being performed.

2 marks for a totally correct using keywords in context and explicit description including good explanation of utilisation,

1 mark for some basic table (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): 11 & 12, Virtual Memory (1 & 2), Paged (and segmented) Virtual Memory.

TOTAL marks (2 marks) [10]

Marker's feedback 1.i.**Pedagogic assessment [criterion]:**

The question assesses lecture 11 learning objective [LO's]; General information related to Virtual Memory (2); Segmented Virtual Memory.

The question's answer should clearly evidence knowledge of required salient facts.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: indicates, memory, modified, status, marks, block, modified, set, written, dirty, page (or segment), replaced, ejected, removed, physical, written, back, secondary, hard disk, prior, replacement, clear (= "0"), location, overwritten, without, write back, cycle, performed.

Well done most of you were correct and did [correctly] ascertain that compaction [using shuffling] was the method utilised; if this was explained well [with correct terminology] full marks were awarded.

However, if the answer was fuzzy [either grammatically or in the technical sense], or not concise, and did not utilise the correct technical terminology marks would not have been awarded.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

Section B

3.

- a) In the context of converting an address generated by a program [a compiler] to the actual address; state:
 - i) The names of the two memories involved; and (1 mark)
 - ii) The unit that performs [undertakes] this translation process. (1 mark)

3.a.

Bookwork (2 marks).

- a) In the context of converting an address generated by a program [a compiler] to the actual address; state:
- i) The names of the two memories involved; and (1 mark)
 - ii) The unit that performs [undertakes] this translation process. (1 mark)

Example answer:- The following points should be covered to some degree in the answer:

In the context of converting an address generated by a program [a compiler] to the actual address:

- i) The names of the two memories involved are:

- a. Virtual memory; and
- b. Physical memory.

- ii) The unit that performs [undertakes] this translation process is the:
This process is undertaken by the MMU (Memory management unit).

2 marks for an answer that mentions all the salient facts in a sensible way (2 marks for a clear, correct answer, 1 mark for a 'right lines' solution),
1 mark for correct answer but not detailed [enough].

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): Lecture 11: Memory Management (1).

TOTAL marks (2 marks) [2]

Marker's feedback 3.a.

Pedagogic assessment [criterion]:

The question assesses lecture 11 learning objective [LO's]; General information related to Virtual Memory (2); Segmented Virtual Memory.

The question's answer should clearly evidence knowledge of required salient facts.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: virtual, physical, memory, translation, process, the MMU, Memory management unit.

Well done most of you were correct and did [correctly] ascertain that compaction [using shuffling] was the method utilised; if this was explained well [with correct terminology] full marks were awarded.

However, if the answer was fuzzy [either grammatically or in the technical sense], or not concise, and did not utilise the correct technical terminology marks would not have been awarded.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- b) To address the question: “given a single user program where does it fit in memory?” State the steps an operating system take to load a single user program into memory; given this is uniprogramming. (5 marks)

3.b.

Application (5 marks).

- b) To address the question: “given a single user program where does it fit in memory?” State the steps an operating system takes to load a single user program into memory; given this is uniprogramming. (5 marks)

Example answer:- The following points should be covered to some degree in the answer:

OS like KOMODO or original MSDOS undertake the following steps when a program is loaded into memory:

- 1) OS given a file name;
- 2) Loads it from disc;
- 3) Jumps to start of program;
- 4) Executes the program; may do I/O etc. via OS;
- 5) Returns to OS when done.

5 marks for a totally correct content – all five issues covered comprehensively,

3 marks for all issues covered – NOT comprehensively [though].

2 marks for half issues covered,

1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): 10; Memory Management (1).

TOTAL marks (5 marks) [7]

Marker’s feedback 3.b.

Pedagogic assessment [criterion]:

Marker's feedback

The question assesses lecture 10 learning objectives 1, 2, & 3 [each to some degree]; 1.

Describe the role of the memory allocation in an OS; 2. State where a simple single program fit in memory; and 3. Discuss the issues with a single program.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: operating, system, given, file, name, Loads, from, disc, Jumps, start, program, Executes, I/O, returns, done.

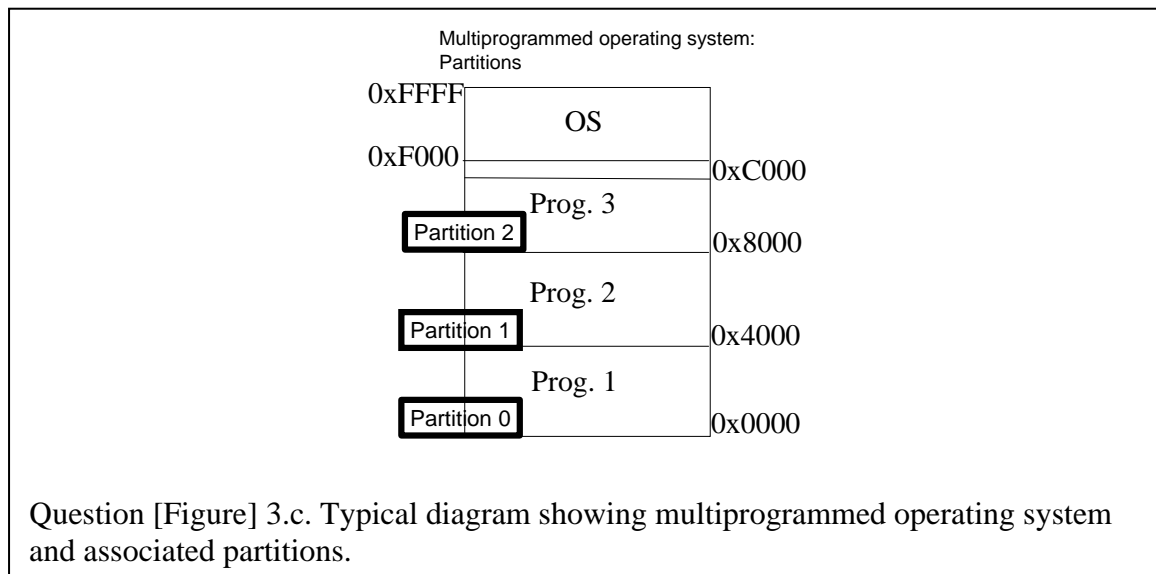
Main differentiation that must be clearly evidenced in your answer is that: i) the list and text [correct terminology] states the steps – in correct sequence. The other [in respect to a full, concise description of the process] is to state all five steps utilising all [in the correct context] the correct terminology (keywords and naming conventions).

The question's answer should clearly evidence knowledge of required salient facts relating to the calculation of the page frame (and page offset) and the process; this was not done explicitly in some of the answers given. If the answers did not detail the differences plainly as stated in the above (and in the Example answer); e.g. answer gives evidence of knowledge of required salient facts, full marks were not awarded.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- c) With respect to multiprogramming, and the diagram in figure 3.c., state the following:
 - i) How many programs can be loaded into the partitions in figure 3.c? (1 mark)
 - ii) What operation does the operating system perform when all partitions are full and no more programs need to be loaded? (1 mark)
 - iii) What does the operating system normally do when a program performs an I/O operation? (1 mark)
 - iv) What happens when one of the programs finishes? (1 mark)



3.c.

Application of your knowledge - Bookwork (4 marks).

- i) How many programs can be loaded into the partitions in figure 3.b?(1 mark)

Example answer:- The following points should be covered to some degree in the answer:

The OS can load multiple programs; in this case it can load a maximum of 3 programs to fill all three partitions.

- ii) What operation does the operating system perform when all partitions are full and no more programs need to be loaded? (1 mark)

Example answer:- The following points should be covered to some degree in the answer:

When 3 programs are running in a multiprogramming [fixed Partition] system – the OSs function it to switch between them – or time division multiplex – or context switch at regular intervals.

- iii) What does the operating system normally do when a program performs an I/O operation?(1 mark)

Example answer:- The following points should be covered to some degree in the answer:

When a program performs an I/O operation the OS will switch to another program – as I/O operations are slow.

- iv) What happens when one of the programs finishes? (1 mark)

Example answer:- The following points should be covered to some degree in the answer:

When one of the programs finishes the OS brings in a new program; into the same partition that was vacated by the program that has just finished.

4 marks for a totally correct content, and all issues addressed comprehensively;

3 marks for three-quarters of the issues covered, and issues addressed comprehensively;

2 marks for half issues covered, and issues addressed comprehensively;

1 mark for some basic knowledge (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): 10; Memory Management (1).

TOTAL marks (4 marks) [11]

Marker's feedback 3.c.**Pedagogic assessment [criterion]:**

The question assesses lecture 10 learning objective 4; explain multiprogramming [and fixed partitions]; as the terms 'multiprogramming' and 'fixed' partitions are directly related to the methodology, used in the past, to load multiple programs into memory.

Background: These multiprogramms are placed in memory; the naming convention used for the area of memory they were placed in is a 'partition.' It is essential in your answer that you made it explicit that these partitions are 'fixed partitions' as opposed to variable [in size]; [variable partitions are discussed further on in the lecture series]...

The number of pages (3) should be correctly stated. Clear statement that the OS basically then runs the programs in memory one after the other – using appropriate terminology – in the explanation. States that I/O in one program initiate context switching to another program [in memory]. When a program has finished executing – it is replaced by another – that program partition is reassigned to a new program.

The question's answer should clearly evidence knowledge of required salient facts relating to the terms multiprogramming and fixed partitions.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example, with respect to Multiprogramming: [different from] uniprogramming, [different from] single program, runs a number of programs, concurrently, programs are loaded [into memory], loaded in to primary [memory], loaded into physical [memory], [the OS] switches [between them], [switches at] regular intervals. With respect to fixed partitions: fixed size, memory divided, partitions fixed in size.

Main differentiation that must be clearly evidenced in your answer is that: the FULL names of the two items involved are explicitly stated. In the context of your answer to the multiprogramming it must be made clear that it is a technique for regularly [context] switching between multiple programs. Whereas fixed partitions are memory locations that are of fixed size.

Full marks were only awarded if the points above (and in the Example answer) evidence knowledge of required salient facts were explicitly in your answer.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- d) Describe in detail how a 'segment' is loaded. (5 mark)

3.d

Bookwork (5 marks).

d) Describe in detail how a 'segment' is loaded. (5 mark)

Example answer:- The following points should be covered to some degree in the answer:

Description of the segmentation process; or how a 'segment' is loaded; this works in almost exactly the same way as paged virtual memory:

1. The processor generates a logical address.
2. The segment number field is used by the MMU (memory management unit) to look to see whether the segment is in memory or not, then:
3. If it is in memory, a physical address is computed by adding the base address of the segment to the offset; this is used as a physical address to memory; or
4. If it is not in memory, the transfer is aborted (segment fault); and then the operating system will load the segment from disk to memory.

5 marks for a concise description of complete segmentation loading process,

2 ½ marks for half issues covered,

1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): 12; Virtual Memory (2) Segmented Virtual Memory.

TOTAL marks (5 marks) [16]

Marker's feedback 3.d.

Pedagogic assessment [criterion]:

The question assesses lecture 12 learning objective [LO's]: 1. Explain what is meant by segmented virtual memory.

The question's answer should clearly evidence knowledge of required salient facts.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example:

processor, generates, logical, address, segment, number, field, MMU (memory management unit), in [memory], not (in [memory]), physical, adding, base, offset, transfer, aborted, segment, fault), disk, memory.

ALSO related issues and keywords are: Segments, dividing [up], virtual address space, support, management, execution, multiple processes, operating system.

Well done, a number of you were correct and delineated correctly the main rationale [in many books and the lectures] that stated "how a 'segment' is loaded," if you put this in a

concise sentence, and used all the correct technical terminology, you were awarded full marks.

Those whom did not write down the full set of salient facts were marked accordingly; see template answer.

Some [answers] were not detailed enough – and did not use the correct naming conventions [or terminology] in context to state how segmented virtual memory support the management of the execution of multiple processes in an operating system; and hence marks were not awarded.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- e) Given a physical address size of 2G and associated 64K block size. Calculate the number of page frames in the physical address space. NOTE: To gain full marks you must show full working. (2 marks)

3.e.

Application (2 marks).

- e) Given a physical address size of 2G and associated 64K block size. Calculate the number of page frames in the physical address space. NOTE: To gain full marks you must show full working. (2 marks)

Example answer:- The following points should be covered to some degree in the answer:

Virtual address space 2GB and block size 64KB.

If the virtual address space is 2 GB and the page size is 64 KB there are:

$$\text{Number of Page frames} = \frac{\text{Address space}}{\text{Block size}}$$

$$\frac{2G}{64K} = \frac{2,147,483,648}{65,536} = \frac{2^{31}}{2^{16}} = 2^{31-16} = 2^{15} = 32,768 \approx 32k \text{ page frames}$$

2 marks for an answer that calculates the correct answer and is laid out correctly e.g.

2 marks for a correct answer and full working out,

1 mark for a ‘right lines’ approach. Moderate marks will be awarded in the case of correct application for a wrongly calculated.,

½ marks for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s).: 11; Virtual Memory (1).

TOTAL marks (2 marks) [18]

Marker’s feedback 3.e.

Pedagogic assessment [criterion]:

The question assesses lecture 11; Virtual Memory (1) learning objective 1 and 2 directly; 1.

Explain what is meant by a paged virtual memory system; 2. Determine the structure of an address in a paged virtual memory system.

Well done, the majority of you were able to first: 1. remember the equation (address space divided by block size); second 2. substitute the correct numbers form address space and page size; third 3. convert these to power of 2; fourthly 4. utilise the mathematical norm for dividing power (i.e. subtract the power of two of the page size [the divisor] from the power of two of the address space [the dividend]); fifth 5. convert the resultant answer (which is a power of 2) in to an integer number – this is the number of pages frames. If you undertook 1 to 5 and at each stage attained the correct answers – you will have been full marks – if not full marks could not be awarded.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: address space, & block size.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- f) Given a 4G address spaces and associated 16K page sizes; calculate the number of pages that result in the virtual address space. NOTE: To gain full marks you must show full working. (2 marks)

3.f.

Application (2 marks).

- f) Given a 4G address spaces and associated 16K page sizes; calculate the number of pages that result in the virtual address space. NOTE: To gain full marks you must show full working. (2 marks)

Example answer:- The following points should be covered to some degree in the answer:

Given a block [page] size of 16 KB and a physical address space of 4 GB.
If the virtual address space is 4 GB and the block size is 16 KB there are:

$$\text{Number of Pages} = \frac{\text{Address space}}{\text{Page size}}$$

$$\frac{4G}{16K} = \frac{4,294,967,296}{16,384} = \frac{2^{32}}{2^{14}} = 2^{32-14} = 2^{18} = 262,144 \approx 262k \text{ page frames}$$

2 marks for an answer that calculates the correct answer and is laid out correctly e.g.
2 marks for a correct answer and full working out,
1 mark for a 'right lines' approach. Moderate marks will be awarded in the case of correct application for a wrongly calculated.

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): 11; Virtual Memory (1).

TOTAL marks (2 marks) [20]

Marker's feedback 3.f.

Pedagogic assessment [criterion]:

The question assesses lecture 11; Virtual Memory (1) learning objective 1 and 2 directly; 1. Explain what is meant by a paged virtual memory system; 2. Determine the structure of an address in a paged virtual memory system.

Well done, the majority of you were able to first: 1. remember the equation (address space divided by page size); second 2. substitute the correct numbers form address space and page size; third 3. convert these to power of 2; fourthly 4. utilise the mathematical norm for dividing power (i.e. subtract the power of two of the page size [the divisor] from the power of

two of the address space [the dividend]); fifth 5. convert the resultant answer (which is a power of 2) in to an integer number – this is the number of pages. If you undertook 1 to 5 and at each stage attained the correct answers – you will have been full marks – if not full marks could not be awarded.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: address space, & page size.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

4.

a) Draw up a table that lists:

- 1) Page Replacement policy name; and
- 2) Brief description of how the policy works.

In the table describe three policies: First in First Out; Least Recently Used; and Not Recently Used. (5 mark)

4.a

Bookwork (5 marks):

- a) Draw up a table that lists:
- 1) Page Replacement policy name; and
 - 2) Brief description of how the policy works.
- In the table describe three policies: First in First Out; Least Recently Used; and Not Recently Used. (5 mark)

The following points should be covered to some degree in the answer:

Policy name	Description of how the policy works
First in First Out	“Based on the theory that the best page to remove is the one that has been in memory the longest.” The First in First Out policy identifies the oldest page in real memory and get rid of that; they can be tagged with a sequence number.
Least Recently Used	“Policy chooses the pages least recently accessed [referenced] to be swapped out.” The least recently used works on temporal locality principle. It infers that if something has been used recently then it probably will be again - and the converse. The simplest implementation is to associate a timestamp counter (may need 64 bits) with every page, updated whenever the page is accessed.
Not Recently Used	“Replace the page which is <i>not used recently</i> .” Recently used pages kept in memory; this infers not recently used pages replaced. The R and M bits in a page table are used: The R bit set when referenced; and The M bit set when modified (written to).

6 marks for an answer that depicts all the salient facts in a sensible way; and the use of keywords in context; also describing all three in detail;

3 marks for an answer that depicts a proportion of the salient facts in a sensible way; and the use of some keywords in context;

1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s).: Lectures 13: Virtual Memory (3).

TOTAL marks (5 marks) [5]

Marker’s feedback 4.a.

Pedagogic assessment [criterion]:

The question assesses lecture 13 learning objective [LO’s]; 1. Discuss the concept of ‘Page Replacement;’ 2. Differentiate between First in First Out (FIFO) and Least Recently Used (LRU); 3. Explain Not Recently Used (NRU).

The question’s answer should clearly evidence knowledge of required salient facts.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example:

best, page, remove, memory, longest, First in First Out, policy, oldest, tagged, sequence number, least, recently, accessed, referenced, swapped, out, temporal locality principle, timestamp, counter, 64 bits, updated, accessed,

replace, not used recently, recently used pages, kept in memory, replaced, R, M, page, table, referenced, modified, written to.

Most [students], correctly wrote a brief description as covering all three – no reason full marks were not awarded – if full concise descriptions – covering all issues – were given – in good plain English.

Marks were not awarded if:

- 1/ only one (or two) were correctly described;
 - 2/ All were described, but the functions they performed were not explicitly presented to meet the questions “describe the policies” requirement;
 - 3/ fuzzy grammar or technical description was given;
 - 4/ correct [technical] terminology was not used in your description of these functions.
- ... then marks were not awarded; or if the English description was not constructed well and put in plain English and good grammar was not used.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

- b) Given a keyboard sends characters into the computer system. Name and describe the two registers normally used to undertake this process. (5 marks)

4.b.

Bookwork & Critique [Differentiate] (5 marks):

- b) Given a keyboard sends characters into the computer system. Name and describe the two registers normally used to undertake this process. (5 marks)

The following points should be covered to some degree in the answer:

The name of the first is the Status register.

The Status register indicates the status of the I/O device.

In our simple example, assuming that only one bit in the status register is used (bit 0) and the other 7 bits have the value 0. Bit 0 has two states:

If bit 0 is set to '1', a character has been typed and its value is in the data register; and
If bit 0 is cleared to '0', no character has arrived since the last time the processor read from the data register.

The name of the second is the Data Register.

The Data Register holds the 'value' of the character typed at the keyboard.

Characters are encoded using numeric schemes, an 8-bit scheme is called ASCII, and each of the 256 possible ASCII characters has an 8-bit code.

ASCII is gradually being superseded by the 16-bit Unicode standard [1] – used in Java. So the word "Hello" would be encoded as the sequence (decimal) 72-101-108-108-111.

5 marks for an answer that depicts all points, and the use of keywords in context;

3 marks for half of the facts;

1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): Lectures 14: Controlling Input and Output 1.

TOTAL marks (5 marks)[10]

Marker's feedback 4.b.

Pedagogic assessment [criterion]:

The question assesses lecture 14 learning objective [LO]: Explain in simple terms how a processor interacts with an I/O device; and State what is meant by programmed I/O; Simple I/O devices utilise the status and data register for 'processor interacts.'

The question's answer should clearly evidence knowledge of required salient facts.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: **status** register [interrogated]; checking if one set; bit 0 is 0, there is no character to read; bit = 1, there is a character to read; Read character from data register; Stored in main memory; clear the status register's bit 0 to 0.

Well done most of you covered the majority of the seven points in the template answer; and as such were awarded the appropriate marks.

Where marks were NOT awarded it was due to [not mentioning or stating or not utilising]:

- 1/ not utilising the correct [appropriate] technical terminology or naming conventions;
- 2/ not specifying [explicitly] stating the state ['0' or '1'] of the bits in the status register, when different events happen (and what each means);
- 3/ stated addresses were not explicitly stated [utilises] in the answer, reference template answer.
- 4/ what finally happens to the status register bit, once the data register is read; and
- 5/ really, the marks were explicitly given [awarded] for an explicit [technically correct] answer; as it states [explicitly] in the question; this was a real hint to be verbose and not brief.

If you covered all [or most] the points then full marks were awarded. However if the answer did not utilise the correct keywords in context, and did not show you exercised your academic knowledge in this domain issue by not covering most of the issues full marks could not be awarded.

This theory of the three areas was covered in the lecture series in three different audio visual medias: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.