Comments

John Gurd:

188 candidates sat the examination this year. The average mark was 57.53%.

The compulsory questions, A1 and B1 were answered by 188 and 183 candidates, respectively. For question A1, the best mark was 9/10, the worst mark was 1/10 and the average mark was 5.05/10. For question B1, the best mark was 10/10, the worst mark was 1/10 and the average mark was 5.60/10. Marks were mostly loss for partial or imprecise answers. Detailed feedback for question B1 has been provided separately by Richard.

Question A2 was answered by 108 candidates. The best mark was 17/20, the worst mark was 1/20 and the average mark was 10.03/20. Marks were mostly lost because of non-existent or poor answers to parts e), f) and g) of the question. For the second year in succession, this strongly suggests that many candidates did not revise the material covering the structure and operation of the file manager (lecture 16).

Question B2 was answered by 173 candidates. The best mark was 20/20, the worst mark was 2/20 and the average mark was 13.61/20. Detailed feedback for this question has been provided separately by Richard.

Question B3 was answered by 99 candidates. The best mark was 20/20, the worst mark was 1/20 and the average mark was 11.47/20. Detailed feedback for parts a), b) and c) has been provided separately by Richard. For part d), I identified 12 key points from the model answer and simply counted how many of these were mentioned in each answer. No-one mentioned all 12, but there were several answers that mentioned 11 and thereby obtained full marks. Many answers mentioned only 5 or 6 of the points and so obtained only half marks. Given its crucial importance, I was surprised how few candidates thought to mention that the operation of both P() and V() must be atomic. Marks for part e) reflected how well each candidate understood the underlying principles.

Please see the following pages for Richard Neville's feedback.

Section B

Operating Systems

Approximate number of students who undertook B2 was 172..

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] is on Blackboard 9.

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 undertaking past exam papers? [enough]
Did I undertaking 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…

B1.a) What is a page replacement algorithm? (2 marks)

B1.a)

Bookwork (2 marks):

a) What is a page replacement algorithm? (2 marks)

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

In a virtual memory, the memory space is divided into pages. There are normally more pages than can fit into the real (RAM) memory of the system and thus some pages are held on background storage to be moved into main memory only when the CPU wants to access them. When a page needs to be moved into main memory, it is necessary to decide which page to reject to make space for it. The page replacement algorithm is used to make the decision of which page to reject.

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 13 Virtual Memory (3).

TOTAL marks (2 marks) [2]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses Lectures 13 Virtual Memory (3); what is a page replacement algorithm?
The question's answer should clearly evidence knowledge of required salient facts relating to "what is a page replacement algorithm?"

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to page replacement algorithm: virtual memory, divided, pages, real, RAM, memory, system, background storage, main, memory, CPU, access, reject, make space, make the decision, which page to reject; plus all those underlined in template answer in box above.

Main differentiation that must be clearly evidenced in your answer is you must describe the algorithm explicitly: the algorithm must be clearly delineated [explained]; your description of the algorithm must include terms like the one in the list of keywords above.
The question's answer should clearly evidence knowledge of required salient facts relating to "what is a page replacement algorithm?"; this was not done explicitly in some of the answers given – as the terminology (keywords and naming conventions) given above were not used.
If the answers did not detail the differences [in each phase of the algorithm or its us] plainly

as stated in the above (and in the Example answer); if for example the answer does not 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 "what is a page replacement algorithm?" was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

B1.b) In the context of operating systems; what is meant by the term programmed I/O? Give a brief answer; with respect to a keyboard I/O device – flowcharts are not required. (2 marks)

B1.b)

Bookwork (2 marks):

b) In the context of operating systems; what is meant by the term programmed I/O? Give a brief answer; with respect to a keyboard I/O device – flowcharts are not required. (2 marks)

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

The processor periodically polls the status of the I/O device checking on whether a data transfer should be made.

In this case, the programmed I/O code is periodically called by the controlling program.

If a character has been typed, it is read and placed in memory.

If character has not been typed, the programmed I/O code exits and the processor can get on with useful work.

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).: Lectures 14 Controlling Input and Output 1.

TOTAL marks (2 marks) [4]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses lecture 17 learning objective 3; what is meant by the term programmed I/O?
The question's answer should clearly evidence knowledge of required salient facts relating to "what is meant by the term programmed I/O?"

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to what is meant by the term programmed I/O?: processor, periodically, polls, status, I/O device, checking, data, transfer, programmed I/O, controlling, character, typed, read, placed, memory, exits; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer is you description should mention all the issues explicitly: the issue must be clearly delineated; your description of each issue must include the keywords mentioned above but placed in context.

The question's answer should clearly evidence knowledge of required salient facts relating to "what is meant by the term programmed I/O?"; 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); if for example the answer does not 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 "what is meant by the term programmed I/O?" was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

B1.c) An input/output (I/O) module in a computer system has a Direct Memory Access (DMA) interface. Explain what the DMA interface does.

(2 marks)

B1.c)
Application, critique (2 marks),

c) An input/output (I/O) module in a computer system has a Direct Memory Access (DMA) interface. Explain what the DMA interface does. (2 marks)

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

The DMA interface will transfer blocks of data between the I/O module and memory over the system bus without intervention from the processor.
A DMA device is capable of reading from or writing directly to memory in the same way as a processor does.
It is optimised for transferring blocks of data into the memory system.
In our example of reading from a disk, the DMA will handle the transfer of a whole block of data without processor intervention.

2 marks for a totally correct; and explicit concise explanation, should mention: relevant information.
1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s).: 15; Controlling Input and Output 2.
TOTAL marks (2 marks) [6]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses 15; Controlling Input and Output 2; Explain what the DMA interface does.
The question's answer should clearly evidence knowledge of required salient facts relating to "Explain what the DMA interface does?"

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to explaining what the DMA interface does: transfer, blocks, data, between, I/O module, memory, system, bus, intervention, processor, reading, writing, block, without, intervention; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer is you Explain what the DMA interface does explicitly: the issues must be clearly delineated; your description of each issues should include the keywords – mentioned above – but putting all keywords in context.

The question's answer should clearly evidence knowledge of required salient facts relating to explaining what the DMA interface does; 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 issue] plainly as stated in the above (and in the Example answer); if for example the answer does not 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 that explained what the DMA interface does was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

B1.d) One method for implementing virtual memory is paged virtual memory. This procedure can be viewed as a sequence of steps. Explain the paged virtual memory procedure, by outlining the sequence of steps for translating a virtual address to a physical address. (2 marks)

B1.d)
Bookwork and analysis (2 marks),

d) … Explain the paged virtual memory procedure, by outlining the sequence of steps for translating a virtual address to a physical address.. (2 marks)

Example answer:- 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 a totally correct explicit delineation of the process using keywords in context – plus a complete – well presented – description.
1 mark for some basic table (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) [8]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses Lecture(s) No(s).: 11; Virtual Memory (1); Explain the paged virtual memory procedure, by outlining the sequence of steps for translating a virtual address to a physical address…
The question's answer should clearly evidence knowledge of required salient facts relating to "Explain the paged virtual memory procedure, by outlining the sequence of steps for translating a virtual address to a physical address."

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to Explaining the paged virtual memory procedure, by outlining the sequence of steps for translating a virtual address to a physical address.:

processor, generates, logical, address, page, number, field, MMU, memory, not, physical, replacing, frame, can, be found, offset, not, transfer, aborted, page fault, operating system, load. disk; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer is explaing the paged virtual memory procedure, by outlining the sequence of steps for translating a virtual address to a physical address explicitly: the issue must be clearly delineated; your description of each issues must include the keywords mentioned above.
The question's answer should clearly evidence knowledge of required salient facts relating to explaining the paged virtual memory procedure, by outlining the sequence of steps for translating a virtual address to a physical address; 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 issue] plainly as stated in the above (and in the Example answer); if for example the answer does not 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 relating to explaining the paged virtual memory procedure, by outlining the sequence of steps for translating a virtual address to a physical address was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

B1.e) Contrast what is meant by the terms *multiprogramming* and *fixed partitions*. (2 marks)

B1.e)
Bookwork (2 marks),

e) Contrast what is meant by the terms *multiprogramming* and *fixed partitions*. (2 marks)

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

Multiprogramming:
Multiprogramming has been used in the past; to differentiate from an operating system (OS) running a single program [or Uniprogramming] and one that runs a number of programs concurrently (or multiprogramming).
The OS must first load the multiple programs (into memory [primary {physical} memory]).
The OS will then switch between them [the different programs]; this may be due to the program requiring I/O, or at regular intervals the OS will switch to another of the other programs.
When one of the programs is finished the OS bring in a new one.

Fixed partitions:
Fixed partition divides memory into fixed size blocks.
Fixed partitioning: involved partitioning the available primary memory into a number of regions with each region having a fixed size. The sum of the sizes of all regions [plus that used by the OS itself] equals the size of the primary memory.

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).: 10, Virtual Memory (1).

TOTAL marks (2 marks) [10]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses Lecture(s) No(s).: 10, Virtual Memory (1); Differentiate between multiprogramming and fixed partitions.
The question's answer should clearly evidence knowledge of required salient facts relating to "Differentiate between 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 differentiating between multiprogramming and fixed partitions: multiprogramming, load, multiple, programs, memory, primary, physical, switch, between, different, regular, intervals, finished, bring in, new one; Fixed, partition, divides, memory, fixed, size, blocks, primary, memory, regions;

fixed size, sum, all regions, size, primary memory; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer you must explain and differentiating between multiprogramming and fixed partitions explicitly: the issues must be clearly delineated; your description of issues must include the keywords mentioned above.
The question's answer should clearly evidence knowledge of required salient facts relating to differentiating between multiprogramming and fixed partitions; 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 issue] plainly as stated in the above (and in the Example answer); if for example the answer does not 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 differentiating between multiprogramming and fixed partitions was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

Section B

B2.a) In the context of a segmented memory, name and briefly describe two alternative algorithms used to determine where to place the segment in a memory that has external fragmentation in a segmented memory. (4 mark)

B2.a)
Application (example re-ordering) (2 marks):

a) Name and briefly describe two alternative algorithms used to determine where to place the segment in a memory that has external fragmentation. (4 mark).

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

An algorithm can be used to determine where to place the segment in a memory that has external fragmentation.
The operating system maintains a list of the addresses and sizes of all the holes and can use algorithms like, two alternative algorithms are:

i) Best Fit – scan the complete 'list of holes' and determine which best fits the segment; tends to produce a lot of small holes.
ii) First fit – scan the list until a [the first] hole is found that fits the segment.

4 marks for a concise description of complete segmentation loading process; name's [correctly] both algorithm's and concise descriptions,
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).: 12; Virtual Memory (2), Segmented Virtual Memory.

TOTAL marks (4 marks) [4]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses Lecture(s) No(s).: 12; Virtual Memory (2), Segmented Virtual Memory; Name and briefly describe two alternative algorithms used to determine where to place the segment in a memory that has external fragmentation in a segmented memory.
The question's answer should clearly evidence knowledge of required salient facts relating to "naming and briefly describe two alternative algorithms used to determine where to place the segment in a memory that has external fragmentation in a segmented memory."

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to naming and briefly describe two alternative algorithms used to determine where to place the segment in a memory that has external fragmentation in a segmented memory: Best, Fit, scan, complete 'list of holes,'

determine, best fits, segment, lot, small, holes, first, fit, hole, found, fits; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer that names and briefly describe two alternative algorithms used to determine where to place the segment in a memory that has external fragmentation in a segmented memory explicitly: the issues must be clearly delineated; your description of each issue must include the keywords described above.
The question's answer should clearly evidence knowledge of required salient facts relating to naming and briefly describe two alternative algorithms used to determine where to place the segment in a memory that has external fragmentation in a segmented memory; 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 issue] plainly as stated in the above (and in the Example answer); if for example the answer does not 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 that named and briefly describe two alternative algorithms used to determine where to place the segment in a memory that has external fragmentation in a segmented memory was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

B2.b) In the case of a simple computer system with real memory. Explain why a multiprogrammed operating system would need to be able to relocate code? (4 mark)

B2.b)
Application (example re-coding) (4 marks):
The following points should be covered to some degree in the answer:

b) In the case of a simple computer system with real memory and with relocation of programs in memory in mind. Explain why a multiprogrammed operating system would need to be able to relocate code? (4 mark)

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

The typical fully commented ordered interrupt sequence is:

In a multiprogrammed system, it is necessary to enable more than one program [to run] in the memory at one time. As it would be inefficient to save and load processes to and from disk every time a process switch occurred. In general it is not possible to know which combination of processes will be needed in memory; and it would be restrictive if a program had to be loaded into the same set of addresses every time [it was swapped in]. Hence, a scheme is necessary – where a program can be loaded starting at any convenient memory location, this is "relocation".

4 marks for majority of above; e.g. for an answer that orders all lines correctly,
3 marks for correct answer but not concise [enough],
2 mark for some information & for a right-lines approach,
1 marks for some basic understanding (or attempt).
Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s).: Lectures 10, Memory Management (1).

TOTAL marks (4 marks) [8]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses Lectures 10, Memory Management (1); Explain why a multiprogrammed operating system would need to be able to relocate code?
The question's answer should clearly evidence knowledge of required salient facts relating to "What is meant by the term "programmed I/O" in the context of operating systems?"
In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to what is meant by the term "programmed I/O" in the context of operating systems: multiprogrammed, more [than] one program. run. memory, one time, inefficient, save, load, processes, disk, swapped, relocation; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer is you must state what is meant by the term "programmed I/O" in the context of operating systems explicitly: the

issues must be clearly delineated; your description of each issue must include keywords – as per those above.
The question's answer should clearly evidence knowledge of required salient facts relating to the what is meant by the term "programmed I/O" in the context of operating systems; 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); if for example the answer does not 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 what is meant by the term "programmed I/O" in the context of operating systems was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

B2.c) On a paged machine with 3 pages frames (PFs) available for it, a particular process makes accesses to the following pages in the order given:

Access:	3	7	1	3	2	1	3	7	0

Show the contents of the 3 page frames and the cumulative total number of page faults (PF) after each memory access assuming that an LRU page replacement algorithm is in use and that the page frames are initially empty. The type of diagram you should draw up is depicted in figure B2.c. (4 marks)

Access:	3	7	1	3	2	1	3	7	0		
Most recent:	X	X	X	X	X	X	X	X	X	)	Contents of
Second most :	X	X	X	X	X	X	X	X	X	)	page frames
Third most:	X	X	X	X	X	X	X	X	X	)	in memory
Total PFs:	X	X	X	X	X	X	X	X	X		

Figure, Question B2.c. Typical diagram showing 3 page frames and the cumulative total number of page faults.

B2.c)
Application (4 marks),

c) …Show the contents of the 3 page frames and the cumulative total number of page faults (PF) after each memory access assuming that an LRU page replacement algorithm is in use and that the page frames are initially empty… (4 marks)

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

Access:	3	7	1	3	2	1	3	7	0		
Most recent:	3	7	1	3	2	1	3	7	0	)	Contents of
Second most :	-	3	7	1	3	2	1	3	7	)	page frames
Third most:	-	-	3	7	1	3	2	1	3	)	in memory
Total PFs:	1	2	3	3	4	4	4	5	6		

4 marks for a totally correct content, 3 marks for all 3 page frames totally correct and 1 mark for the cumulative total number of page faults totally correct.
2 marks for half issues covered,
1 mark for some basic calculations (or attempt).

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

TOTAL marks (4 marks) [12]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses Lecture(s) No(s).: 13; Virtual Memory (3); show the contents of the 3 page frames and the cumulative total number of page faults (PF) after each memory access assuming that an LRU page replacement algorithm is in use and that the page frames are initially empty.
The question's answer should clearly evidence knowledge of required salient facts relating to "show the contents of the 3 page frames and the cumulative total number of page faults (PF) after each memory access assuming that an LRU page replacement algorithm is in use and that the page frames are initially empty."
In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to showing the contents of the 3 page frames and the cumulative total number of page faults (PF) after each memory access assuming that an LRU page replacement algorithm is in use and that the page frames are initially empty: Access, Most recent, Second most, Third most, Total PFs (page frames) ; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer show the contents of the 3 page frames and the cumulative total number of page faults (PF) after each memory access assuming that an LRU page replacement algorithm is in use and that the page frames are

initially empty explicitly: the table must be clearly delineated [draw]; your description [diagram] of each row and columns must include the correct page (frame) number(s).
The question's answer should clearly evidence knowledge of required salient facts [in the form of a tabulation] relating to the issues involved; this was not done explicitly in some of the answers given – as the terminology (keywords and naming conventions) given above was not used – and the correct page (frame) number(s) [sequence] was also not given. If the answers did not detail the differences [for each PF (accessed and loaded in sequence)] plainly as stated in the above (and in the Example answer); if for example the answer does not 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 that shows the contents of the 3 page frames and the cumulative total number of page faults (PF) after each memory access assuming that an LRU page replacement algorithm is in use and that the page frames are initially empty was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

B2.d) Given the overall steps the processor takes to handle an interrupt can be summarised in six basic steps. List and briefly describe the six basic steps. (4 mark)

B2.d)
Bookwork (4 marks),

d) Given the overall steps the processor takes to handle an interrupt can be summarised in six basic steps. List and briefly describe the six basic steps. (4 mark)

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

1. External line interrupts processor;
2. Interrupt acknowledgement (IACK) cycle identifies the interrupting device;
3. Processor accepts interrupt after current instruction;
4. The processor stores the information necessary to restart the original program following the interrupt;
5. Interrupt Service Routine (ISR) is run for interrupting device until return from interrupt instruction is reached; then finally…
6. Stored information is reloaded into the processor, processor continues executing the original program as if nothing had happened.

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; Lectures 15: Controlling Input and Output 2.

TOTAL marks (4 marks) [16]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses Lectures 15: Controlling Input and Output 2; list and briefly describe the six basic steps of an interrupt.
The question's answer should clearly evidence knowledge of required salient facts relating to "list and briefly describe the six basic steps of an interrupt."
In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to listing and briefly describe the six basic steps of an interrupt: External, line, interrupts, processor, Interrupt, acknowledgement, IACK, cycle, identifies, interrupting, device, accepts, after, current, instruction, stores, information, restart the original program following the interrupt, Interrupt Service Routine (ISR), run, interrupting, device, Stored, reloaded, continues, executing, original, program; plus all those underlined in template answer in box above.

Main differentiation that must be clearly evidenced in your answer lists and briefly describe the six basic steps of an interrupt explicitly: the four steps must be clearly delineated; your description of each step must include terms like thoughts mentioned in the list of keywords above.
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); if for example the answer does not 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 that listed and briefly described the six basic steps of an interrupt was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

B2.e) Given an 4G address spaces and associated 512K 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)

B2.e)
Application (2 marks),

e) Given a 4G address spaces and associated 512K 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:

If the virtual address space is 4 GB and the block size is 512 KB there are:

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

$$= \frac{4G}{512K} = \frac{4{,}294{,}967{,}296}{524{,}288} = \frac{2^{32}}{2^{19}} = 2^{32-19} = 2^{13} = 8{,}192\ (512\text{K})\ \text{pages}$$

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) [18]

Marker's feedback
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.

B2.f) Given a physical address size of 1G and associated 256K 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)

B2.f)
Application (2 marks),

f) Given a physical address size of 1G and associated 256K 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 1GB and block size 256KB.
If the virtual address space is 1 GB and the page size is 256 KB there are:

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

$$= \frac{1G}{256K} = \frac{1{,}073{,}741{,}824}{262{,}144} = \frac{2^{30}}{2^{18}} = 2^{30-18} = 2^{12} = 4{,}096\ (256\text{K})\ \text{page frames}$$

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) [20]

Marker's feedback
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.

B3.a) Given the simple page table diagram in figure B3.a and the virtual address 0x00040003.

a) State the physical address given the data in the page table;

(1 mark)

b) Demand paging can be viewed as a sequence of steps. Explain the 'demand paging' procedure, by outlining the sequence of steps.

(4 mark)

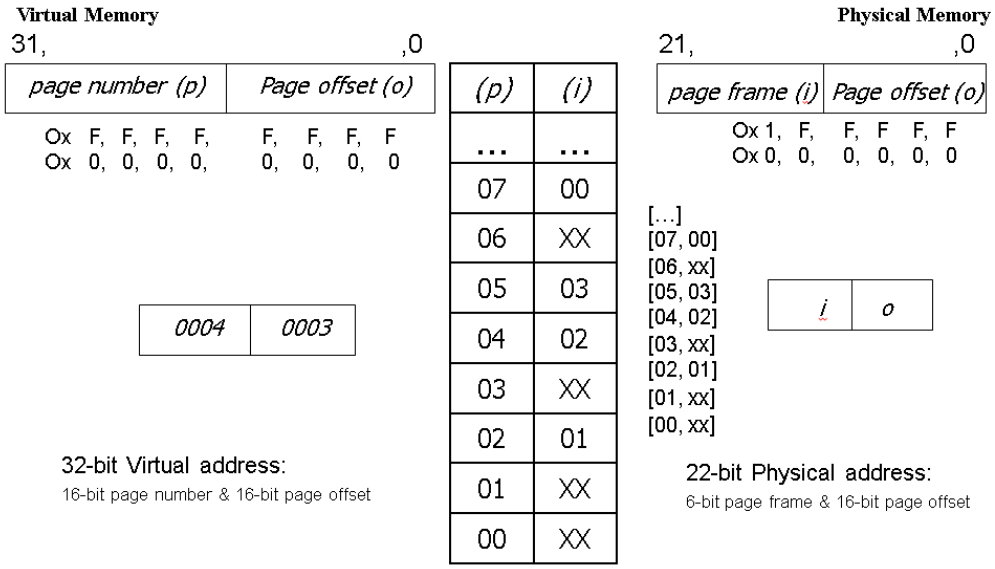

Figure B3.a, Question 4 e) Simple page table diagram.

4.a & b.
Bookwork (5 marks):

a) State the physical address given the data in the page table; (1 mark)

b) Then give a description of the procedure the paged virtual memory utilises to generate a physical memory address from a virtual memory address. (4 mark)

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

a) The physical address (0x i o) produced from the page table is:
0x i o = 0x 02 0003;

b) Demand paging outlined as a sequence of steps:

1) The current process will be halted;
2) The operating system will cause the page to be loaded from disk into a page frame;
   - Whilst waiting for the disk, other processes can run in a multitasking operating system.
3) When the page has been loaded, the memory reference will be tried again.

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 (1).
TOTAL marks (5 marks) [5]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses lecture 17 learning objective 3; state the physical address given the data in the page table; and then give a description of the procedure the paged virtual memory utilises to generate a physical memory address from a virtual memory address.
The question's answer should clearly evidence knowledge of required salient facts relating to "state the physical address given the data in the page table; and then give a description of the procedure the paged virtual memory utilises to generate a physical memory address from a virtual memory address."

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to Demand paging: current; process; halted, operating system; page; loaded; from; disk; page frame; memory reference; and tried again; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer must state the sequence of steps; and then give a brief definition of each step explicitly: the issues must be clearly delineated; your description of each issue must include the keywords.
The question's answer should clearly evidence knowledge of required salient facts relating to state the physical address given the data in the page table; and then give a description of the procedure the paged virtual memory utilises to generate a physical memory address from a virtual memory address; 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); if for example the answer does not 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 enabling you to state the physical address given the data in the page table; and then give a description of the procedure the paged virtual memory utilises to generate a physical memory address from a virtual memory address was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

B3.c) State and briefly describe the steps an operating system take to load a single user program into memory; given this is *uniprogramming*. (5 marks)

B3.c)
Bookwork & Critique [Differentiate] (5 marks):

c) State and briefly describe the steps an operating system take 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 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).: 10; Memory Management (1)…
TOTAL marks (5 marks)[10]

Marker's feedback
Pedagogic assessment [criterion]:
The question assesses Lecture(s) No(s).: 10; Memory Management (1); State the steps an operating system take to load a single user program into memory; given this is uniprogramming.
The question's answer should clearly evidence knowledge of required salient facts relating to "State the steps an operating system take to load a single user program into memory; given this is uniprogramming."
In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context, for example: with respect to state the steps an operating system take to load a single user program into memory; given this is uniprogramming: OS, file name, Loads, Jumps, start, Executes, Returns, OS; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer must state the steps an operating system take to load a single user program into memory; given this is

uniprogramming explicitly: the issues (steps) must be clearly delineated; your description of each step must include the keywords mentioned above.
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); if for example the answer does not 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 relating to the steps an operating system take to load a single user program into memory; given this is uniprogramming was covered in the lecture series in three different audio visual media: 1) the actual live lecture; 2) the audio recording of the live lecture; and 3) the real time video of the lecture.

END OF EXAMINATION