Comments

The overall performance for question A1 (basic stuff) is very good which shows that the students have been able to grasp the fundamentals of the course.

Some comments about A1 are:

a) Although it was explicitly asked not to use binary, many students used it (or show no method at all). In these cases I gave 1 mark instead of 2. Many students did Hex->Dec by adding, which is not really a sensible method, however I was lenient and accepted these

b) Some students seem to believe that the PC is the only register that can be used as based. Obviously there is no limitation in which register can be used for the base. Some students forgot that the offset can be either a register or a literal.

Indirect addressing is useful for any kind of data structures, not only stacks.

c) 1-address inst. style is not accumulator architecture.

Not many students attempted Question A2 but the overall performance has been good enough and in general consistent with the results in Q1.

Some comments:

a) Generally good performance understanding the different (pseudo)instructions STMFD is not a pseudo instruction and can be used for many things, not only the stack. Both ADR and ADRL are pseudo instructions, the difference being the range and number of instructions.

b) Generally happy with the explanations of the methods, although a few students said stack when they meant address/translation table. I’m not sure whether this was due to the exam pressure or if there is an underlying problem understanding the different data structures. When discussing memory utilization, most students understood that having a translation table requires a fair amount of memory, but not many considered that the instructions are also stored in memory and so need to be taken into account for this.

c) Most students that did a serious attempt to this exercise got very good marks. However, there were many that not even tried to do it, not sure whether it was due to lack of time. A few students moved the address of the element to the PC, which is not what was asked for.

Please also see Richard Neville's feedback on the following pages.
One and a half hours

Closed Book Examination
(A copy of an "ARM Instruction Set Summary" is attached)

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Fundamentals of Computer Architecture

Thursday 22\textsuperscript{nd} January 2016?

Time: 14:00 – 15:30?

Please answer Questions A1 and B1.
and
TWO other Questions from A2, B2, or B3.

Use a SEPARATE answer book for each SECTION.

For full marks your answers should be concise as well as accurate.
Marks will be awarded for reasoning and method as well as being correct.

The use of electronic calculators is NOT permitted.
1. **Computer Architecture**

**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 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…
Section B1

B1.a) With respect to the ‘stack’ in a Java Virtual Machine? Brief explain the types of information the ‘stack’ holds. (2 mark)

B1.a Bookwork (2 marks):
The following points should be covered to some degree in the answer:
The stack memory is basically used for:

Parameter passing:
Saving registers; and
Temporary variables.

In answer to:-
Brief explain the types of information the ‘stack’ holds:

To [hold] parameters passed to methods;
[Saves] Local variables;
[Saves] Temporary variables;
[Saved] registers;
[Saves] Return links.

2 marks for an answer that depicts all the salient facts in a sensible way; all facts are correctly delineated and briefly described;
1½ marks for a right-lines approach;
1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s.): Lecture 18: Java Memory Usage.
TOTAL marks (2 marks) [2]

Marker’s feedback

Pedagogic assessment [criterion]:
The question assesses Lecture 18: Java Memory Usage:

Well done, most of you were able to state what “explain the types of information the ‘stack’ holds” and you stated it concisely and explicitly.
The question’s answer should clearly evidence knowledge of required salient facts relating to “explain the types of information the ‘stack’ holds”.
In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: parameters passed [to] methods, Local variables, Temporary variables, registers, Return links; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer is that: “explain the types of information the ‘stack’ holds” a full list of what types of information must include: all the appropriate keywords described in the correct context.

The question’s answer should clearly evidence knowledge of required salient facts relating to “explain the types of information the ‘stack’ holds”; this was not done explicitly in some of the answers given. If the answers did not detail what it holds plainly as stated in the above (and in the Example answer); e.g. if answer does not give evidence of knowledge of required salient facts, full marks were not awarded.

This theory of “explain the types of information the ‘stack’ holds” 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) With respect to the JVM; and in relation to the “3-steps taken to create a new object;” briefly explain each step; and also draw up a set of 3-diagrams (outlined in figure B1.b.) of the 3-steps; fully label and annotate each; given this code snippet of Java code:

```java
String s;
s = new String("abc");
```
and the address it is allocated is 1000. (4 marks)

![Diagram showing 3-steps to create a new object](image)

Figure B1.b., Question figure B1.b., a diagram explaining the 3-steps to create a new object.
B1.b. Application (Critique) (4 marks):

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

3-Steps taken when “we create a new object:"

Step 1: A new section of memory is obtained (e.g. at address 1000);
   [which is the] Right size for [the] object;
Step 2: Object is initialised; and [finally]
Step 3: Address of object is written to ‘s.’

4 marks for an answer that depicts all the salient facts in a sensible way; good briefly described and expression is evaluated totally correct;
3 marks for correct answer but not detailed [enough];
2 mark for a right-lines approach;
1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): Lecture 18: Java Memory Usage.
TOTAL marks (4 marks) [6]

Marker’s feedback
Pedagogic assessment [criterion]:
The question assesses Lecture 18: Java Memory Usage.

Well done, most of you were able to state “3-steps taken to create a new object.”
The question’s answer should clearly evidence knowledge of required salient facts relating to “3-steps taken to create a new object.”
In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: new, memory [is] obtained, right size, object, initialised, address, written; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer is that [the]: “3-steps taken to create a new object” incur memory: allocation, initialisation and initialisation.
The question’s answer should clearly evidence knowledge of required salient facts relating to the “3-steps taken to create a new object”; this was not done explicitly in some of the answers given. If the answers did not detail the mechanism plainly as stated in the above (and in the Example answer); e.g. if the answer does not give evidence of knowledge of required salient facts, full marks were not awarded.
This theory of “3-steps taken to create a new object” 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) Operating System Kernel consists of basically five main functions; name the five main functions a Kernel performs for an (OS) and briefly describe each. (4 marks)

The following points should be covered explicitly in any exam; to gain full marks for your answer:

Five of the main functions a Kernel performs for an (OS) are:

1. **File Manager** – manages files on disk and the file structure;
2. **Device Drivers** – control I/O devices;
3. **Memory Manager** – allocates memory to programs;
4. **Scheduler and Dispatcher** – decides which program to run and ensures that it has the correct resources; and
5. **Network manager** – controls networking (connections to other computers)...

**4 marks** for an answer that depicts all the salient facts in a sensible way; good briefly described and expression is evaluated totally correct;

**3 marks** for correct answer but not detailed [enough];

**2 marks** for a right-lines approach;

**1 mark** for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s).: Lecture 15: System Software.

TOTAL marks (4 marks) [10]

**Marker’s feedback**

**Pedagogic assessment [criterion]:**
The question assesses Lecture 15: System Software.

Well done, most of you were able to state what the System Kernel consists of basically five main functions [name and briefly describe them].

The question’s answer should clearly evidence knowledge of required salient facts relating to what the System Kernel consists e.g. name and briefly describe the five main functions.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: **File Manager**, **manages**, **files** on disk, **file**, **structure**, **Device**, **Drivers**, **control** I/O devices, **Memory**, **Manager**, **allocates**, **memory** [to]
programs, Scheduler, Dispatcher, decides [which] program to run; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer is that the System Kernel consists of basically five main functions [name and briefly describe them].
The question’s answer should clearly evidence knowledge of required salient facts relating to the issues aligned to what the System Kernel consists of basically five main functions [name and briefly describe them]; this was not done explicitly in some of the answers given.
If the answers did not detail the mechanism plainly as stated in the above (and in the Example answer); e.g. if the answer does not give evidence of knowledge of required salient facts, full marks were not awarded.
This theory of the System Kernel consists of basically five main functions 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 B2

B2.a) In your lectures you were introduced to code, in the form of, a loop for ‘polling a simple device;’ which would be something like that presented in figure 3.a. State [explicitly] the function each line performs in the comment column; when you copy figure B2.a into your answer book. Hint: this means you should be as: concise and explicit in the explanation of the: labels, instructions [operation], operand(s), registers, variables etc.; as possible. (4 marks)

<table>
<thead>
<tr>
<th>Label</th>
<th>Operation</th>
<th>Operand</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>loop</td>
<td>ADR</td>
<td>R1, status_reg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LDR</td>
<td>R0, [R1]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TST</td>
<td>R0, #0x80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BEQ</td>
<td>loop</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ADR</td>
<td>R1, data_reg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LDR</td>
<td>R0, [R1]</td>
<td></td>
</tr>
</tbody>
</table>

figure B2.a., Question figure B2.a., A table; showing out-of-order code for a loop that can check a table of peripherals.
B2.a. **Application (example re-coding) (4 marks):**

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

The typical commented code is:

```asm
loop
ADR R1, Status_Reg ; R1 points to status register.
LDRB R0,[R1] ; read status, R0 contains value of status register.
TST R0, #0x80 ; test ready bit (bit 7) of status register.
BEQ loop ; if not ready, try again; until bit (bit 7) SET.
ADR R1, Data_Reg ; R1 points to data register.
LDRB R0,[R1] ; ready, [so] read data register [content].
```

4 marks for majority of above; e.g. for an answer that orders all lines correctly,
3 marks for correct answer but not all correct order [enough],
2 marks for some in order & for a right-lines approach,
1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): Lecture 14: Input/Output (2).

**TOTAL marks (4 marks)** [4]

**Marker’s feedback**

**Pedagogic assessment [criterion]:**

The question assesses Lecture 14: Input/Output (2) objective 1: ‘polling a simple device’.

Well done, most of you were able to state [explicitly] the function each line performs in the ‘polling a simple device’ code.

The question’s answer should clearly evidence knowledge of required salient facts relating to the function each line performs in the ‘polling a simple device’ code.

In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: points [to] status register, read status, test ready bit ([bit] 7) [of] status register, points [to] data register, ready, [so] read data; plus all those underlined in template answer in box above.

Main differentiation that must be clearly evidenced in your answer is that: by stating [explicitly] the function each line performs in the ‘polling a simple device’ code you fully comprehend each lines function.

The question’s answer should clearly evidence knowledge of required salient facts relating to the issues aligned to stating [explicitly] the function each line performs in the ‘polling a simple device’ code; this was not done explicitly in some of the answers given. If the answers did not detail the mechanism plainly as stated in the above (and in the Example answer); e.g. if the answer did not give evidence of knowledge of required salient facts, full marks were not awarded.

This theory of issues enabling you to state [explicitly] the function each line performs in the ‘polling a simple device’ code were 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 context of data exchange between CPU and peripherals. Differentiate between the two main data exchange protocols; polling and interrupts (their different steps/phases).

(4 marks)

B2.b. Application (example differentiate) (4 marks):

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

1. Polling basically has two phases:
   - Polling phase 1: CPU polls the status register to check if a key has been pressed.
   - Polling phase 2: Then it reads the data register [in the peripheral] in order to transfer the data from the peripheral to the CPU. [Note this is in the context of a keyboard connected to a peripheral.]

2. Interrupts nominally involve three steps:
   - Interrupts step 1: When the CPU starts the interrupt handler it first checks the status register. If the status [specified by a set bit] is incorrect the handler initiates an error handler.
   - Interrupts step 2: As long as the status facilitates a data transfer; the data register is then read; and the data is saved [in the appropriate location].
   - Interrupts step 3: Finally an acknowledgement is written back to the peripheral.

4 marks for majority of above; e.g. for an answer that orders all lines correctly (2 marks for a detailed and concise description.),
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): Lecture 14: Input/Output (2).
TOTAL marks (4 marks) [8]

Marker’s feedback

Pedagogic assessment [criterion]:
The question assesses Lecture 14: Input/Output (2) objective 1: Differentiate between the two main data exchange protocols; polling and interrupts (their different steps/phases).

Well done, most of you were able to differentiate between the two main data exchange protocols; polling and interrupts (their different steps/phases).
The question’s answer should clearly evidence knowledge of required salient facts relating to differentiate between the two main data exchange protocols; polling and interrupts (their different steps/phases).
In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: CPU, polls, status register, check, key, pressed, reads, data register, transfer, data, from, peripheral, to CPU, incorrect, initiates, error handler; plus all those underlined in template answer in box above.

Main differentiation that must be clearly evidenced in your answer is that: differentiate between the two main data exchange protocols; polling and interrupts (their different steps/phases).

The question’s answer should clearly evidence knowledge of required salient facts relating to the issues aligned to differentiate between the two main data exchange protocols; polling and interrupts (their different steps/phases); this was not done explicitly in some of the answers given. If the answers did not detail the mechanism plainly as stated in the above (and in the Example answer); e.g. if the answer did not give evidence of knowledge of required salient facts, full marks were not awarded.

This theory aligned to differentiate between the two main data exchange protocols; polling and interrupts (their different steps/phases) 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) What is bytecode in the context of Java and how does it get executed by a real processor? (4 marks)

B2.c. Application (example) (Critique) (4 marks):

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

1. The **Java compiler does not produce real machine instructions.** It produces instead, bytecode, which is a stack based (zero address) instruction set.
2. This has the advantages of portability and compactness.
3. The simplest way to execute bytecode is with a software interpreter.
4. However, performance considerations have led to the development of dynamic compilation virtual machines.
5. Here [**dynamic compilation**] bytecode is **initially interpreted** but, if monitoring shows that the code is being heavily executed, the bytecode is translated to native machine code.
6. Plus any and all [related] full explanation(s) [diagrammatic and textual] – re. diagram – such as those depicted in lectures, entitled: Java Bytecode; Why Java Bytecode? Zero Address Instructions; etc…

4 marks for an answer that depicts all the salient facts in a sensible way; all keywords correctly delineated [in context] and aligned to appropriate step,
3 marks for correct answer but not all keywords aligned correctly,
2 mark for a right-lines approach; but more alignment errors,
1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information; Lecture(s) No(s): Lecture 14: Input/Output (2).

TOTAL marks (4 marks) [12]

Marker’s feedback

**Pedagogic assessment [criterion]:**
The question assesses Lecture 17: Java Bytecode.

Well done, most of you were able to state what is bytecode in the context of Java.
The question’s answer should clearly evidence knowledge of required salient facts relating to what is bytecode in the context of Java.
In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: Java, compiler, does not, produce, real, machine, instructions, bytecode, stack based, zero address, instruction set, execute, bytecode, software interpreter, dynamic, compilation, initially interpreted; plus all those underlined in template answer in box above.
Main differentiation that must be clearly evidenced in your answer is that: it must state concisely what is bytecode, in the context of Java.
The question’s answer should clearly evidence knowledge of required salient facts relating to the issues aligned to what is bytecode in the context of Java; this was not done explicitly in some of the answers given. If the answers did not detail the mechanism plainly as stated in the above (and in the Example answer); e.g. if the answer did not give evidence of knowledge of required salient facts, full marks were not awarded. This theory of what is bytecode in the context of Java 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) Explain how an expression of the form \( x = (a-b) \times (c+d) \) is evaluated using [a sequence of] bytecode instructions. Typical bytecode instructions are: PUSH and POP. (4 mark)

B2.d. Application (example details) (4 marks):

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

Bytecode instructions are zero address, that is they usually don’t specify the source and destination of their operands. Instead these are implicit as the top locations of the stack (the exact use depends on the instruction). PUSH and POP instructions move data between permanent memory and the stack.

The expression \( x = (a-b) \times (c+d) \) is evaluated thus:

- PUSH \( a \)
- PUSH \( b \)
- SUB
- PUSH \( c \)
- PUSH \( d \)
- ADD
- MUL
- POP \( x \)

4 marks for majority of above; e.g. for an answer that orders all lines correctly (2 marks for a detailed and concise description.),
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): Lecture 17: Input/Output (2).
TOTAL marks (4 marks) [16]

Marker’s feedback

Pedagogic assessment [criterion]:

The question assesses lecture Lecture 17: Input/Output (2): explain how an expression of the form \( x = (a-b) \times (c+d) \).

Well done, most of you were able to state what mapping was performed and you explain how an expression of the form \( x = (a-b) \times (c+d) \) using PUSH and POP instructions etc.

The question’s answer should clearly evidence knowledge of required salient facts relating to explain how an expression of the form \( x = (a-b) \times (c+d) \) using PUSH and POP instructions etc. In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: PUSH a, PUSH b, PUSH c, SUB, ABB, MUX, POP x.
Main differentiation that must be clearly evidenced in your answer is that: the code sequence must explain how an expression of the form \( x = (a-b) \times (c+d) \) using PUSH and POP instructions etc.

The question’s answer should clearly evidence knowledge of required salient facts relating to the issues aligned to explain how an expression of the form \( x = (a-b) \times (c+d) \) using PUSH and POP instructions etc; this was not done explicitly in some of the answers given. If the answers did not detail the mechanism plainly as stated in the above (and in the Example answer); e.g. if the answer did not give evidence of knowledge of required salient facts, full marks were not awarded.

This theory of explain how an expression of the form \( x = (a-b) \times (c+d) \) using PUSH and POP instructions etc. 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) In general array access involves a computed index which is added to the base of the array. Draw up a diagram that depicts ‘a’ the base, ‘i’ the index. The array has ten elements. Depict the case where ‘i=5’ in your diagram; diagram should be fully labelled and annotated. (4 marks)

B2.e. Application [iii. A OxCamb. type final Q – how much do they really know?] (4 marks):

Application of their knowledge via diagrammatic depiction.

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

Diagram must be fully labelled and annotated.

4 marks for an answer that depicts all the salient facts in a sensible way; all keywords correctly delineated [in context] and aligned to appropriate step.

3 marks for correct answer but not all keywords aligned correctly.

2 mark for a right-lines approach; but more alignment errors.

1 mark for some basic understanding (or attempt).

Reference Learning Resources, Background Reading, and Lecture itself for detailed information;

Lecture(s) No(s).: Lecture 19: Arrays (1): Array Implementation.

TOTAL marks (4 marks) [20]

Marker’s feedback
Pedagogic assessment [criterion]:

The question assesses lecture Lecture 19: Arrays (1): Array Implementation objective 1: aligned to drawing up a diagram that depicts ‘a’ the base, ‘i’ the index.

Well done, most of you were able to drawing up a diagram that depicts ‘a’ the base, ‘i’ the index.

The question’s answer should clearly evidence knowledge of required salient facts relating to the function of a general array when access involves a computed index which is added to the base of the array.
In the answer [some of] the following terminology (keywords and naming conventions) should be utilised in context; for example: base, array, a[0], address, a + i; plus all those underlined in template answer in box above.

Main differentiation that must be clearly evidenced in your answer is that: the diagram relating to the function of a general array when access involves a computed index which is added to the base of the array; which depicts the process of adding ‘a’ the base and ‘i’ the index; is that the diagram conforms closely to the [template] example given above – with all the correct and appropriate labelling.

The question’s answer should clearly evidence knowledge of required salient facts relating to the issues aligned to access which involves a computed index which is added to the base of the array; which depicts the process of adding ‘a’ the base and ‘i’ the index. If the answers did not detail the mechanism plainly as stated in the above (and in the Example answer); e.g. if the answer does not give evidence of knowledge of required salient facts, full marks were not awarded.

This theory of access which involves a computed index which is added to the base of the array; which depicts the process of adding ‘a’ the base and ‘i’ the index 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