

THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

DEFERRED FINAL EXAMINATION

CSC 2101
COMPUTER SYSTEMS

Date: 11TH DECEMBER 2019
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: SPORTS HALL

Instructions

1. There are five (5) questions and **two (2) sections** in this paper.
2. *Answer all the questions in Section A and choose any three (3) questions from Section B*

- iv. Pass by reference vs pass by value [2 marks]
- d. What is the meaning and what role do the following play in the CPU: [4 marks]
 - i. MAR
 - ii. MBR
 - iii. I/O AR
 - iv. PC

QUESTION THREE

- a. List and explain **four (4)** problems that are solved by the Transport layer [4 marks]
- b. Using an n-bit address, determine the value of n required to address 1023 cells. With this value of n, what will be the addresses of the last two cells in binary? [5 marks]
- c. List and explain **five (5)** services provided by the operating system [5 marks]
- d. Discuss the following ROM variations: [2 marks]
 - iv. PROM
 - v. EPROM
- e. Explain three techniques for I/O operation [9 marks]

QUESTION FOUR

- a. Give brief definitions for each of the following; [3 marks]
 - i. Seek time
 - ii. Rotational latency
 - iii. Transfer time
- b. With the aid of a diagram, give the 4 layers of the TCP/IP protocol. Give a brief description of what each layer does. [8 marks]
- c. Compare and contrast the two physical network technologies, Circuit Switched (connection oriented) and Packet Switched (Store and Forward) [8 marks]
- d. What is the 8-bit binary representation of the integer 106? [1 mark]
- e. Compare compilation and interpretation [5 marks]

QUESTION FIVE

- a. What is a compiler? [1 mark]
- b. Compiling analysis consists of three phases. Explain each phase: [6 marks]
- i. Linear analysis
 - ii. Hierarchical analysis
 - iii. Semantic analysis
- c. Describe the advantages and disadvantages of magnetic storage, optical storage and solid-state storage using criteria such as versatility, durability, capacity, access time and transfer rate. [10 marks]
- d. What is an interconnection structure? [2 marks]
- e. Define *three (3)* functional groups into which bus lines can be classified and state the significance of each classification width. [6 marks]

END OF EXAM

Optimum!!!



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

CSC 2111
COMPUTER ARCHITECTURE
FINAL EXAMINATION

Date: 9th JULY, 2018
Time: 09:00 hrs – 12:00 hrs
Duration: 3 Hours
Venue: UPPER DINING HALL

INSTRUCTIONS

1. This exam has two sections A and B.
2. Answer **ALL** the questions from **Section A**.
3. Answer **ANY three (3)** questions from Section B.
4. **Total number of questions answered should be five (5).**
5. Clearly identify the problem being solved.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION [40 MARKS]

1. *Structure* and *function* are key terms in computer architecture and organisation.
 - a. Distinguish between the two terms. (2 marks)
 - b. Hence, draw a diagram and describe the *general structure* and *functions* of an I/O module. (8 marks)
 - c. Define the three (3) modes of operation that are possible for communication among I/O modules, processors and memory. (3 marks)
2. Categorise each invention below according to its era in the history of computing: pre-mechanical, mechanical or electronic. (5 marks)
 - a. Abacus
 - b. Slide rule,
 - c. Difference Engine
 - d. Pascaline
 - e. Napier's bones,
 - f. Comptometer
 - g. Pacioli's finger-counting system
 - h. Schickard's calculator
 - i. Sectors
 - j. Leibniz step reckoner
3. Draw a diagram and explain the physical layer of QPI. (5 marks)
4. Explain the difference between DRAM and SRAM in terms of the following characteristics: (5 marks)
 - a. Technology
 - b. Speed
 - c. Size
 - d. Cost
 - e. Application
5. Explain the differences among FIFO, LRU and LFU cache Replacement Algorithms. (3 marks)
6. Explain the four (4) key features of the hierarchy of memory. (4 marks)
7. Explain the process by which clock signals are generated for use by the processor. (2 marks)
8. Explain two (2) approaches to dealing with multiple interrupts. (3 marks)

SECTION B: ANSWER THREE (3) QUESTIONS IN THIS SECTION [60 MARKS]

QUESTION ONE

Consider a computer M_2 with the following CPIs for instructions:

Type A CPI = 1.3; Type B CPI = 1.7; Type C CPI = 2.1; Type D CPI = 2.4;
and Type E = 2.7

- i. Given a Program P_1 with the following mix of instructions:
 Type A = 15 %; Type B = 25%; Type C = 27 %; Type D = 3 %;
 and Type E = the remaining instructions.
- Calculate the average CPI of Machine M_2 . (5 marks)
 - Calculate the execution time of P_1 on M_2 if $I_C = 21,131$ and clock rate is 3.4 GHz. (5 marks)
- ii. Suppose machine M_2 runs another program P_2 2.9 times slower than P_1 with clock rate and CPIs remaining the same. What variable in the performance equation changed? By how much? (10 marks).

QUESTION TWO

Consider a machine with a main memory of 2^{32} bytes and block size of 32 bytes. Data is addressed to the word and words are 32 bits. Physical addresses are 32 bits.

- What is the *number* and *range* of addressable locations in the main memory? (2 marks)
- Assuming that a direct mapped cache consisting of 128 lines is used with this machine,
 - How is a main memory address divided into tag, line, and word values? (6 marks)
 - Suppose the word with address F A B 1 2 3 8 9 (in hex) is stored in the cache. What are the addresses of the other words stored along with it? (2 marks)
- Assuming that a four-way set-associative mapped cache consisting of 128 lines is used with this machine,
 - How is a main memory address divided into tag, set, and word values? (6 marks)
 - Which set does the data that is brought in go to if the physical address F A B 1 2 3 8 9 (in hex) is supplied to the cache? (2 marks)
 - Why is the tag value also stored in the cache? (2 marks)

QUESTION THREE

Consider a simple abstract computer in which both instructions and data are 16 bits long: (Opcode = 4 bits and memory location or I/O device = 12 bits). Its opcodes are as follows:

Operation Codes

- 2 = Store AC to memory
- 7 = Store AC to I/O
- 5 = Add to AC from memory
- 1 = Load AC from memory
- 3 = Load AC from I/O

Memory	
300	0001100101000001
301	0101100101000000
302	0010100100111001
303	0011000000000110
304	0101100100111001
305	0111000000000101
306	
939	?
940	0002
941	0003
I/O Devices	
005	?
006	007

Using the format below to keep track of the state of the registers while the programme loaded into memory is executing, SIMULATE the fetch/execute process [20 marks].

NOTE:

Use hexadecimal notation in your solution.

	Fetch	Execute
Step 1	MAR:	MAR:
	MBR:	MBR:
	I/O AR:	I/O AR:
	I/O BR:	I/O BR:
	AC:	AC:

QUESTION FOUR

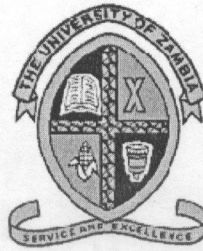
Consider a single-platter disk with the following parameters:

- Rotation speed = 7200 rpm
- Number of tracks on one side of the platter = 30,000
- Number of sectors per track = 600
- Seek time = 1 ms for every hundred tracks traversed.

Let the disk receive a request to access a random sector on a random track and assume the disk head starts at track 0.

- i. What is the average seek time? (5 marks)
- ii. What is the average rotational latency?(5 marks)
- iii. What is the transfer time for a sector? (5 marks)
- iv. What is the total average time to satisfy a request? (5 marks)

The End



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

CSC 2111
COMPUTER ARCHITECTURE
DEFERRED EXAMINATION

Date: 31ST DECEMBER, 2018
Time: 09:00 hrs – 12:00 hrs
Duration: 3 Hours
Venue: SPORTS HALL

INSTRUCTIONS

1. This exam has two sections A and B.
2. Answer **ALL** the questions from **Section A**.
3. Answer **ANY three (3)** questions from Section B.
4. **Total number of questions answered should be five (5).**
5. Clearly identify the problem being solved.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION [40 MARKS]

1. What are the four main components of any general-purpose computer? (1 mark)
2. Diagram and describe the *general structure and functions* of a generic External Device. (5 marks)
3. List three broad classifications of external, or peripheral, devices. (3 marks)
4. What are the advantages of using a glass substrate for a magnetic disk? (5 marks)
5. Diagram and explain how data are written onto and read from a magnetic disk? **Note: Explain both Traditional and Contemporary read mechanisms.** (9 marks)
6. Diagram and explain the difference between a simple CAV system and a multiple zoned recording system. (6 marks)
7. What are the differences among EPROM, EEPROM, and flash memory? (3 marks)
8. For a direct-mapped cache, a main memory address is viewed as consisting of three fields. List and define the three fields. (3 marks)
9. For an associative cache, a main memory address is viewed as consisting of two fields. List and define the two fields. (2 marks)
10. For a set-associative cache, a main memory address is viewed as consisting of three fields. List and define the three fields. (3 marks)

SECTION B: ANSWER THREE (3) QUESTIONS IN THIS SECTION [60 MARKS]

QUESTION ONE

Consider a computer M_2 with the following CPIs for instructions:

Type A CPI = 1.5; Type B CPI = 1.9; Type C CPI = 2.3; Type D CPI = 2.6;
and Type E = 2.9

- i. Given a Program P_1 with the following mix of instructions:
Type A = 10 %; Type B = 20%; Type C = 22 %; Type D = 15 %;
and Type E = the remaining instructions.
 - a. Calculate the average CPI of Machine M_2 . (5 marks)
 - b. Calculate the execution time of P_1 on M_2 if $I_c = 21,100$ and clock rate is 2.4 GHz. (5 marks)

- ii. Suppose machine M_2 runs another program P_2 2.9 times faster than P_1 with clock rate and CPIs remaining the same. What variable in the performance equation changed? By how much? **(10 marks)**.

QUESTION TWO

Consider a machine with a main memory of 2^{16} bytes and block size of 16 bytes. Data is addressed to the word and words are 16 bits. Physical addresses are 16 bits.

- i. What is the *number* and *range* of addressable locations in the main memory? **(2 marks)**
- ii. Assuming that a direct mapped cache consisting of 64 lines is used with this machine,
 - a. How is a main memory address divided into tag, line, and word values? **(6 marks)**
- iii. Assuming that a two-way set-associative mapped cache consisting of 64 lines is used with this machine,
 - a. How is a main memory address divided into tag, set, and word values? **(6 marks)**
 - b. Why is the tag value also stored in the cache? **(2 marks)**
- iv. Assuming that a fully associative mapped cache consisting of 64 lines is used with this machine,
 - a. How is a main memory address divided into tag and word values? **(4 marks)**

QUESTION THREE

In relation to main memory error correction functions:

- i. Develop a SEC code for a 16-bit data word. **[8 marks]**
- ii. Generate the code for the data word 0101000000111001. **[8 marks]**
- iii. Show that the code will correctly identify an error in data bit 5. **[4 marks]**

QUESTION FOUR

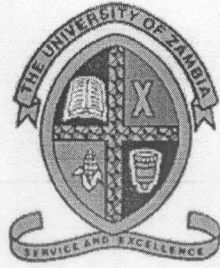
Consider a single-platter disk with the following parameters:

- Rotation speed = 7200 rpm
- Number of tracks on one side of the platter = 30,000
- Number of sectors per track = 600
- Seek time = 1 ms for every hundred tracks traversed.

Let the disk receive a request to access a random sector on a random track and assume the disk head starts at track 0.

- i. What is the average seek time? **(5 marks)**
- ii. What is the average rotational latency?(**5 marks**)
- iii. What is the transfer time for a sector? **(5 marks)**
- iv. What is the total average time to satisfy a request? **(5 marks)**

The End



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

OPERATING SYSTEMS
CSC2202

FINAL EXAMINATION

Date: Thursday, 14th November, 2019
Venue: P207
Time: 09 – 12hrs
Duration: 3hrs

Instructions

1. This exam has two sections A and B.
2. Answer **ALL** the questions from **Section A**.
3. Answer any **three (3)** questions from **Section B**.
4. **Total number of questions answered should be 5.**
5. Write your answers on a separate answer sheet.

SECTION A (Answer all questions)

QUESTION 1 (20 marks)

- A. [2 marks] What other hardware mechanism can be used on a uniprocessor to achieve mutual exclusion?
- B. [3 marks] What are the three main purposes of an operating system?
- C. [2 marks] List two reasons why an operating system designer might choose not to have user threads map 1:1 with kernel threads.
- D. [3 marks] For each of the following traps, indicate whether the trap is synchronous or asynchronous with respect to a user-level program.
 - i. System call
 - ii. Exception
 - iii. Interrupt
- E. [2 marks] Why might it be advantageous to keep a process running on the same processor on which it last ran (this is called processor affinity)?
- F. [4 marks] Imagine that you've been asked to build an operating system for a simple embedded processor. The processor has no virtual memory and no memory translation unit. What functionality must you build into your process loader if you wish to have multiple programs resident in memory?
- G. [4 marks] In a system with virtual memory, how can you share memory between two processes?

QUESTION 2 (20 marks)

For each synchronization problem described below, select the best synchronization primitives to solve the problem. You may use each primitive as many times as you need to. Briefly, explain why you chose the primitive you did. Select the synchronization primitive from the following list:

1. Counting semaphore
 2. Binary semaphore
 3. Lock (w/out a CV)
 4. Lock and condition variable
-
- A. **[4 marks]** A common problem in soccer collisions between players jumping for headers (this often leads to concussions). They've decided that clever CSC2202 students could easily solve this problem with a synchronization primitive that would arbitrate which player got to jump up for the header (such primitives would have to be very high performance). Which primitive would you suggest?
- B. **[4 marks]** Mrs Kumar was making pancakes for hungry teenagers. The pancakes come out in batches of three. She'd like a synchronization primitive that would allocate pancakes to teenagers without fighting. (There is no need to worry about leftovers between batches all pancakes are consumed pretty much instantly.) Suggestions?
- C. **[4 marks]** You are competing in a new Olympic event called a distributed relay. One team member has to run one lap at the UNZA track. The next team member must run a lap at the CBU track. The third team member runs a lap at Mulungushi track and the last team member runs a lap at the UNILUS track. Each runner must not start until the previous runner has completed his/her lap. Naturally, the traditional passing of the baton or slapping of the hands won't work, so they've turned to you, to provide the proper synchronization. What mechanism do you use?
- D. **[4 marks]** Competition for parking in UNZA carpark has become brutal due to the massive quantities of potholes accumulating on our streets. The traditional use of spacesavers (things like cones or lawn chairs that mark a spot as being "owned" because someone invested the physical labor in shoveling it out) has become too contentious and

the UNZA Department of Engineering is looking for a better solution. They've decided to have security hand out parking tokens and any car without a visible token will be towed to the far reaches of the universe. Each security has a token checkin point and cars must drive to the checkin point to obtain a token for a specific spot and return a token when they leave a spot (cars that do not return tokens within seven minutes of leaving a spot are subject to enormous fines). They would like the checkin points to operate as efficiently as possible, allocating and deallocating spots in parallel as much as possible. What synchronization primitive(s) should they use?

- E. **[4 marks]** It is well known that graduate students (as well as many others) are motivated by free food. After the first couple of years (once classes are complete), a graduate student's day consists mostly of doing research and periodically checking email to determine if anyone has announced any free food lately. Unfortunately, the better research is going, the less likely students are to check email, and by the time they get to the location of the free food, it's often gone. (While they could configure their mail to alert them every time a new message comes in, most messages do not concern free food, so this would be quite distracting.) There must be a better way can you propose use of a synchronization primitive that would let them receive/see messages only when they concerned free food?

SECTION B (Choose any three)

QUESTION 3 (20 marks)

- A. [5 marks] Consider a machine with a physical memory of 8 GB, a page size of 8 KB, and a page table entry size of 4 bytes. How many levels of page tables would be required to map a 46-bit virtual address space if every page table fits into a single page? Be explicit in your explanation.
- B. [4 marks] List the fields of a Page Table Entry (PTE) in your scheme.
- C. [3 marks] Without a cache or TLB, how many memory operations are required to read or write a single 32-bit word?
- D. [6 marks] Briefly describe two approaches to avoiding deadlock.
- E. [2 marks] List two events that may take a process to a ready state.

QUESTION 4 (20 marks)

- A. [6 marks] How much physical memory is needed for a process with three pages of virtual memory (for example, one code, one data, and one stack page)?
- B. Think of the various deadlock detection and prevention algorithms we've discussed in this course, and consider the following snapshot of a system with five processes (P1, P2, P3, P4, P5) and four resources (R1, R2, R3, R4). There are no current outstanding queued unsatisfied requests.

Currently Available Resources

R1	R2	R3	R4
2	1	2	0

Process	Current Allocation				Max Need				Still Needs			
	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4
P1	0	0	1	2	0	0	3	2	0	0	2	0
P2	2	0	0	0	2	7	5	0	0	7	5	0
P3	0	0	3	4	6	6	5	6	6	6	2	2
P4	2	3	5	4	4	3	5	6	2	0	0	2
P5	0	3	3	2	0	6	5	2	0	3	2	0

1. **[5 marks]** Is this system currently deadlocked, or can any process become deadlocked? Why or why not? If not deadlocked, give an execution order.
 2. **[3 marks]** If a request from a process P1 arrives for (0, 4, 2, 0), can the request be immediately granted? Why or why not? If yes, show an execution order.
 3. **[3 marks]** If a request from a process P2 arrives for (0, 1, 2, 0), can the request be immediately granted? Why or why not? If yes, show an execution order.
- C. **[3 marks]** Explain why mobile operating systems such as iOS and Android do not support swapping?

QUESTION 5 (20 marks)

- A. For each of the following pairs of terms, identify the context(s) in which they occur. Then define each term and clarify the key difference(s) between the two terms.
1. “host OS” and “guest OS” **[3 marks]**
 2. “page” and “frame” **[3 marks]**
 3. “reference bit” and “dirty bit” **[3 marks]**
 4. “file” and “directory” **[3 marks]**
 5. “disk partition” and “file system volume” **[3 marks]**
- B. **[5 marks]** When multiple processes need to cooperate, there is a choice between shared memory and inter-process communication (IPC). Compare and contrast these two techniques. Make sure to clarify the role of the operating system in each.

QUESTION 6

- A. **[4 marks]** Explain how a scheduling algorithm could produce good throughput, but poor response time. Then explain how a scheduling algorithm could produce good response time, but poor throughput.
- B. **[6 marks]** There are many system processes active on any Linux system. These are typically created at system startup, and operate in the background as daemon processes.

Give three examples of system (daemon) processes in a Linux system, and briefly state their role in the operation of the system.

- C. [4 marks] One of the design decisions in OS memory management is the choice between swapping and paging. Define each of these terms, and clarify their respective roles in OS memory management.
- D. [6 marks] Below are three different techniques for organizing the data blocks for each file in a file system. Briefly describe each approach, identifying the strengths and weaknesses of each.
1. Contiguous allocation
 2. Linked allocation
 3. Indexed allocation.

QUESTION 7

- A. [6 marks] The readers and writers problem can be formulated in several ways with regard to which category of processes can be started when. Carefully describe *three* different variations of the problem, each one favoring (or not favoring) some category of processes. For each variation, specify what happens when a reader or a writer becomes ready to access the database, and what happens when a process is finished.
- B. [4 marks] Two computer science students, Keziah and Haward, are having a discussion about inodes. Keziah maintains that memories have gotten so large and so cheap that when a file is opened, it is simpler and faster just to fetch a new copy of the i-node into the inode table, rather than search the entire table to see if it is already there. Haward disagrees. Who is right and why?
- C. [5 marks] A typical printed page of text contains 50 lines of 80 characters each. Imagine that a certain printer can print 6 pages per minute and that the time to write a character to the printer's output register is so short it can be ignored. Does it make sense to run this printer using interrupt-driven I/O if each character printed requires an interrupt that takes 50 μ sec all-in to service?

- D. [2 marks] Let's assume you have exactly three page frames and they contain the pages A, B, and C. Construct a page reference sequence of 10 page accesses, including A, B, C and any other pages you want demonstrating that MIN produces a better hit rate than does LRU. Include the hit rates for each algorithm. [2marks]
- E. [3 marks] RAID level 3 is able to correct single-bit errors using only one parity drive. What is the point of RAID level 2? After all, it also can only correct one error and takes more drives to do so.

END OF EXAM

Omnium Optimi!!!



**THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF COMPUTER SCIENCE
CSC2202 - OPERATING SYSTEMS**

FINAL EXAM

Thursday 29th November, 2018

Time: 09:00 - 12:00HOURS

Duration: 3 HOURS

Venue: P207

INSTRUCTIONS

- This paper has a total of SEVEN(7) questions
- You must answer a total of FIVE(5) questions
- All questions carry equal marks (20 marks each)
- Clearly number all your answers
- Use the marks as a guide to the detail required in your answers while keeping your answers concise and relevant

Question 1 [20 marks]

1. (a) (5 points) What is the difference between a program (an executable file) and a process and how is a program transformed into a process?
- (b) (3 points) Professor Theu is playing with kittens. He throws out a yarn ball and the kittens all race to fetch it, but only one succeeds. There are 12 kittens. After playing with the ball for a moment, the kitten brings the yarn ball back, returns it to Professor Theu and gets a treat. Which of deadlock, race condition, or starvation can occur? Please explain
- (c) (4 points) Explain how a scheduling algorithm could produce good throughput, but poor response time. Then explain how a scheduling algorithm could produce good response time, but poor throughput.
- (d) (3 points) Why don't we typically allow user level processes to disable interrupts?
- (e) (5 points) Explain how you would enhance a multi-level feedback queue scheduler to support user specified process priorities. That is, a user has a way to indicate that some processes are more important than other processes.

Question 2 [20 marks]

2. Answer the following questions in a few sentences as necessary.
 - (a) (4 points) Typically a system call returns exactly once from an invocation. Name two Linux system calls that violate this behavior, and explain briefly how they violate the behavior.
 - (b) (6 points) Let's assume you have exactly three page frames and they contain the pages A, B, and C. Construct a page reference sequence of 10 page accesses, including A, B, C and any other pages you want demonstrating that MIN produces a better hit rate than does LRU. Include the hit rates for each algorithm.
 - (c) (2 points) A system is designed with the condition that no thread holding lock A can acquire lock B. What problem is this system designed to prevent?
 - (d) (2 points) Why does modern virtual memory support require hardware support?
 - (e) (2 points) Why on earth does the MIPS have a Random register? How would you use it?
 - (f) (4 points) A MIPS instruction stores a value from a general purpose register into memory. List as many different ways as possible that this instruction could cause an exception.

Question 3 [20 marks]

3. For each of the problems described below, indicate which of the following synchronization primitives is BEST suited for it. Explain briefly why you chose the primitive you did.

1. Counting semaphore
2. Lock with Condition Variable
3. Locks
4. Readers-Writers Locks
5. Monitors

- (a) (4 points) You have a bushel of apples. There are a pile of worms nearby. The bad news is that both you and the worms want to eat the apples. The good news is that the worms are willing to use whatever synchronization primitive you want. The worms don't mind if there are other worms or people eating the apple while they are munching away, but you are a bit squeamish and refuse to eat an apple while any worms are eating it (you are however, not so squeamish as to pass up an apple that currently has no worms, even if had worms in the past).

- (b) (4 points) You notice that the person you'd like to ask out on a date is wearing a mood ring. You decide that it's best to ask the person out when the mood ring is either blue or purple. Once again you find yourself in the fortunate situation that the mood ring contains an embedded controller capable of issuing appropriate synchronization operations before it changes color (and of course, you know how to use synchronization primitives as well). What synchronization primitive do you want to share with the mood ring to help you get a date?
- (c) (4 points) Professor Kumar has four cats and two hamsters. Her friend Mary has eleven cats. Kumar invites Mary's eleven cats over for a playdate. Each cat is allowed to play with either hamster, but only one cat can play with a particular hamster at any one time. The cats are clever beasts and know how to use synchronization primitives. What primitive to you want to use to grant the cats access to the hamsters?
- (d) (4 points) You've been giving a set of self-synchronizing chairs. The set supports the operations: `allocate_chair`, `free_chair`, `spin_all_chairs`, `throw_chair_down_stairs`. The set was manufactured by a company all of whose employees aced CSC2202. What primitive do you suppose they used to implement the chair interfaces?
- (e) (4 points) Every CSC2111 student was so excited about the Test 2 results that they wanted to schedule a meeting with Professor Kabemba. Naturally, she required proper synchronization to do so. What primitive did she pick?

Question 4 [20 Marks]

- 4. (a) (2 points) What other hardware mechanism can be used on a uniprocessor to achieve mutual exclusion?
- (b) (3 points) What are the three main purposes of an operating system?
- (c) (2 points) List two reasons why an operating system designer might choose not to have user threads map 1:1 with kernel threads.
- (d) (3 points) For each of the following traps, indicate whether the trap is synchronous or asynchronous with respect to a user-level program.
 - i. System Call
 - ii. Exception
 - iii. Interrupt
- (e) (2 points) Why might it be advantageous to keep a process running on the same processor on which it last ran (this is called processor affinity)?
- (f) (4 points) Imagine that you've been asked to build an operating system for a simple embedded processor. The processor has no virtual memory and no memory translation unit. What functionality must you build into your process loader if you wish to have multiple programs resident in memory?
- (g) (4 points) In a system with virtual memory, how can you share memory between two processes?

Question 5 [20 marks]

- 5. The Stoopid architecture has a 12bit, segmented, virtual address space. The top three bits of an address identify a segment. The next four identify a page number and the last five are offsets.

segnumber(3)	pgnumber(4)	offset(5)
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- (a) (2 points) How large (in bytes) are pages in this architecture?
- (b) (8 points) You are told that the architecture has a TLB, but that they haven't quite worked out the details of a) what each TLB entry looks like, and b) how many TLB entries they should include. Propose a TLB entry design then make (and justify) a suggestion for how many TLB entries they should have

- (c) (4 points) Assume that the architecture supports paging. How many entries would you expect to find in a page table?
- (d) (6 points) Stoopid Inc. has asked you to come in and consult for them. They know that NULL pointers are an endless source of bugs. They are trying to decide whether they can/should make the hardware guarantee that NULL pointers always cause faults or leave it to the operating system to enforce that.
 - i. Would it be possible for the hardware to guarantee that an access to the memory location referenced by a pointer whose value is NULL always generates faults? (How?)
 - ii. If the hardware designers either can't or don't provide that support, how would you design your operating system to make sure that accesses to the location referenced by a NULL pointer always generates a fault?

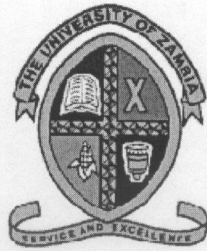
Question 6 [20 marks]

- 6. (a) For each of the following pairs of terms, identify the context(s) in which they occur. Then define each term and clarify the key difference(s) between the two terms.
 - i. (3 points) "host OS" and "guest OS"
 - ii. (3 points) "page" and "frame"
 - iii. (3 points) "reference bit" and "dirty bit"
 - iv. (3 points) "disk partition" and "file system volume"
 - v. (3 points) "host OS" and "guest OS"
- (b) (5 points) When multiple processes need to cooperate, there is a choice between shared memory and inter-process communication (IPC). Compare and contrast these two techniques. Make sure to clarify the role of the operating system in each.

Question 7 [20 marks]

- 7. (a) (5 points) Every file in a filing system has a set of attributes (read only, date created etc.) Assume a filing system allows an attribute of temporary, meaning the creating process only uses the file during the time it is executing and has no need for the data thereafter. Assume the process is written correctly, so that it deletes the file at the end of its execution. Do you see any reason for an operating system to have temporary file attribute? Give your reasons.
- (b) (5 points) An operating system supplies system calls to allow you to COPY, DELETE and RENAME a file.
Discuss the differences between using COPY/DELETE and RENAME to give a file new name?
- (c) (5 points) An operating system only allows a single directory hierarchy but allows arbitrary long filenames. Could you simulate something approximating a hierarchical file system? Give your reasons.
- (d) (5 points) When a file is removed, the blocks it occupies are simply placed back onto the free list. Can you see any problems with this? If so, how would you overcome them and what problems, if any, would now exist and how would you resolve these?

END OF EXAM
Omnium Optimi!!!



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

**DATABASES AND INFORMATION SYSTEMS
MANAGEMENT SYSTEMS
CSC 2702**

Date: 4th DECEMBER 2018
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. Answer *all* the questions in Section A.
2. Choose *any THREE (3)* questions in Section B.

SECTION A

Answer ALL Questions in this section. Both questions carry an equal weight of **20 Marks**.

Question 1 [20 Marks]

- i. Define the following terms briefly in not more than 3 lines: [**5 Marks**]
 - a. *Database*
 - b. *Database program*
 - c. *Database System*
 - d. *Record*
 - e. *Attribute*
- ii. What is a DBMS, and what are its functions? (list at least 3 functions) [**5 Marks**]
- iii. Describe the main components you are likely to find in a DBMS environment?
[**5 Marks**]
- iv. Give at least 5 reasons why the file based system approach is desirable over the database approach. [**5 Marks**]

Question 2 [20 Marks]

- i. Explain what it means to say a database displays both *entity integrity* and *referential integrity*? [**4 Marks**]
- ii. Define the following terms in relation to the database: [**4 Marks**]
 - a. Intentions
 - b. Extension
- iii. Draw a well labelled diagram of the ANSI-SPARC DBMS architecture and describe the different aspect of it. [**6 Marks**]
- iv. What are the three components that describe a data model? [**3 Marks**]
- v. State three categories in which you can classify data models? [**3 Marks**]

SECTION B

There are FOUR questions in this section. All questions carry an equal weight of **20 Marks**.

Choose only **three (3)** question!

Question 3

- i. In relation to Relational Database Model, list at least five (5) attributes that differentiate relations from tables. [**5 Marks**]
- ii. Suppose you wanted to apply for a Job in a database computing environment, what are the five (5) different roles you may likely find? [**5 Marks**]
- iii. What do you mean when you say “cardinality of the relation” and “degree of the relation” when you are talking about relational databases? [**4 Marks**]
- iv. What two conditions must be met before an entity can be classified as a weak entity? Give an example of a weak [**2 Marks**]
- v. Discuss the difference between a composite key and a composite attribute. How would each be indicated in an Entity Relationship Diagram? [**4 Marks**]

Question 4

- i. Define the following terms: [**5 Marks**]
 - a. *Composite key*
 - b. *Super key*
 - c. *Candidate key*
 - d. *Foreign key*
 - e. *Primary key*
- ii. Briefly describe the four (4) integrity constraints that are associated with relational database model? [**4 Marks**]
- iii. What is the difference between a “view” and “base relation”? [**2 Marks**]
- iv. Give at least 3 reasons why the file based system approach is undesirable over manual filing system? [**3 Marks**]
- v. What three data anomalies are likely to be the result of data redundancy? [**6 Marks**]

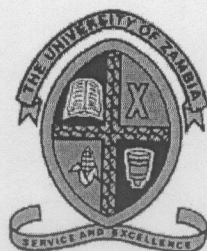
Question 5

- i. What is a partial dependency? With what normal form is it associated? **[4 Marks]**
- ii. Explain the difference between “Functional Dependency” and “Transitive Dependency”. **[4 Marks]**
- iii. When is a relationship in ER modelling said to be “recursive”? **[2 Marks]**
- iv. Define the following attributes and give example of each: **[6 Marks]**
 - a. Derived
 - b. Composite
 - c. Multi-valued
- v. Briefly, but precisely, explain the difference between single-valued attributes and simple attributes. Give an example of each. **[4 Marks]**

Question 6

- i. In database development process, what does the term “fact-finding” mean? **[2 Marks]**
- ii. State when “fact-finding” in Q6 (i) is particularly important during database development life cycle? **[2 Marks]**
- iii. Explain why “fact-finding” is crucial to the database development process? Especially to phase you have stated in Q6 (ii). **[4 Marks]**
- iv. State and briefly explain the five (5) most used fact-finding techniques you may adopt for your database design. **[10 Marks]**
- v. Why is a table whose primary key consists of a single attribute automatically in 2NF when it is in 1NF? **[2 Marks]**

---- End of Exam ----



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

**CSC 2702 DATABASES AND
INFORMATION MANAGEMENT SYSTEMS**

Date: 19th NOVEMBER, 2019
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. There are **two (2) Sections** in this exam, **Section A** and **Section B**.
2. In Section A, **Answer all the questions** and in Section B **choose any three (3) questions**.

SECTION A

Answer ALL Questions in this section. Both questions carry an equal weight of **20 Marks**.

Question 1 [20 Marks]

- i. Define the following terms briefly in not more than 3 lines: [**5 Marks**]
 - a. *Database*
 - b. *Database program*
 - c. *Database System*
 - d. *Record*
 - e. *Attribute*
- ii. What is a DBMS, and what are its functions? (list at least 3 functions) [**5 Marks**]
- iii. Describe the main components you are likely to find in a DBMS environment?
[**5 Marks**]
- iv. Give at least 5 reasons why the file based system approach is desirable over the database approach. [**5 Marks**]

Question 2 [20 Marks]

- i. Explain what it means to say a database displays both *entity integrity* and *referential integrity*? [**4 Marks**]
- ii. Define the following terms in relation to the database: [**4 Marks**]
 - a. *Intentions*
 - b. *Extension*
- iii. Draw a well labelled diagram of the ANSI-SPARC DBMS architecture and describe the different aspect of it. [**6 Marks**]
- iv. In relation to databases, explain what a data model is. Also state three components that describe a data model? [**3 Marks**]
- v. State three categories in which you can classify data models? [**3 Marks**]

SECTION B

There are FOUR questions in this section. All questions carry an equal weight of **20 Marks**.

Choose only **three (3)** question!

Question 3

- i. In relation to Relational Database Model, list at least five (5) attributes that differentiate relations from tables. [**5 Marks**]
- ii. Suppose you wanted to apply for a Job in a database computing environment, what are the five (5) different roles you may likely find? [**5 Marks**]
- iii. What do you mean when you say “cardinality of the relation” and “degree of the relation” when you are talking about relational databases? [**4 Marks**]
- iv. What two conditions must be met before an entity can be classified as a weak entity? Give an example of a weak [**2 Marks**]
- v. Discuss the difference between a composite key and a composite attribute. How would each be indicated in an Entity Relationship Diagram? [**4 Marks**]

Question 4

- i. Define the following terms: [**5 Marks**]
 - a. *Composite key*
 - b. *Super key*
 - c. *Candidate key*
 - d. *Foreign key*
 - e. *Primary key*
- ii. Briefly describe the four (4) integrity constraints that are associated with relational database model? [**4 Marks**]
- iii. What is the difference between a “view” and “base relation”? [**2 Marks**]
- iv. Give at least 3 reasons why the file based system approach is undesirable over manual filing system? [**3 Marks**]
- v. What three data anomalies are likely to be the result of data redundancy? [**6 Marks**]

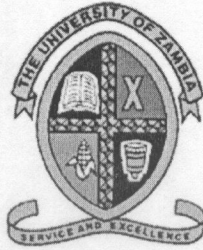
Question 5

- i. What is a partial dependency? With what normal form is it associated? [4 Marks]
- ii. Explain the difference between “Functional Dependency” and “Transitive Dependency”. [4 Marks]
- iii. When is a relationship in ER modelling said to be “recursive”? [2 Marks]
- iv. Define the following attributes and give example of each: [6 Marks]
 - a. Derived
 - b. Simple
 - c. Composite
 - d. Multi-valued
- v. Briefly, but precisely, explain the difference between single-valued attributes and simple attributes. Give an example of each. [4 Marks]

Question 6

- i. In database development process, what does the term “fact-finding” mean? [2 Marks]
- ii. State when “fact-finding” in Q6 (i) is particularly important during database development life cycle? [2 Marks]
- iii. Explain why “fact-finding” is crucial to the database development process? Especially to phase you have stated in Q6 (ii). [4 Marks]
- iv. State and briefly explain the five (5) most used fact-finding techniques you may adopt for your database design. [10 Marks]
- v. Why is a table whose primary key consists of a single attribute automatically in 2NF when it is in 1NF? [2 Marks]

---- End of Exam ----



THE UNIVERSITY OF ZAMBIA

School of Natural Sciences

Department of Computer Science

DEFERRED FINAL EXAMINATION

DISCRETE STRUCTURES CSC 2901

Date:	WEDNESDAY 26 TH MAY, 2018
Time:	14:00hrs – 17:00hrs
Duration:	3 Hours
Venue:	SPORTS HALL

Instructions

- There are TWO (2) sections in this examination paper. Section A has SIX (6), questions and you are required to answer ALL OF THEM. Section B has FIVE (5) questions and you are required to answer ANY THREE (3) OF THEM IN ANY ORDER.*
- Section A questions have 40 marks in total and all questions in section B have the weight of 20 marks each.*
- Kindly ensure that each question starts on its separate page or booklet.*

SECTION A: There are five (5) questions in this section and you are required to answer ALL of them. [40 Marks]

Question A1. By showing your work clearly and without using a calculator, find the following

a) Inverse of $7 \pmod{24}$ [4 Marks]

b) $7^8 \pmod{39}$ [4 Marks]

Question A2. Prove, by contraposition, that for a positive integer n , if n^2 is divisible by 2, then n is divisible by 2 [6 Marks]

Question A3. Let A and B be subsets of U . show that

a) $A \subseteq B \Rightarrow A - (A - B) = A$ [6 marks]

b) $(A - B) - (C \cup B')$ is a null set. [4 marks]

Question A4. Given that $S = \{1,2,3,4\}$ and $R = \{(1,2), (2,3), (3,4), (4,2), (2,1)\}$

a) Draw the digraph for R . [2 marks]

b) Find R^+ , the connectivity relation of R [6 marks]

c) Draw the digraph for R^+ [2 marks]

Question A5. Show that the function $f:R \rightarrow R$, defined as

$$f(x) = 3x^2 + 3$$

is not a bijection

[6 Marks]

SECTION B: There are five (5) questions in this section and you are required to answer only three (3) of them in any order. [60 Marks]

Question B1.

a) Consider the following algorithm.

Algorithm sum(n : positive integer)

$s := 0$

for $i := 1$ **to** n **do**

for $j := 1$ **to** i **do**

$s := s + j$

end for

end for

return s .

end.

i) Draw the flowchart for this algorithm

ii) Use a table to simulate how $sum(4)$ is evaluated. [10 Marks]

iii) How many times is the statement $s := s + j$ executed in ii) above? [6 marks]

[4 marks]

Question B2.

- a) Define the following
- i) A one to one function f [4 marks]
 - ii) An onto function f [4 Marks]
 - iii) An inverse of a function f [4 Marks]
- b) Prove that if $f(x) = \log(x)_2$ and $g(x) = 2^x$, then g and f are inverses of each other [4 marks]
- c) Let the function $f: Z^2 \rightarrow Z$ be defined as $f(x, y) = xy$
Show that f is onto but not one to one [4 marks]

Question B3.

- a) Let $(A, \cdot, +, ', 0, 1)$ be a Boolean algebra. Let $x, y \in A$. Prove the following identities analytically.
- i) $(x \cdot y)' = x' + y'$ [6 marks]
 - ii) $xy + xy' = x$ [4 marks]
- b) Let $F(x, y) = (x + y)(x'y)' + y$
- i) Draw the Logic network for F. [2 marks]
 - ii) Simplify the expression [8 Marks]

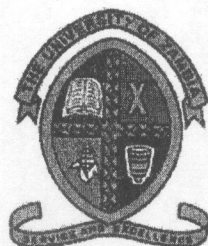
Question B4.

- a) State the sum rule for two sets [4 Marks]
- b) How many 3 digit numbers are divisible by
- i) 5? [4 Marks]
 - ii) 3? [4 Marks]
 - iii) 5 and 3? [4 Marks]
 - iv) 5 or 3 [4 marks]

Question B5.

- a) Assume that you are in a class of 20 students and your Discrete mathematics lecturer wants to constitute a team of 7.
- i) In how many ways can these teams be constituted? [5 marks]
 - ii) In how many ways can you be a member of the team? [5 Marks]
 - iii) Hence, what is the probability that you are chosen? [4 Marks]
- b) You pick two marble, one after the other, without replacing, from a bag containing 6 blue marbles and 4 red ones. What is the probability that the second marble picked is blue, given that the first one was red? [6 Marks]

*****END OF EXAMINATION*****



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

CSC 2901
DISCRETE STRUCTURES

FINAL EXAMINATION

Date: 10th JULY, 2018
Time: 14:00 hrs – 17:00 hrs
Duration: 3 Hours
Venue: P207

INSTRUCTIONS

1. This exam has two sections A and B.
2. Answer **ALL** the questions from **Section A**.
3. Answer **ANY three (3)** questions from Section B.
4. **Total number of questions answered should be five (5).**
5. Clearly identify the problem being solved.

SECTION A: THERE ARE FIVE (5) QUESTIONS IN THIS SECTION AND YOU ARE REQUIRED TO ANSWER ALL OF THEM. [40 MARKS]

Question A1. By showing your work clearly and without using a calculator, find the following

- a) Inverse of $7 \pmod{24}$ [4 Marks]
 b) $7^8 \pmod{39}$ [4 Marks]

Question A2. Prove, by contraposition, that for a positive integer n , if n^2 is divisible by 2, then n is divisible by 2 [6 Marks]

Question A3. Let A and B be subsets of U . show that

- a) $A \subseteq B \Rightarrow A - (A - B) = A$ [6 marks]
 b) $(A - B) - (C \cup B')$ is a null set. [4 marks]

Question A4. Given that $S = \{1,2,3,4\}$ and $R = \{(1,2), (2,3), (3,4), (4,2)\}$

- a) Draw the digraph for R . [2 marks]
 b) Find R^+ , the connectivity relation of R [6 marks]
 c) Draw the digraph for R^+ [2 marks]

Question A5. Show that the function $f:R \rightarrow R$, defined as

$$f(x) = 3x + 3$$

is a bijection [6 Marks]

SECTION B: THERE ARE FIVE (5) QUESTIONS IN THIS SECTION AND YOU ARE REQUIRED TO ANSWER ONLY THREE (3) OF THEM IN ANY ORDER. [60 MARKS]

Question B1.

- a) Consider the following algorithm.

Algorithm sum(n : positive integer)

```

s := 0
  for i := 1 to n do
    for j := 1 to i do
      s := s + j
    end for
  end for
returns.
    
```

end.

- i) Draw the flowchart for this algorithm [10 Marks]
 ii) Use a table to simulate how $sum(4)$ is evaluated. [6 marks]
 iii) How many times is the statement $s := s + j$ executed in ii) above? [4 marks]

Question B2.

- a) Define the following
- i) A one to one function f [4 marks]
 - ii) An onto function f [4 Marks]
 - iii) An inverse of a function f [4 Marks]
- b) Prove that if $f(x) = \log_2(x)$ and $g(x) = 2^x$, then g and f are inverses of each other [4 marks]
- c) Let the function $f: Z^2 \rightarrow Z$ be defined as $f(x, y) = xy$
Show that f is onto but not one to one [4 marks]

Question B3.

- a) Let $(A, \cdot, +, ', 0, 1)$ be a Boolean algebra. Let $x, y \in A$. Prove the following identities analytically.
- i) $(x \cdot y)' = x' + y'$ [6 marks]
 - ii) $xy + xy' = x$ [4 marks]
- b) Let $F(x, y) = (x + y)(x'y)' + y$
- i) Draw the Logic network for F . [2 marks]
 - ii) Simplify the expression [8 Marks]

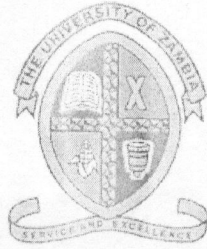
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- a) State the sum rule for two sets [4 Marks]
- b) How many 3 digit numbers are divisible by
- i) 5? [4 Marks]
 - ii) 3? [4 Marks]
 - iii) 5 and 3? [4 Marks]
 - iv) 5 or 3 [4 marks]

Question B5.

- a) Assume that you are in a class of 20 students and your Discrete mathematics lecturer wants to constitute a team of 7.
- i) In how many ways can these teams be constituted? [5 marks]
 - ii) In how many ways can you be a member of the team? [5 Marks]
 - iii) Hence, what is the probability that you are chosen? [4 Marks]
- b) You pick two marble, one after the other, without replacing, from a bag containing 6 blue marbles and 4 red ones. What is the probability that the second marble picked is blue, given that the first one was red? [6 Marks]

*****END OF EXAMINATION*****



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 2912
NUMERICAL ANALYSIS

Date : 19 NOVEMBER 2018
Time : 14:00hrs – 17:00HRS
Duration : 3 Hours
Venue : NSLT

Instructions

1. There are **two (2)** Sections in this exam, **Section A** and **Section B**.
2. In Section A, answer all the questions and in Section B **choose any three (3)** questions.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

1. Let $f: R \rightarrow R$ be a function defined on R . Define the following: [12 Marks]
a. Limit L of a f at x_0
b. Continuity of a f at x_0
c. Differentiability of a function at x_0
2. Suppose a number p_0 approximates p . Define the following [4 Marks]
a. Absolute error of this approximation
b. Relative error of this approximation
3. State the following theorems [18 Marks]
a. Rolle's theorem
b. Mean value theorem
c. Intermediate value theorem
d. Taylor's theorem
4. Suppose p_0 , approximates 100 to 5 significant digits. What is the range of p_0 ? [4 Marks]
5. Let a function f have a root in $[2, 3]$. How many iterations of the bisection method are required to approximate the root to 10^{-4} accuracy? [4 Marks]

SECTION B: ANSWER THREE (3) OF THE FOUR (4) QUESTIONS

1.
a. Prove that if a function f is differentiable at a point x_0 , then it is also continuous at x_0 . [10 Marks]
b. Use the mean value theorem to show that for an interval $[a, b]$, where $a > 0$, and $\left|\frac{1}{x}\right| \leq K, \forall x \in [a, b]$, [10 Marks]

$$\ln\left(\frac{b}{a}\right) \leq K|b - a|$$

2.
a. How many iterations are required to approximate $\sqrt{2}$ in $[1, 2]$ to 10^{-4} accuracy using the Bisection method? [10 Marks]
b. Use the Newton's method to approximate $\sqrt{2}$ to 10^{-4} accuracy. Let $p_0 = 1$ [10 Marks]

3.

a. Suppose $x_0 = 1, x_1 = 2,$ and $x_2 = 3,$ and you are given that $P_{0,1}(x) = 2x$ and $P_{0,2}(x) = x^2,$ find $P_{0,1,2}(2.5)$ [10 Marks]

b. Given the following data

x	1	2	3
y	1.6	4.4	12

Use the Newton's divided difference method to interpolate $f(1.5)$ [10 Marks]

4.

a. Estimate [8 Marks]

- i. $f'(3)$
- ii. $f''(2)$

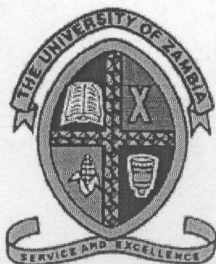
b. Estimate

$$\int_2^4 x^2 dx$$

using the composite [12 Marks]

- i. Trapezoidal rule, with $h = 1$
- ii. Simpson rule, with $n = 2$

*****END OF EXAMINATION*****



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 2912
Numerical Analysis

Date: 4TH NOVEMBER 2019
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: NSLT

Instructions

1. There are two (2) Sections in this exam, Section A and Section B.
2. In Section A, answer all the questions and in Section B choose any three (3) questions of the five (5) in any order.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION**[40 Marks]**

1. Define the following
 - a. Continuity of a function [3 Marks]
 - b. A fixed point of a function [3 Marks]
 - c. Differentiability of a function [3 Marks]
 - d. Relative error [3 Marks]

2. Concisely, state, without proof, the following theorems
 - a. Rolle's theorem [4 Marks]
 - b. Mean Value theorem [4 Marks]
 - c. Intermediate value theorem [4 Marks]
 - d. Taylor's theorem [4 Marks]
 - e. Fixed point theorem [4 Marks]

3. Prove that If a function is continuous in the interval $[a, b]$ and differentiable in the open interval (a, b) such that $f'(x) \neq 0$ for x in this interval, then f has at most one root, in the interval $[a, b]$ [8 Marks]

SECTION B: ANSWER THREE (3) OF THE FIVE (5) QUESTIONS.**[60 Marks]**

1.
 - a. Show that the graph of the equation $x^3 + 2x - 4 = 0$, crosses the x-axis exactly once in the interval $[1, 2]$ [8 Marks]
 - b. Approximate this root to 10^{-4} accuracy using the
 - i. Newton-Raphson method. [6 Marks]
 - ii. Secant method [6 Marks]

2.
 - a. Derive, P_4 , the fourth Taylor polynomial for the function $f(x) = e^x$ about the point $x_0 = 0$. [8 Marks]
 - b. Use P_4 to approximate \sqrt{e} . [4 Marks]
 - c. What is the relative error of this approximation? [4 Marks]
 - d. Using the remainder term, establish the upper bound of the error introduced by this approximation. [4 Marks]

3. Consider the function g defined below

$$g(x) = 1 + \frac{2}{1+x}$$

- a. Show that g has a unique fixed point in the interval $[1, 2]$ [8 Marks]

- b. Show that the fixed point of the g is the root of the function [6 Marks]

$$f(x) = x^2 - 3$$

- c. Hence, use the fixed point iteration method to approximate the number $\sqrt{3}$, to 10^{-3} accuracy. [6 Marks]

4. Consider the table of values of the function f at the given points of x

x	0.4	0.8	1.2
$f(x)$	2.225541	4.953032	11.02318

Approximate $f(0.5)$ using

- a. Neville's Iterated method [10 Marks]
 b. Newton's Forward Divided Differences [10 Marks]

5. Given the set of points for f below.

x	0.2	0.4	0.6	0.8	1.0
$f(x)$	1.105171	1.221403	1.349859	1.491825	1.648721

- a. Using $h = 0.4$, approximate
 i. $f'(0.6)$ [4 Marks]
 ii. $f'(0.2)$ [4 Marks]
 b. Evaluate

$$\int_{0.2}^{1.0} f(x) dx$$

Using Composite

- i. Trapezoidal rule $n = 2$ [6 Marks]
 ii. Simpson rule with $n = 2$ [6 Marks]

*****END OF EXAMINATION*****

The University of Zambia Examination 2019
School of Natural Science
Department of Computer Science
Digital Electronics CSC 3120

Time: 3 Hours

Instructions: Answer any 5 questions

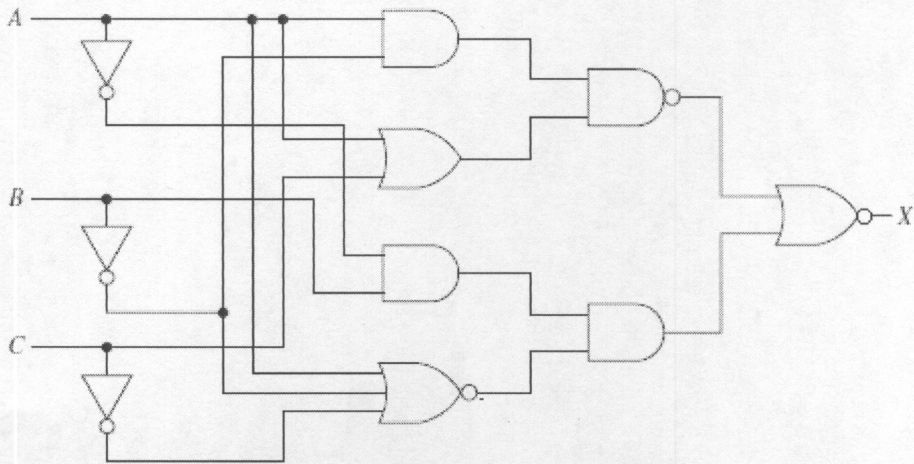
All questions carry 20 marks

1.

- a. Using Karnaugh map design a circuit which outputs a low when a number is a prime and a high when it is not a prime. The input is a 4 bit binary number. [11]
- b. Perform 2twos complement to perform the following
 - i. $52 - 84$ [5]
 - ii. $112 - 67$ [4]

2.

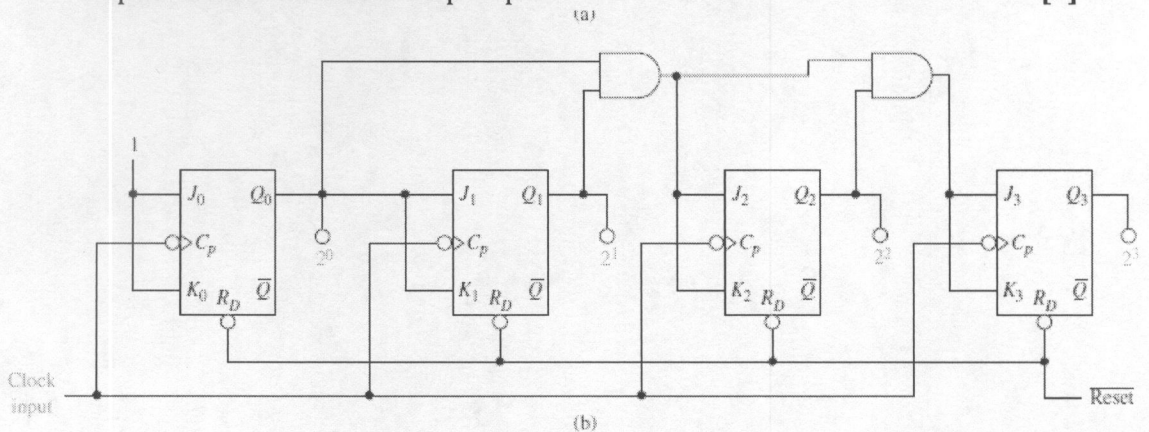
- a. Using Boolean algebra and DeMorgan's theorem to simplify the circuit below. [15]



- b. For the simplified circuit implement it using only NAND gates. [5]

3.

- a. Design a modulus ripple counter that counts from 0 up to 6. Draw the output waveforms. [10]
- b. What is the advantage of using synchronous counters over ripple counters? [3]
- c. Briefly explain how a synchronous counter shown below functions. Draw the output waveforms for each flip-flop. [7]

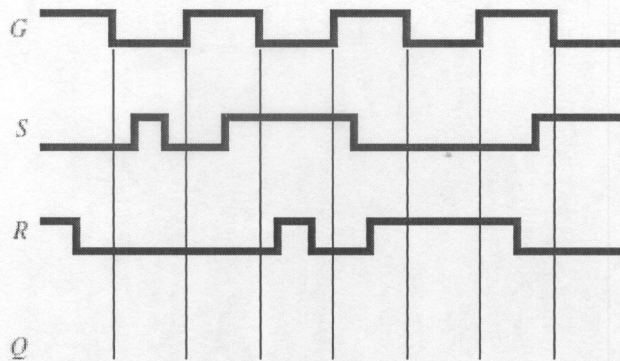


4.

- a. Draw a 4 bit Johnson shift register. Draw the output waveforms for each clock pulse. [12]
- b. Design a binary comparator circuit using exclusive-ORs and a NOR gate that will compare two 4-bit binary strings. [8]

5.

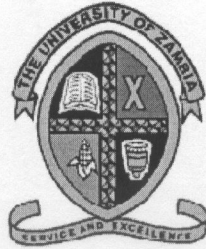
- a. Sketch the Q output waveform for a gated S - R flip-flop given the inputs at S , R , and G shown in below. [8]



6.

- b. Draw a four bit parallel in serial out shift register using J - K flip flops. [12]
- a. Draw an inverter using CMOS transistors. [8]
- b. Briefly explain the difference between static RAM and dynamic RAM. What are the advantages of each? [6]
- c. What is read only memory (ROM) used for? Name three types ROM. [6]

END OF EXAMINATION



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 3202
ARTIFICIAL INTELLIGENCE

Date: 21st NOVEMBER 2018
Time: 9:00hrs – 12:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. There are **two (2) Sections** in this exam, **Section A** and **Section B**.
2. In Section A, **answer all the questions** and in Section B **choose any three (3) questions of the four (4)**.

SECTION A: ANSWER ALL QUESTIONS

1. Define the following
 - a. an agent [2 Marks]
 - b. deterministic agent environment [2 Marks]
 - c. dynamic agent environment [2 Marks]
 - d. a local search algorithm [2 Marks]
 - e. a complete search algorithm [2 Marks]
 - f. an admissible heuristic [2 Marks]
 - g. a consistent heuristic [2 Marks]
 - h. entailment of a sentence by a knowledgebase [2 Marks]
 - i. a valid sentence (in PL) [2 Marks]
 - j. a non-satisfiable sentence (in PL) [2 Marks]
 - k. a sound inference rule [2 Marks]
 - l. a constraint satisfaction problem (CSP) [2 Marks]
2. List the different types of agents. [4 Marks]
3. Describe what the PEAS task environment of an agent is. [4 Marks]
4. Briefly describe the components of a search problem. [5 Marks]
5. Discuss the similarities and differences between the Hill-climbing and Simulated Annealing local search algorithms. [3 Marks]

SECTION B: ANSWER THREE OF THE FOUR QUESTIONS

1.
 - a. Prove that if a heuristic is consistent then it is admissible. [4 Marks]
 - b. Suppose the farmer problem (discussed in class) has the following state representation $fwgc$ where $f,w,g,c \in \{0, 1\}$, 0 is for east side of the river and 1 is west side of the river and the initial state is 0000.
 - i. List the four operators for this problem. [4 Marks]
 - ii. Formulate a heuristic for this problem. [4 Marks]
 - iii. Draw a search tree for A^* , using the heuristic above, with no return to ancestor and show the path to the goal. Assume each operator costs 1. [8 Marks]
2.
 - a. Explain the different techniques used in CSPs to guide the order in which the values are assigned to variables [8 Marks]
 - b. Describe how you would formulate any one of the following two problems as a CSP. [Hint: identify the specific components in the problem domain to formulate a CSP e.g. state representation, variables, constraints, values etc.] [6 Marks]

- i. School time-tabling
or
- ii. Map colouring

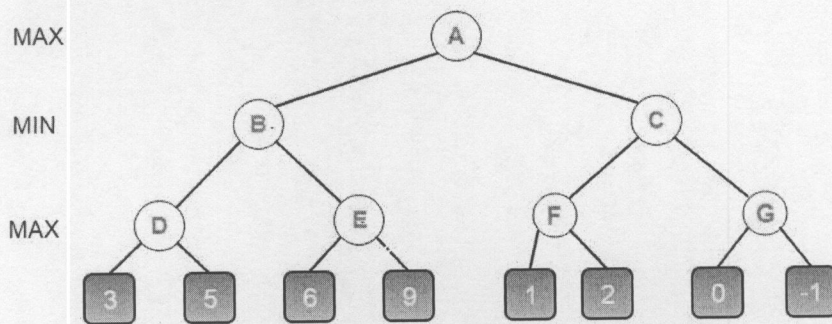
c. Describe the algorithm for solving the problem formulated above [6 Marks]

3.

a. Describe, clearly, how the MinMax algorithm operates. [8 Marks]

b. How does the alpha-beta improve the MinMax algorithm? [4 Marks]

c. Perform the Minmax algorithm, with apha-beta pruning, on the game tree below and show the move played by MAX and the branches of the tree which are not traversed. [8 Marks]



4.

a. State the following inference rules

- i. Modus Ponens
- ii. Resolution

[2 Marks]

[2 Marks]

b. Given the following knowledgebase

IF the battery is good then there is electricity. IF there is electricity and the sparkplugs are good then the sparkplugs will fire. IF the sparkplugs fire and there is gas then the engine will run. IF the engine runs and there are good tires, then the car will move.

i. Translate this knowledgebase into PL.

[6 Marks]

ii. Suppose that you are given the facts that there is gas in the tank, the battery is charged, the fuel line and cables are both okay, and the plugs are clean. Prove that the engine runsbackward chaining

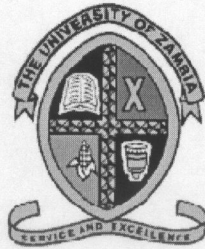
[6 Marks]

c. Translate the statement, "none of my friends are perfect" into FoL using the

- i. Universal quantification
- ii. Existential quantification

[2 Marks]

[2 Marks]



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 3600
SOFTWARE ENGINEERING

Date: 6th DECEMBER 2018
Time: 09:00hrs – 12:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. Answer *all* the questions in Section A and choose any *three (3)* questions from Section B

SECTION A
ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION 1 [20 marks]

- A. What are the differences between a software life cycle model and a process model?
[4 marks]
- B. Giving reasons for your answer based on the type of system being developed, suggest the most appropriate generic software process model that might be used as a basis for managing the development of the following systems: **[8 marks]**
- i. A system to control anti-lock braking in a car
 - ii. A virtual reality system to support software maintenance
 - iii. A university accounting system that replaces an existing system
 - iv. An interactive travel planning system that helps users plan journeys with the lowest environmental impact
- C. Based on your experience with a bank ATM, draw an activity diagram that models the data processing involved when a customer withdraws cash from the machine.
[8 marks]

QUESTION 2 [20 marks]

- A. When describing a system, explain why you may have to design the system architecture before the requirements specification is complete. **[6 marks]**
- B. What is the difference between a scenario and a use case? When do you use each construct? **[6 marks]**
- C. What is the difference between a task and an activity? **[4 marks]**
- D. What is the purpose of modeling? **[4 marks]**

SECTION B
ANSWER ANY THREE (3) QUESTIONS IN THIS SECTION

QUESTION 3 [20 marks]

- A. Identify the objects from the following dental office problem statement:

Tom is starting a dental practice in a small town. He will have a dental assistant, a dental hygienist, and a receptionist. He wants a system to manage the appointments.

When a patient calls for an appointment, the receptionist will check the calendar and will try to schedule the patient as early as possible to fill in vacancies. If the patient is happy with the proposed appointment, the receptionist will enter the appointment with patient name and purpose of appointment. The system will verify the patient name and supply necessary

details from the patient records including the patient's ID number. After each exam or cleaning, the hygienist or assistant will mark the appointment as completed, add comments, and then schedule the patient for the next visit if appropriate.

The system will answer queries by patient name and by date. Supporting details from the patient's records are displayed along with the appointment information. The receptionist can cancel appointments. The receptionist can print out a notification list for making reminder calls 2 days before appointments. The system includes the patient's phone numbers from the patient records. The receptionist can also print out daily and weekly work

schedules with all the patients. **[8 marks]**

- B. Draw an object model for the dental office problem **[8 marks]**
- C. Draw a use case diagram for the dental office problem **[4 marks]**

QUESTION 4 [20 marks]

A small specialist language training company would like to improve the services offered to existing clients and increase its client base by replacing existing call centre and paper-based mailshots, with online web technology deployment.

- A. As a consultant requirements engineer, discuss the tools and techniques that you would deploy to elicit, analyse, document, and check services requested by the company and any actual or implied constraints [12 marks]
- B. Discuss whether it is advantageous for the company to continue requirements engineering beyond the first phase of the development process. [8 marks]

QUESTION 5 [20 marks]

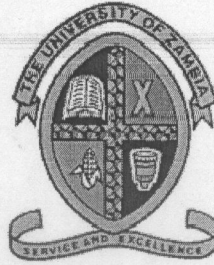
- A. Compare and contrast the main features and practices of the agile approach and more traditional approaches at each of the key phases of the software development life cycle. [12 marks]
- B. Discuss how the clearly identifiable good practices in agile methodologies can be effectively incorporated into any software life cycle environment [8 marks]

QUESTION 6 [20 marks]

A local transport service requires proprietary software that can manage passenger access of services by introducing automated entry and exit barriers.

- A. Briefly discuss the applicability of the following architectural models, and illustrate how each might be applied to the scenario described: [12 marks]
 - i. The repository model;
 - ii. *The client-server model*;
 - iii. The abstract machine model.
- B. Briefly discuss the potential benefits and challenges of code, architectural and design refactoring [8 marks]

END OF PAPER



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

IT PROJECT MANAGEMENT
CSC 3612

2018-2019 FINAL EXAM

Date: 12TH November 2019
Venue: P207
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours

Instructions

- 1. This examination has two sections A and B*
- 2. Section A comprises six [6] questions. Answer any four [4] questions. Each question carries 20 marks.*
- 3. Section B comprises one [1] question. Answer the question. It carries 20 marks*

Section A

Answer any four [4] questions. Each question carries 20 Marks

Question 1 [20 marks]

- A. Define project Management? List at least 4 advantages of using Project Management? [6]
- B. List the 10 characteristics of Organizational culture? [5]
- C. Explain the three sphere model of System Management with examples? [6]
- D. Map the PM processes groups in Project Integration Management and Project Quality Management? [3]

Question 2 [20 marks]

- A. Explain the different processes involved in Project Integration Management? [6]
- B. Explain the different methods in selecting Projects? [10]
- C. Briefly explain SWOT analysis with examples? [4]

Question 3 [20 marks]

- A. Explain the different methods in collecting requirements? [6]
- B. What is the best practice guidance on Creating a WBS and WBS dictionary? [6]
- C. What are the different approaches in developing WBS? [5]
- D. Give some suggestions for improving user input?[3]

Question 4 [20 marks]

- A. Write short notes on Activity List, Activity attributes and Milestone? [6]
- B. Explain the Arrow Diagramming Method and Precedence Diagramming Method? [6]
- C. How you use Critical Path Analysis to make schedule trade-offs? [4]
- D. What are the techniques used to shorten the project schedule? [4]

Question 5 [20 marks]

- A. Distinguish between Cost and Project Cost Management? Explain the different processes in Project Cost Management? [6]

B. Given the following information for a one-year project, answer the following questions.

Planned Value (PV)	= \$40,000
Earned Value (EV)	= \$30,000
Actual Cost (AC)	= \$50,000
Budget at completion (BAC)	= \$200,000

- i) What is the cost variance, schedule variance, cost performance index (CPI), and schedule performance index (SPI) for the project [4]
 - ii) How is the project doing? Is it ahead of schedule or behind of schedule? Is it under budget or over budget?[2]
 - iii) Use the CPI to calculate the estimate at completion (EAC) for this project, Is the project performing better or worse than planned? [1]
 - iv) Use the SPI to estimate how long it will take to finish this project? [1]
 - v) Sketch the earned value chart based for this project? [2]
- C. What is Project Portfolio Management? What are the benefits Portfolio Management? [4]

Question 6 [20 marks]

- A. Explain the different types of cost categories related to quality? [6]
- B. Explain the seven basic tools of quality that help in performing in quality control? [14]

Section – B [Compulsory]

[1x20 = 20 Mark]

Answer the question. This question carries 20 marks

Question 7 [20 marks]

- A. Create a Work Breakdown Structure [5] and Cost estimate model [5] for building a new, state-of-the-art multimedia classroom for your organization within the next six months. The classroom should include 20 high-end personal computers with appropriate software for your organization, a network server, Internet access for all machines, an instructor station, and a projection system. Be sure to include personnel costs associated with the project management for this project. Document the assumptions you made in preparing the estimate and provide explanations for key numbers.

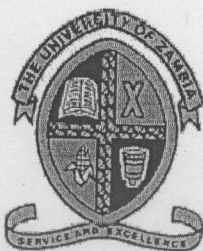
THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
2018/19 ACADEMIC YEAR FINAL EXAMINATIONS
GES 2210: FUNDAMENTALS OF PHYSICAL GEOGRAPHY

Time: Three hours

Instructions: Answer **any four** questions. All questions carry equal marks. Candidates are encouraged to make use of illustrations wherever appropriate. The use of an approved calculator is allowed

1. With reference to: dry adiabatic lapse rate, wet adiabatic lapse rate, dew point lapse rate, latent heat and sensible heat, describe what happens to a parcel of air as it rises to form clouds.
2. What is the earth's energy budget? Outline the energy exchanges that keep it in balance.
3. Name the three tectonic forces and describe any three features that result from each of these forces.
4. Describe the long profile of a stream, and composition of load at various sections of the stream from the headwaters to the mouth.
5. Using an example of the nitrogen cycle:
 - a) Draw a diagram showing the essential features of biogeochemical cycles
 - b) Describe the pathways linking the essential features
 - c) Explain the role of bacteria in this cycle
 - d) What are the human influences on this biogeochemical cycle?
6. Discuss the importance of organic matter and organisms in the soil.

END OF EXAMINATION



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 3712 ADVANCED DATABASES

Date: 15th NOVEMBER, 2019
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. There are two (2) Sections in this exam, **Section A** and **Section B**.
2. In Section A, **Answer all the questions** and in Section B choose **any three (3) questions**.

- d. What general (system) recommendations might you make to the shop manager? (For example, if the system will be integrated, what modules will be integrated? What benefits would be derived from such an integrated system? Include at least two general recommendations) **[10 Marks]**
- e. What is the best approach to conceptual database design? Why? **[5 Marks]**
- f. Name and describe at least four reports the system should have. Explain their use, and who will use those reports? **[4 Marks]**

SECTION B [60 Marks]

Choose ONLY three questions from this section. Each question has a total of 20 Marks.

Question 1. [20 Marks]

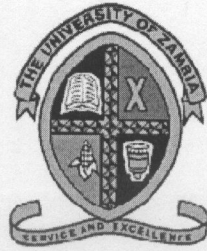
- i. During the process of normalization, what is referred to as partial dependency? **[2 Marks]**
- ii. What three data anomalies are likely to be the result of data redundancy? How can such anomalies be eliminated? **[6 Marks]**
- iii. Why is a table whose primary key consists of a single attribute automatically in 2NF when it is in 1NF? **[2 Marks]**
- iv. How would you describe a condition in which one attribute is dependent on another attribute, when neither attribute is part of the primary key? **[4 Marks]**
- v. Suppose that someone tells you that an attribute that is part of a composite primary key is also a candidate key. How would you respond to that statement? **[6 Marks]**

Question 2. [20 Marks]

- i. In your own terms, define what an information system is? **[2 Marks]**
- ii. Explain the purpose of information system. **[4 Marks]**
- iii. How do systems analysis and systems development fit into a discussion about information systems? **[4 Marks]**
- iv. Briefly describe the different phases of the Database Development Life Cycle. **[8 Marks]**
- v. What is the difference between a *request* and a *transaction*? **[2 Marks]**

- d) Individuals are given different roles in relationship to access control objects or resources.
Explain the roles in access control. **[5 marks]**

THE END



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 3742
INFORMATION AND NETWORK SECURITY

Date: 20th NOVEMBER 2018
Time: 09:00hrs – 12:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. There are **two (2) Sections** in this exam, **Section A** and **Section B**.
2. In **Section A**, **answer all the questions** and in **Section B** **choose any three (3) questions**.

SECTION A [40 marks]

ANSWER ALL QUESTIONS IN THIS SECTION

Question 1 [20 marks]

- a) How can the practice of information security be described as both an art and science?[2 marks]
- b) What does the history of information security begin with? [2 marks]
- c) Differentiate brute force password attack from dictionary password attack. [2 marks]
- d) What is the difference between vulnerability and exposure?[2 marks]
- e) List three commonplace security principles? [3 marks]
- f) Why is the C.I.A. triangle model generally viewed as no longer adequate in addressing the constantly changing environment? [2 marks]
- g) Why is the top-down approach to information security superior to the bottom-up approach? [2 marks]
- h) List three types of data ownership? [3 marks]
- i) How can a security framework assist in the design and implementation of a security infrastructure? [2 marks]

Question 2 [20 marks]

- a) What is risk management? Why is the identification of risks and vulnerabilities to assets so important in risk management?[3 marks]
- b) How can you protect against shoulder surfing?[1 mark]
- c) Where does the value of information come from and give an example?[2 marks]
- d) You are working for a certain organisation. To protect your organization's information, what must you do?[2 marks]
- e) What is the difference between a denial-of-service attack and a distributed denial-of-service attack? Which is more dangerous? Why?[3 marks]
- f) List the two goals of information security governance. [2 marks]
- g) Why does polymorphism cause greater concern than traditional malware?[1 mark]
- h) According to Sun Tzu, what two key understandings must you achieve to be successful in battle?[2 marks]
- i) What has led to the development of a more robust model that addresses the complexities of the current information security environment? [3 marks]
- j) What is residual risk?[1 mark]

SECTION B [60 marks]

ANSWER ANY THREE (3) QUESTIONS IN THIS SECTION

Question 3 [20 marks]

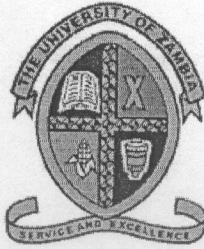
- a) Briefly describe management, operational, and technical controls, and explain when each would be applied as part of a security framework. [5 marks]
- b) Discuss the approaches to information security implementation. [5 marks]
- c) Briefly explain about the critical characteristics of information? [5 marks]
- d) Describe the mitigation strategy for controlling risk. What are the three planning approaches are used as opportunities to mitigate risk? [5 marks]

Question 4 [20 marks]

- a) Attempting to guess or reverse-calculate a password is often called cracking. There are a number of alternative approaches to password cracking. Discuss the approaches. [4 marks]
- b) What is intellectual property (IP)? Is it afforded the same protection in every country of the world? What laws currently protect IP in the United States and Europe? [6 marks]
- c) In the context of information security, social engineering is used by attackers to gain system access or information that may lead to system access. Discuss social engineering. [4 marks]
- d) What are the various types of malware? How do worms differ from viruses? [6 marks]

Question 5 [20 marks]

- a) Who is responsible for risk management in an organization? Which community of interest usually takes the lead in information security risk management? [5 marks]
- b) How do people from varying ethnic backgrounds differ in their views of computer ethics? [5 marks]
- c) What are the differences between a policy, a standard, and a practice? What are the three types of security policies? Where would each be used? [5 marks]
- d) Once an organization has developed its information security policies and standards, the information security community can begin developing the blueprint for the information security program. Discuss blueprint for the information security program. [5 marks]



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 3742
INFORMATION AND NETWORK SECURITY

Date: 5th NOVEMBER 2019
Time: 09:00hrs – 12:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. There are **two (2) Sections** in this exam, **Section A** and **Section B**.
2. In Section A, **Answer all the questions** and in Section B **choose any three (3) questions**.

SECTION A [40 Marks]

INSTRUCTION: Consider the **scenario** given below and answer the follow up questions. Answer **ALL** questions in this section. The marks culminates into 40% of 100 Marks.

SCENARIO: The ABC Car Service & Repair Centers are owned by the SILENT car dealer; ABC services and repairs only SILENT cars. Three ABC Car Service & Repair Centers provide service and repair for the entire state. Each of the three centers is independently managed and operated by a shop manager, a receptionist, and at least eight mechanics. Each center maintains a fully stocked parts inventory. Each center also maintains a manual file system in which each car's maintenance history is kept: repairs made, parts used, costs, service dates, owner, and so on. Files are also kept to track inventory, purchasing, billing, employees' hours, and payroll.

You have been contacted by the manager of one of the centers to design and implement a computerized database system.

Given the preceding information, do the following:

- a. Indicate the most appropriate sequence of activities by labeling each of the following steps in the correct order. (For example, if you think that "Load the database." is the appropriate first step, label it "1.") [11 Marks]

- _____ Normalize the conceptual model.
- _____ Obtain a general description of company operations.
- _____ Load the database.
- _____ Create a description of each system process.
- _____ Test the system.
- _____ Draw a data flow diagram and system flowcharts.
- _____ Create a conceptual model using ER diagrams.
- _____ Create the application programs.
- _____ Interview the mechanics.
- _____ Create the file (table) structures.
- _____ Interview the shop manager.

- b. Describe the various modules that you believe the system should include. [5 Marks]
- c. How will a data dictionary help you develop the system? Give two examples. [5 Marks]

Question 3 [20 Marks]

Consider the following relations defined by the relational schema below and normalize all the relations. [20 Marks]

Student (stuID, fName, lName, emailID, telNo)

Student_Course (studID, courseName, courseFee)

Student_Housing (studID, hostelName, hostelFee)

Student

studID	fName	lName	emailID	telNo
S001	X	Y	xy@gmail.com	09761000000
S002	U	V	uv@gmail.com	09730000000, 09654444444

Student_Course

studID	courseName	courseFee
S001	Artificial Intelligence	2000.00
S002		2500.00

Student_Housing

studID	hostelName	hostelFee
S001	Soweto	600.00
S002	Kafue	800.00

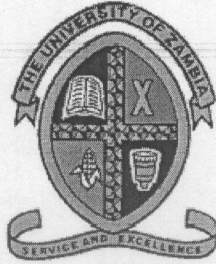
Question 4. [20 Marks]

- i. Discuss the distinction between centralized and decentralized conceptual database design. [4 Marks]
- ii. Distinguish between top-down and bottom-up approaches in database design. [4 Marks]
- iii. In database designing, what are commonly referred to as business rules? [2 Marks]
- iv. Explain why business rules are important to you as a database designer? [4 Marks]
- v. What factors are important in a DBMS software selection? [6 Marks]

Question 5. [20 Marks]

- i. Describe the three levels of backup that may be used in database recovery management?
[6 Marks]
- ii. The DBMS does not guarantee that the semantic meaning of the transaction truly represents the real-world event. What are the possible consequences of that limitation?
Give an example. [2 Marks]
- iii. List and discuss the four transaction properties. [8 Marks]
- iv. What is a transaction log, and what is its function? [2 Marks]
- v. What is a scheduler, what does it do, and why is its activity important to concurrency control?[2 Marks]

---- End of exam ----



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

MANAGEMENT INFORMATION SYSTEMS
CSC 3750

2018-2019 FINAL EXAM

Date: 8th November 2019
Venue: P207
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours

Instructions

- 1. This examination has two sections A and B*
- 2. Section A comprises six [6] questions. Answer any four [4] questions. Each question carries 20 marks.*
- 3. Section B comprises one [1] question. Answer the question. It carries 20 marks*

Answer any four [4] questions. Each question carries 20 Marks

Question 1 [20 marks]

- A. Define the term Management Information System? [2] Briefly explain the three dimensions of Information Systems? [6]
- B. You are starting a small bike messenger company. Given your type of services (hand-delivering packages within a small geographical area), could your firm be a digital firm? If so, what would make this a digital firm? [2]
- C. What is a Business Process? [2] Identify four functional area and give 2 examples of business processes in each area? [4]
- D. Explain the different tools used for collaboration and team work?[4]

Question 2 [20 marks]

- A. Identify and describe the features of organizations that help explain differences in organizations use of information systems?[5]
- B. Explain the impact of information systems in the organization? [5]
- C. How does the use of electronic voting machines act as a "double-edged sword?" What moral dimensions are raised by this use of information technology? [5]
- D. Identify the five moral dimensions that are involved in political, social, and ethical issues and briefly describe each. Of these, which do you think is the most difficult for society to deal with? Support your opinion. [5]

Question 3 [20 marks]

- A. Explain how businesses can benefit from virtualization, green computing, and multicore processors?[6]
- B. Describe the evolving mobile platform and quantum computing? [4]
- C. Define big data and describe the technologies for managing and analyzing it? [6]
- D. Explain why data quality audits and data cleansing are essential? [4]

Question 4 [20 marks]

- A. Write short notes on Client/server computing, Packet switching and TCP/IP and connectivity?[6]
- B. How are RFID systems used in inventory control and supply chain management? [4]
- C. Define computer crime. Provide two examples of crime in which computers are targets and two examples in which computers are used as instruments of crime? [5]
- D. Explain the tools and technologies used for safeguarding the information systems? [5]

Question 5 [20 marks]

- A. How do enterprise systems help businesses achieve operational excellence? [5]
- B. Identify two classifications for supply chain software. For each classification, identify five capabilities? [5]
- C. List all the unique factors that makes E-commerce different? [4]
- D. Name and describe the principal e-commerce revenue models? [6]

Question 6 [20 marks]

- A. Define and describe the various types of enterprise-wide knowledge management systems and explain how they provide value for businesses? [6]
- B. Describe the role of the following in facilitating knowledge management: portals, wikis, social bookmarking, and learning management systems? [4]
- C. List all the Mintzberg's managerial roles? [5]
- D. List and describe the analytic functionalities provided by BI systems? [5]

B. Consider the following table, Network Diagram Data for a Small Project. All duration estimates or estimated times are in days; and the network proceeds from Node 1 to Node 9.

Activity	Initial Node	Final Node	Estimated Duration
A	1	2	2
B	2	3	2
C	2	4	3
D	2	5	4
E	3	6	2
F	4	6	3
G	5	7	6
H	6	8	2
I	6	7	5
J	7	8	1
K	8	9	2

- i. Draw an AOA network diagram representing the project. Put the node in numbers in circles and draw arrows from node to node, labelling each arrow with the activity letter and estimated time. [4]
- ii. Identify all of the paths on the network diagram and note how long they are. [4]
- iii. What is the critical path for this project and how long is it? [1]
- iv. What is the shortest possible time it will take to complete this project? [1]



THE UNIVERSITY OF ZAMBIA
School of Natural Science
Department of Computer Science

FINAL EXAMINATION

**CSC 4130: ADVANCED HARDWARE
DESIGN AND IMPLEMENTATION**

Date: Thursday, 22nd November 2018
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: P 207

Instructions

1. There are **six (6)** questions and **two (2)** Sections in this paper.
2. Each question carries **20 marks**,
3. You are required to answer a total of Five (5) Questions
 - a. Answer **all** the questions in **Section A**
 - b. Choose **any three (3)** questions from **Section B**

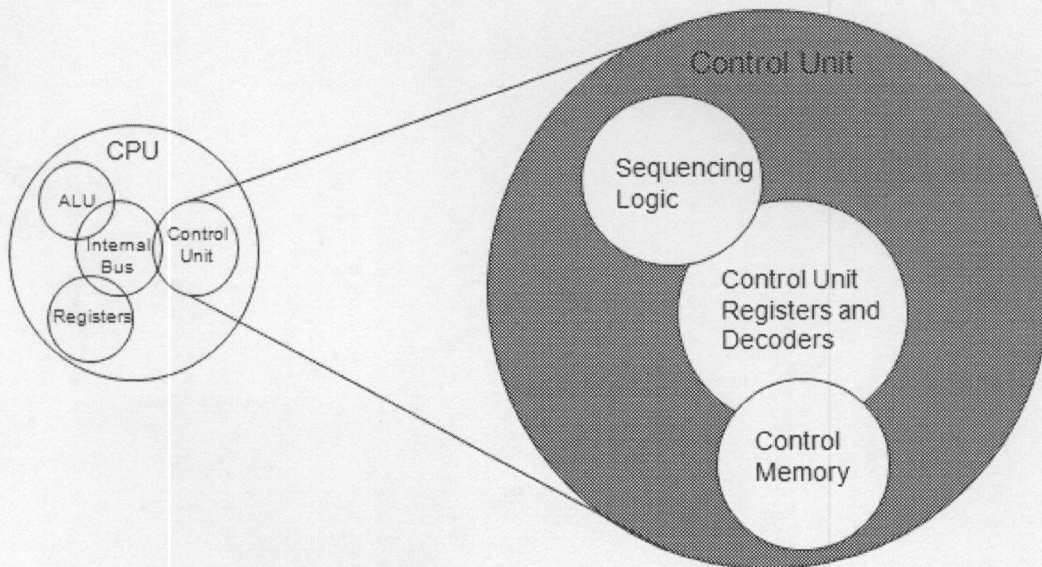
SECTION A

This section has Two Questions. Answer all the questions

Question I

a) The diagram below shows the sub-units of the CPU and control unit. In relation to the diagram below, give the function of each of the following with examples where possible [5 Marks]

- i. Sequencing Logic
- ii. Internal Bus
- iii. Memory Control
- iv. Central Unit Registers and Decoders
- v. ALU

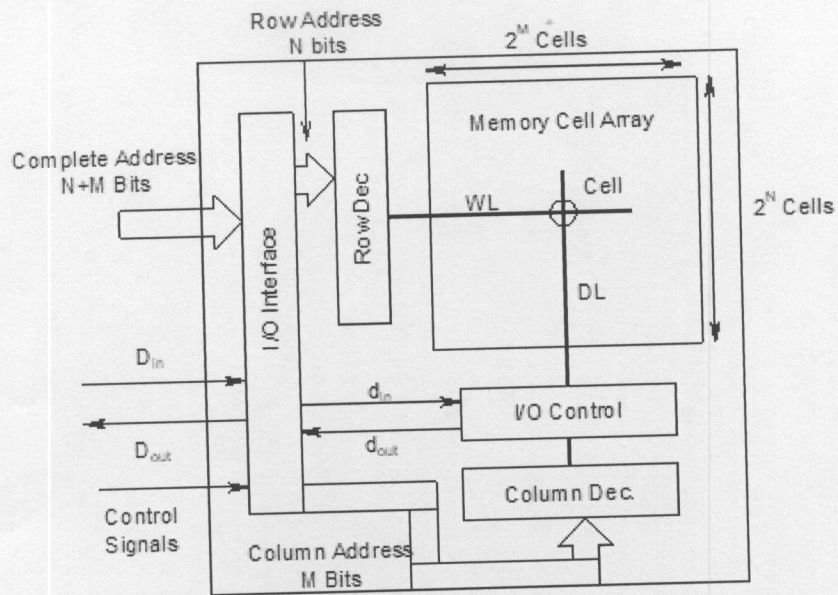


b) Machine language is a set of instructions executed directly by a computer's central processing unit (CPU). Each instruction performs a very specific task, such as a load, a jump, or an ALU operation on a unit of data in a CPU register or memory.

Write the machine code for the Intel 8085 microprocessor used to add two numbers 2H and 4H [5 Marks]

c) The diagram below shows the basic DRAM Chip Organization. Explain with reference to the diagram below how a computer stores and read data from memory using DRAM as examples. In your discussion make reference to [10 Marks]

- i. Row Decoder
- ii. Sensing Amps
- iii. Row Buffer
- iv. Column Decoder

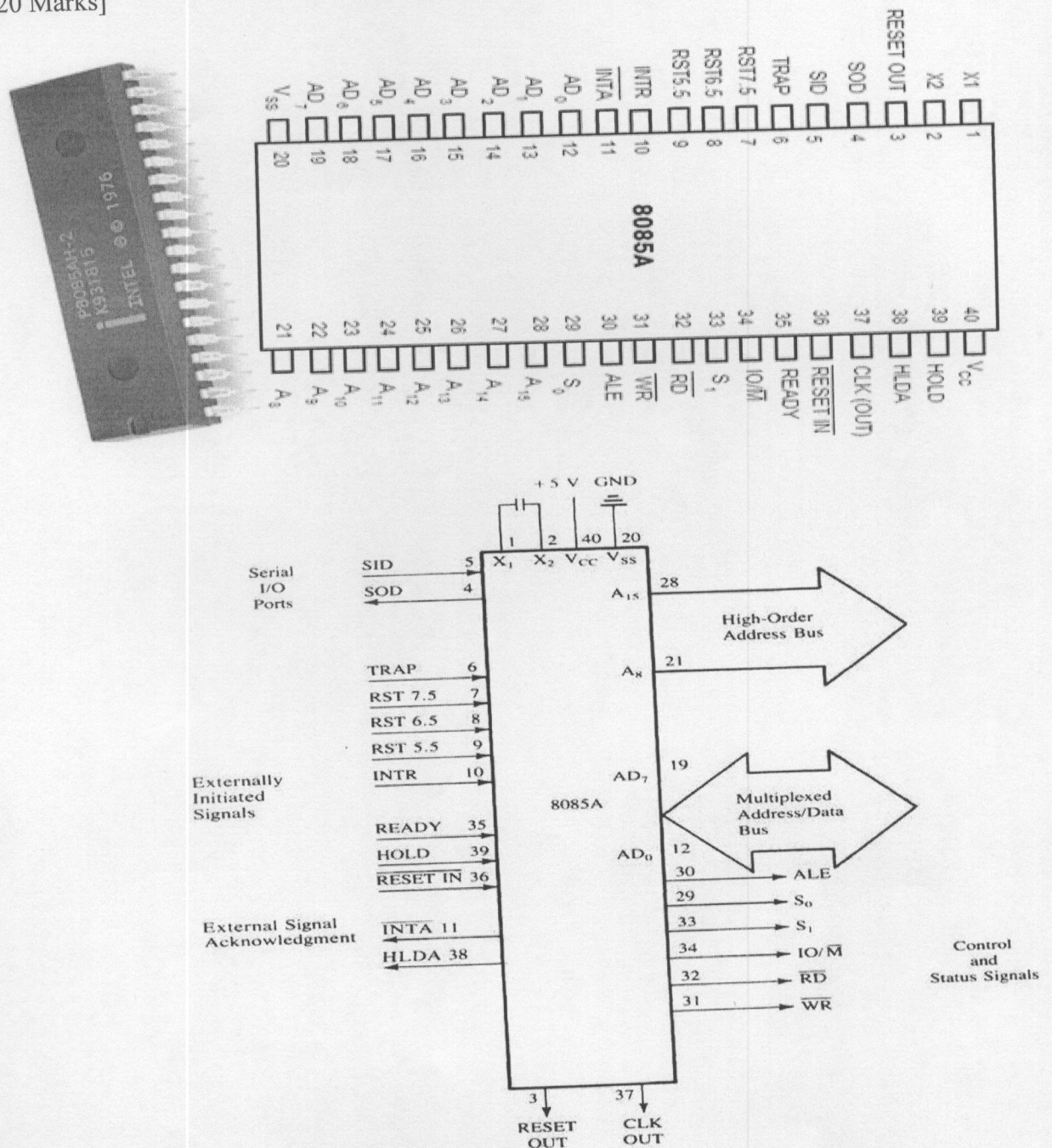


Question II

The diagram below shows the 8085 8-bit general purpose microprocessor that can address 64K Byte of memory. It has 40 pins and uses +5V for power. It can run at a maximum frequency of 3 MHz. The pins on the chip can be grouped into 6 groups:

- Address Bus
- Data Bus
- Control and Status Signals
- Power supply and frequency
- Externally Initiated Signals
- Serial I/O ports

Discuss in detail the functions each of the 40 PINs of the 8085 8-bit microcontroller [20 Marks]



SECTION B

This Section has Four Questions. Choose any Three questions

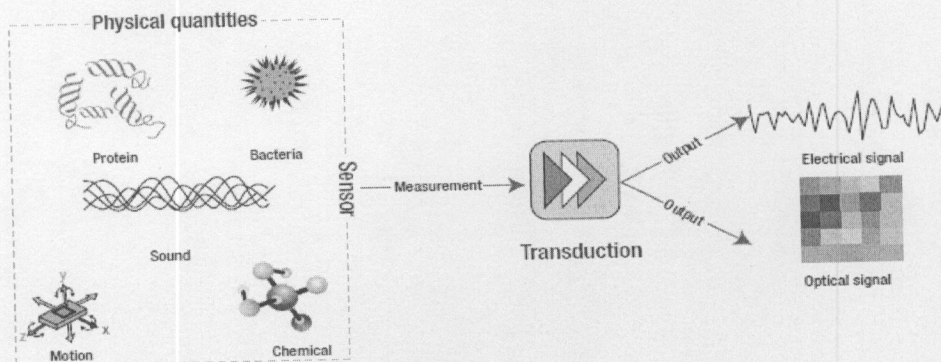
Question I

- a) Computer memory can be defined as any physical device capable of storing information temporarily or permanently. Give a brief description for each of the following in relation to computer memory [2 Marks]
- Bit
 - Word
- b) Draw a well labelled diagram showing the memory unit of the following [6 Marks]
- DRAM Memory Unit
 - SRAM Memory Unit
- c) **Memory signals** falls into three main types or categories as follows;
- Address bus
 - Data bus
 - Control signals
- With the aid of a diagram, discuss each of the three categories of memory signals above [3 Marks]
- d) An instruction is a command to the microprocessor to perform a given task on a specified data. Each instruction has two parts. One is task to be performed, called the operation code (opcode), and the second is the data to be operated on, called the operand. The operand (or data) can be specified in various ways. It may include 8-bit (or 16-bit) data, an internal register, a memory location, or 8-bit (or 16-bit) address. In some instructions, the operand is implicit. The 8085 instruction set is classified into the following three groups according to word size:
- One-word or 1-byte instructions
 - Two-word or 2-byte instructions
 - Three-word or 3-byte instructions
- Discuss** each of the categories by **giving at least one example in each case** based on the 8085 instruction set [9 Marks]

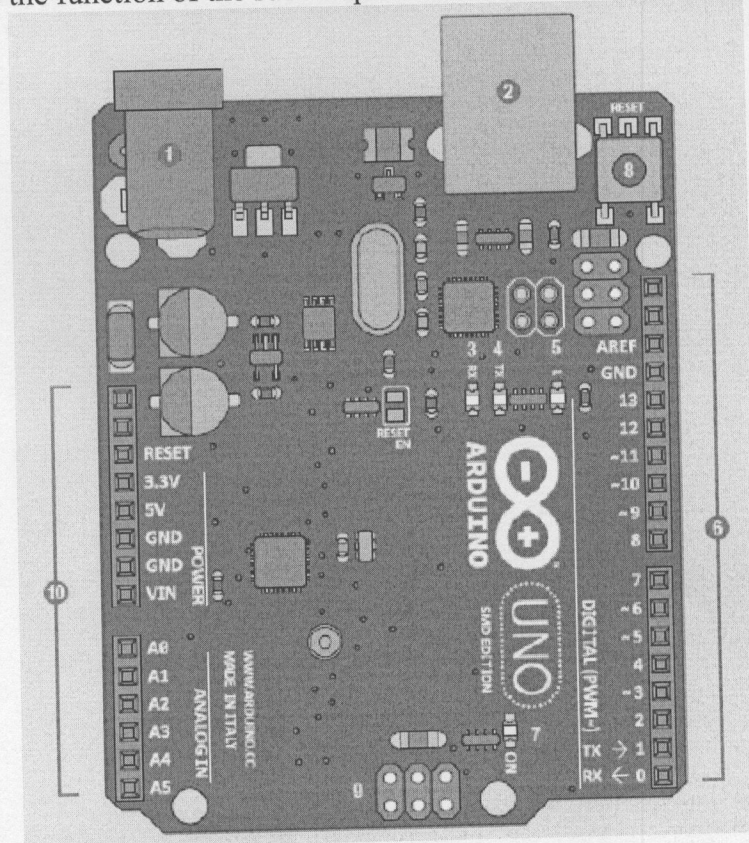
Question II

- a) A Sensor is a device that receives a stimulus and responds with an electrical signal. It is a special type of transducer (device that converts one type of energy into another as shown in the diagram below. Give at least two examples of the sensors in each category below [6 Marks]

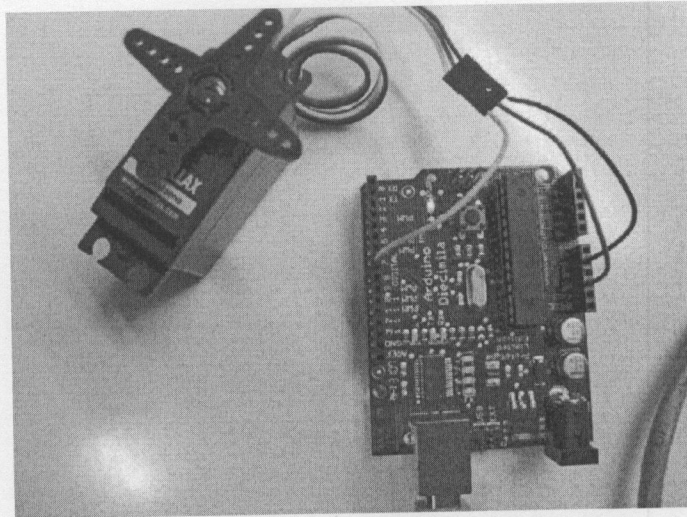
- i. Mechanical
- ii. Optical
- iii. Semiconductor



- b) The diagram below shows the Arduino board with the microcontroller ATmega328. Names and give the function of the subcomponents labels 1 to 10 [10 Marks]

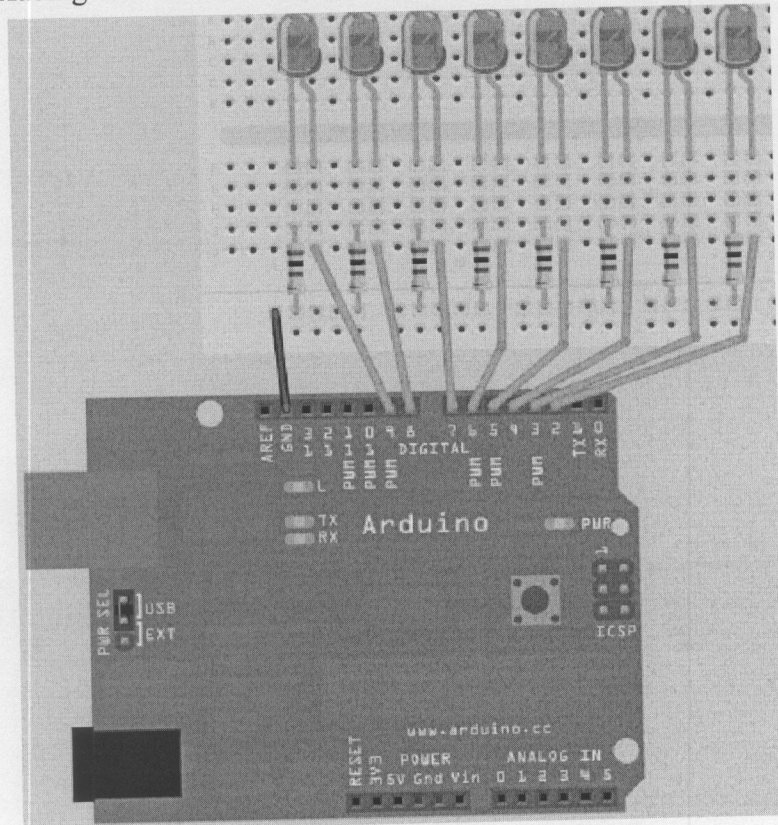


- c) A servo motor is a motor that pulses at a certain rate moving its gear at a certain angle. It has three connections: the black is ground, the red is connected to 5V, and the white (yellow wire) is set to the digital pin. Using PIN 13 as the digital PIN, write the full well commented code for Arduino Standard Servo Motor rotation to exact angel [4 Marks].



Question III

- a) To implement process control, the computer must collect data from and transmit signals to the production process. Give a brief description for each of the following in relation to computer process interfaces [6 Marks]
- Sensors
 - Actuators
 - Digital-to-Analog Conversion
- b) One of the famous TV show movies on our local ZNBC in the 1980s was **KNIGHT RIDER** movie? The car (called KITT) can talk and has a very light bar in front most people like to have one of it. The diagram below shows how to make the light bar using Arduino interfacing with 8 LEDs. Write the full code of this implementation [6 Marks].



- c) The various formats for specifying operands are called the ADDRESSING MODES. For the Intel 8085, these are classified as follows:
- Immediate addressing.
 - Register addressing.
 - Direct addressing.
 - Indirect addressing.
- With the aid of a diagram, discuss each of these categories [8 Marks]

Question IV

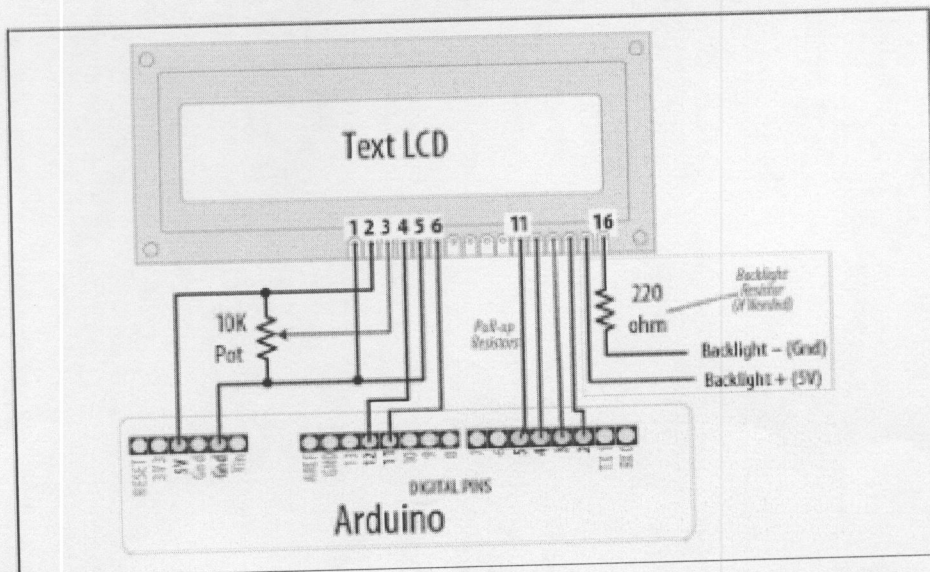
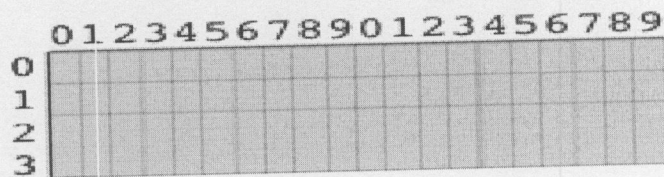
- a) An instruction is a binary pattern designed inside a microprocessor to perform a specific function. The entire group of instructions, called the instruction set, determines what functions the microprocessor can perform. The Intel 8085 instruction set can be classified into the following five functional categories:
- data transfer (copy) operations,
 - arithmetic operations,
 - logical operations,
 - branching operations, and
 - machine-control operations

Discuss each of the instruction set with at least one examples of the actual instruction performed by the Intel 8085 microprocessor [10 Marks].

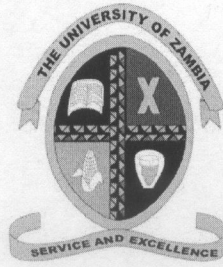
- b) The diagram below show the LCD Screen used as a character matrix on a 4 X 20 display and how to connect the LCD screen to the Arduino UNO Board. The Department of Computer Science has requested you to design and display the welcome message with the clock and counter of the number of people entering the department [10 Marks]

Write the full code that to display the following information on the screen below

- Row 0 and 1: Welcome Message (WELCOME TO COMPUTER SCIENCE DEPARTMENT). This should be scrolling message.
- Row 2: Display the Date and Time
- Row 3: Counter showing number of people entering Department



End of the Examination



THE UNIVERSITY OF ZAMBIA
School of Natural Science
Department of Computer Science

FINAL EXAMINATION

**CSC 4130: ADVANCED HARDWARE
DESIGN AND IMPLEMENTATION**

Date: Thursday, 7th November 2019
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: Upper Dinning Hall

Instructions

1. There are **six (6) questions** and **two (2) sections** in this paper.
2. Each question carries **20 marks**,
3. You are required to answer a total of Five (5) Questions
 - a. Answer **all** the questions in **Section A**
 - b. Choose **any two (2) questions** from **Section B**

SECTION A [40 MARKS]

ANSWER ALL THE QUESTIONS IN THIS SECTION

Question 1 [20 marks]

- a) What are industry-standard frameworks and reference architectures that are required by external agencies known as? [2 marks]
- b) What is the difference between a network intrusion detection system (NIDS) and a network intrusion prevention system (NIPS)? [2 marks]
- c) Which tool is most commonly associated with nation state threat actors? [2 marks]
- d) Which type of mutation completely changes a virus from its original form by rewriting its own code whenever it is executed? [2 marks]
- e) Name the data that is to be encrypted by inputting it into a cryptographic algorithm? [2 marks]
- f) What entity calls in crypto modules to perform cryptographic tasks? [2 marks]
- g) Name the attack that intercepts communications between a web browser and the underlying computer? [2 marks]
- h) John was explaining about an attack that accepts user input without validating it and uses that input in a response. What type of attack was he describing? [2 marks]
- i) Which type of log can provide details regarding requests for specific files on a system? [2 marks]
- j) Which version of Simple Network Management Protocol (SNMP) is considered the most secure? [2 marks]

Question 2 [20 marks]

- a) What is the category of threat actors that sell their knowledge of vulnerabilities to other attackers or governments? [2 marks]
- b) Alexei was given a key to a substitution cipher. The key showed that the entire alphabet was rotated 13 steps. What type of cipher is this? [3 marks]
- c) Which act requires banks and financial institutions to alert their customers of their policies in disclosing customer information? [2 marks]
- d) What is the general term used for describing software that gathers information without the user's consent? [3 marks]

- e) What is the difference between a DoS and a DDoS attack? **[3 marks]**
- f) What kind of attack is performed by an attacker who takes advantage of the inadvertent and unauthorized access built through three succeeding systems that all trust one another? **[2 marks]**
- g) What is the difference between NFC and RFID? **[3 marks]**
- h) Which stage is a “quality assurance” test that verifies the code functions as
- i) intended? **[2 marks]**

SECTION B [60 MARKS]

ANSWER ANY THREE (3) QUESTIONS FROM FOUR (4) IN THIS SECTION

Question 3 [20 marks]

- a) Why do attacks continue to be successful, despite all the efforts to stop them? **[5 marks]**
- b) Employee onboarding refers to the tasks associated with hiring a new employee (onboarding). There are several steps that should be taken to not only make the new employee feel part of the team but also so that the employee can become productive as soon as possible. Discuss any five steps. **[5 marks]**
- c) Enforcing technical access control using the various access control models is only one means of providing security. In addition, establishing a set of “best practices” for limiting access also can help secure systems and their data. Discuss any five best practices. **[5 marks]**
- d) Although there are many different authentication credentials that can be presented to an IT system to verify the genuineness of the user, all credentials can be classified into one of these five categories. Discuss the categories. **[5 marks]**

Question 4 [20 marks]

- a) Two broad categories of information security personnel are responsible for providing protection for an enterprise like a business or nonprofit organization. Discuss the four generally recognized security positions. **[5 marks]**

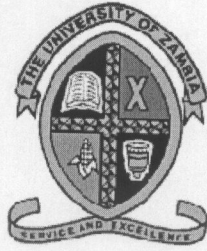
- b) Once accounts have been created, it is important that they be periodically maintained and audited to ensure they follow all enterprise policies. Discuss the audits that should be done. **[5 marks]**
- c) In an offline attack, threat actors steal the file of password digests and load that file onto their own computers. Several offline password attack techniques attempt to match an attacker's known password digest with stolen digests. Discuss any five offline attacks. **[5 marks]**
- d) Due to the widespread use of mobile devices, it is not always feasible to require an employee to carry a company-owned smartphone along with his own personal cell phone. Many organizations have adopted an enterprise deployment model as it relates to mobile devices. Discuss the enterprise deployment models. **[5 marks]**

Question 5 [20 marks]

- a) Malware (malicious software) is software that enters a computer system without the user's knowledge or consent and then performs an unwanted and harmful action. Discuss any five types of malware. **[5 marks]**
- b) Access control models are variously referred to as access control models, methods, modes, techniques, or types and there are five access control models. Explain the models. **[5 marks]**
- c) There are several vulnerabilities inherent to mobile devices. Discuss any five vulnerabilities. **[5 marks]**
- d) There are several attacks that can be directed against wireless data systems. Discuss any five attacks. **[5 marks]**

Question 6 [20 marks]

- a) Discuss four technologies that spyware uses. **[5 marks]**
- b) Despite providing widespread protections cryptography faces constraints (limitations) that can impact its effectiveness. Discuss the constraints. **[5 marks]**
- c) The challenge of keeping computers secure has never been greater, not only because of continual attacks but also because of the difficulties faced in defending against these attacks. Discuss any five difficulties. **[5 marks]**



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 4630
ADVANCED SOFTWARE ENGINEERING

Date: 11th DECEMBER 2018
Time: 09:00hrs – 12:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. Answer *all* the questions in Section A and choose any *three* (3) questions from Section B

SECTION A
ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION 1 [20 marks]

1. Consider an ATM system. Identify at least **four (4)** different actors that interact with this system **[4 Marks]**

2. Draw a class diagram representing the relationship between parents and children. Take into account that a person can have both a parent and a child. Annotate associations with roles and multiplicities. **[4 Marks]**

3. Outline in one paragraph the information you would need to gather in order to perform domain analysis for an airline reservation system. **[8 Marks]**

4. What differentiates a 3-tier client-server architecture from a 2-tier client-server architecture. **[4 Marks]**

QUESTION 2 [20 marks]

1. We discussed architectural styles, architectural design patterns and basic design patterns. Explain the difference between these concepts and when (during the development cycle) they could be used. Why would one even consider applying these methods? Is there any useful result in the short or long term for the software system? **[6 marks]**

2. Sometimes, sequence diagrams can be somewhat similar to the actual code. Why not just code up the algorithm? Why bother with sequence diagrams? **[4 Marks]**

3. What are two aspects of a software system design that are explicitly omitted from a UML class diagram? **[6 Marks]**

4. When is a good time to do paper prototyping in the software development process? **[4 Marks]**

SECTION B
ANSWER ANY THREE (3) QUESTIONS IN THIS SECTION

QUESTION 3 [20 marks]

Lusaka City Council (LCC) have hired your company to build a bus reservation system for all bus trips taken from Intercity Bus Terminal (IBT).

- A. Outline in one paragraph the information you would need to gather in order to perform domain analysis for the LCC IBT bus reservation system.

[7 marks]

- B. Requirements can be divided into four major types functional, quality, platform and process. Describe quality requirements and give 2 examples of main categories for quality requirements.

[3 marks]

- C. Classify the following aspects of the LCC IBT bus reservation system into F for functional, Q for quality, PL for platform, PR for process, and X for 'should not be a requirement'. Also indicate the subcategory of requirement. For something that should not be a requirement, explain why not.

- i. What information appears on tickets and reports.
- ii. How fares are calculated.
- iii. The system must be available at all times. Only 2 minutes' downtime a week is to be permitted.
- iv. The system must run on any Linux system.
- v. A merge-sort algorithm must be used to sort the flights by departure time.

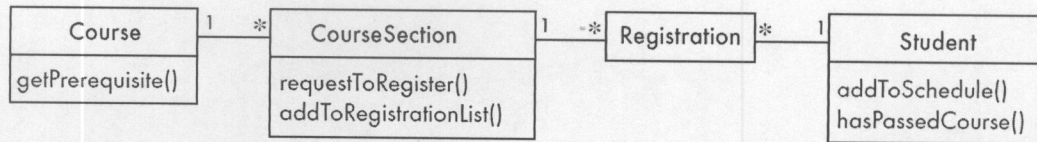
[5 marks]

- D. In describing *simplified use cases* of the LCC IBT bus reservation system, giving the **name** and **steps** of the use cases is enough, however your project manager insists that you describe *complete use cases*. State 5 other components you would add to the description of the use cases of the LCC IBT bus reservation in order to make them complete. Give a short explanation for each component that you state.

[5 marks]

QUESTION 4 [20 marks]

- A. The diagram below shows the classes involved in a fictitious Student Registration System (SRS) for the University of Zambia (UNZA). It shows the classes involved when a student attempts to register for a course.

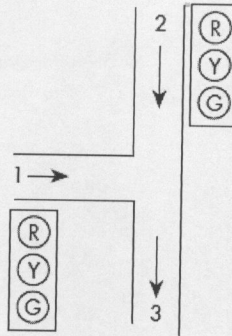


- i. Draw a **simple sequence diagram** based on the given class diagram that shows the interactions that occur in the UNZA SRS when a student attempts to register for a course. [4 marks]

 - ii. Assume that a student is only allowed to register for a course if he has passed the course prerequisites. Draw a new **detailed sequence diagram**, by expanding on your previous answer, showing a *GUI* and *Course* object as well as showing an *optional combined fragment* for the prerequisite. [8 marks]

 - iii. You can use communication diagrams as opposed to sequence diagrams to show the interactions occurring in the UNZA SRS since both types of diagrams contain much of the same information. Describe 4 situations/reasons that make sequence diagrams the better choice when depicting interaction within a software system diagrammatically. [4 marks]
- B. Assume the diagram below represents the road layout when exiting the UNZA Main Campus along Great East Road with a vehicle. Assume movement in the direction from 2 to 3 represents vehicles moving on Great East Road from Arcades roundabout to Manali roundabout. Traffic lights have been installed at this junction as follows:
- i. The traffic light at point 1 has three colors Green, Yellow and Red. When the system starts up the robot is Red.
 - ii. After startup, the system indefinitely rotates among Green, Yellow and Red. The Red light only stays on for 30 seconds, at which time the Green light comes on.
 - iii. The Green light stays on for 25 seconds, at which time the system changes to Yellow.
 - iv. After five more seconds the Yellow light gives way to the Red light again.

- v. Traffic moving from point 2 to 3 always has a Green light unless a vehicle arrives at point 1 and triggers a sensor.
- vi. When the sensor at point 1 is triggered, the robot their changes to Yellow, but only after the traffic coming from point 2 has had at least 25 seconds of Green light. Without this a steady series of vehicles arriving at point 1 would prevent the light at point 2 from staying green long enough for traffic to flow.



Draw a state diagram for the UNZA traffic light system described above, illustrating elapsed-time transitions. **[4 marks]**

QUESTION 5 [20 marks]

- A. Give the three basic principles for object-oriented design patterns. **[6 marks]**
- B. Give a concise description of the differences between the Facade and the Adapter pattern. **[6 marks]**
- C. For Kenneth Kaunda International airport information system, we have a class UserInfo. This class provides two services with respect to travelling to the airport. There are three ways of travelling: public transportation (train, tram, bus), private car and taxi. One service is calcTime(...), which gives an estimation of the travelling time to the airport. The other service is calcPrice(...), which gives an estimation of the price.

The UserInfo class has information about the desired arrival date and time, the starting place (from an address database) and the way of traveling. Which design pattern would you apply in this case? Draw a class diagram. Which parameters should the two methods have?

[8 marks]

QUESTION 6 [20 marks]

A. The Software Engineering Chair at University of Zambia has decided to set up a new coffee management system. These are the (informal) requirements:

- i. A coffee machine dispenses coffee at the press of a button.
- ii. There are different coffee flavors (espresso, cappuccino, or latte macchiato) with different prices.
- iii. Every user has an account on the coffee management system
- iv. Every user logs on to the system using some identification (a password or picture).
- v. Users choose the coffees they had (or will have) and mark them as “dispensed”.
- vi. The price for the coffee is automatically deducted from their account.
- vii. A special user (the “administrator”) can recharge user’s accounts.

1. Consider the scenario 1. A student gets a coffee.
Create a use case (use case description) for the above scenario including alternatives and exceptions. **[4 marks]**

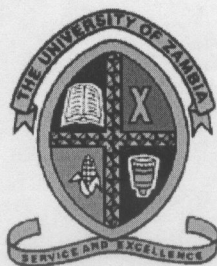
2. Design a user interface for the above use case as a series of screen shot sketches— again, including alternatives and exceptions. **[6 marks]**

3. Develop a class model for the coffee management system:

- Provide a UML system model listing:
 - classes
 - attributes
 - essential methods, and
 - relationships.

[10 marks]

END OF PAPER



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 4630
ADVANCED SOFTWARE ENGINEERING

Date: 26th NOVEMBER 2019
Time: 09:00hrs – 12:00hrs
Duration: 3 Hours
Venue: P207

Instructions

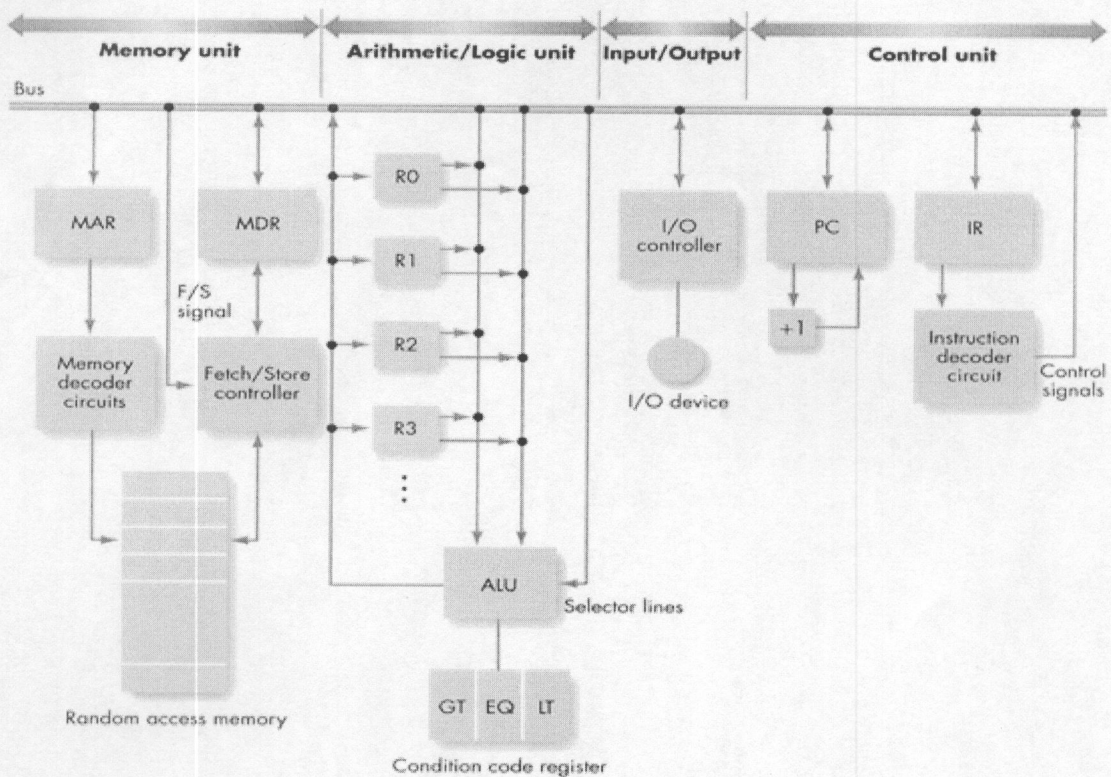
1. Answer *all* the questions in Section A and choose any *three* (3) questions from Section B

SECTION A

This Section has Three Questions. Answer all the questions

Question I

- a) The diagram below shows the Von Neumann architecture which has four functional units namely Memory unit, Input/Output unit, Arithmetic/Logic unit and Control unit. Briefly discuss the Von Neumann computer architecture below [2 Marks]



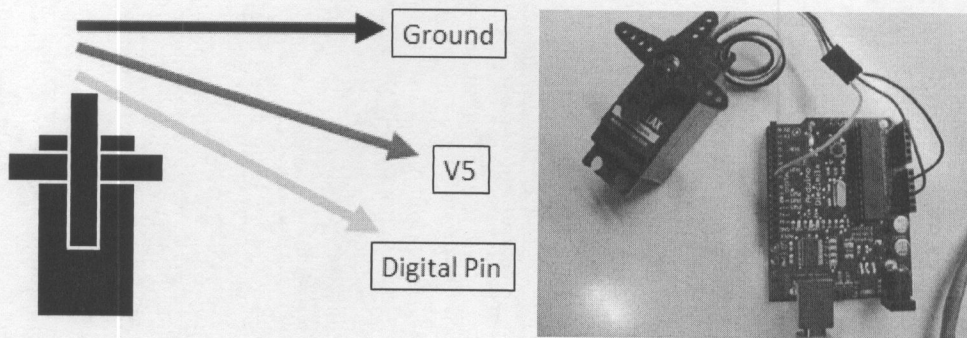
- b) Flynn's taxonomy is a classification of computer architectures. The classification system has been used as a tool in design of modern processors and their functionalities. Since the rise of multiprocessing central processing units, a multiprogramming context has evolved as an extension of the classification system. Discuss each of the following **None Von Neumann Architectures** below [8 Marks]
- Multiple instruction streams, multiple data streams (MIMD)
 - Multiple instruction streams, single data stream (MISD)
 - Single instruction stream, multiple data streams (SIMD)
 - Single instruction stream, single data stream (SISD)SIMD architecture

c) The 8085 instruction set is classified into the following three groups according to word size [6 Marks]

- i. One-word or 1-byte instructions
- ii. Two-word or 2-byte instructions
- iii. Three-word or 3-byte instructions

Briefly discuss each of the above Intel 8085 instruction set above

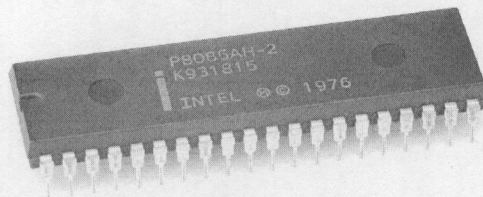
d) A servo motor is a motor that pulses at a certain rate moving its gear at a certain angle. It has three connections: the black is ground, the red is connected to 5V, and the white (yellow wire) is set to the digital pin.



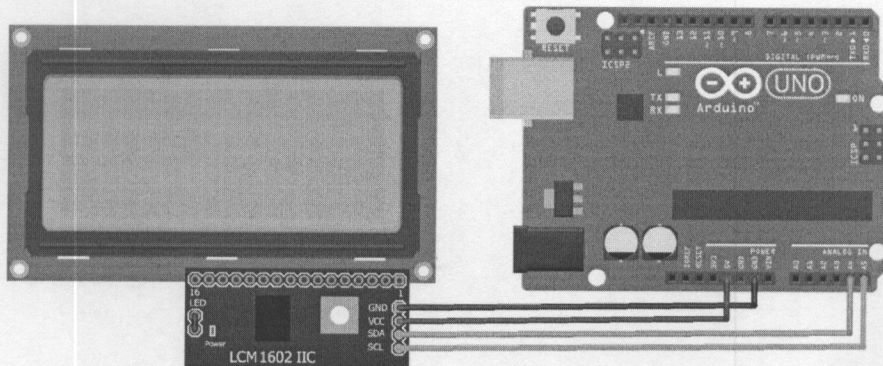
Using PIN 13 as the digital PIN, write the full well commented code for the **Arduino Standard Servo Rotation to Exact Angel** [4 Marks].

Question II

- a) Draw a well labelled diagram showing the following memory units. Discuss how each memory unit store a bit. [6 Marks]
- DRAM
 - SRAM
- b) The diagram below shows the intel 8085 Microprocessor chipset. The intel 8085 uses Machine language which is a set of instructions executed directly by the processing unit. Each instruction of the intel 8085 performs a very specific task, such as LOAD, JUMP, or an ALU operation on a unit of data in a CPU register or memory. **Write the machine code** for the Intel 8085 microprocessor used to [6 Marks]
- Add two numbers (11010011 and 10001010)
 - Subtract two numbers, 10001010 from 11010011



- c) The Department of Computer Science would like to improve on a number of services and features in the computer labs. As a fourth year student, you have been assigned to design and write the code for the prototype that would display the **Date, Time of the Day** and **Welcome Message** to anyone accessing the Computer Labs. The diagram below shows the setup for information display on the LCD screen with three rows. Write the full code to display the following [8 Marks]
- Row Number 1: **Time** (Hours: Minutes: Seconds)
 - Row Number 2: **Date** (Day, Month, Year)
 - Row Number 3: **Welcome Message as Scrolling Text** (WELCOME TO THE DEPARTMENT OF COMPUTER SCIENCE)

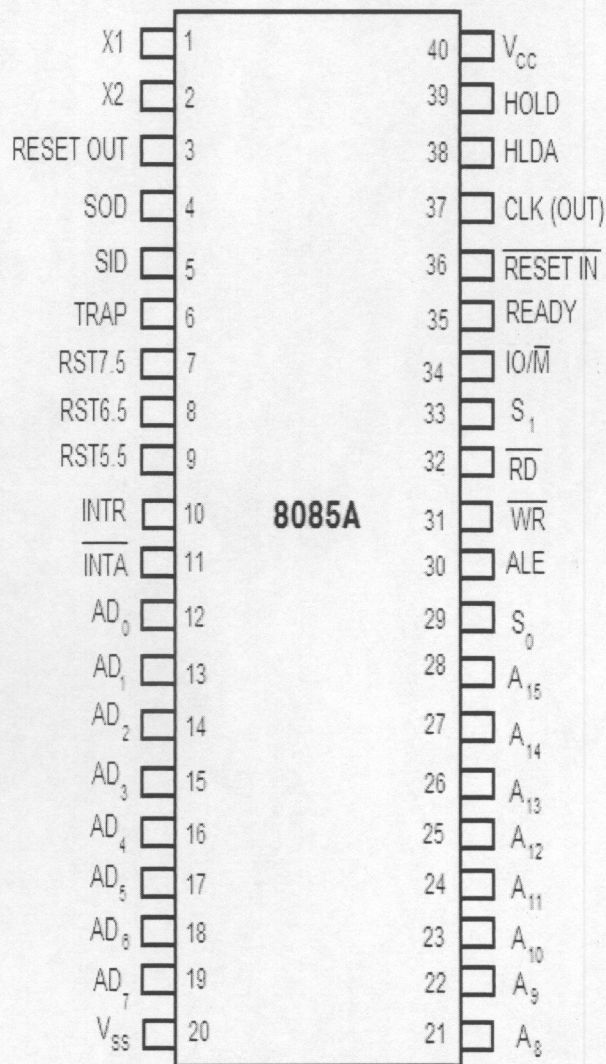


Question III

a) Computer memory can be defined as any physical device capable of storing information temporarily or permanently. Sequential circuits all depend upon the presence of memory. Briefly describe each of the following in relation to computer memory [4 Marks]

- i. Bit
- ii. Word
- iii. Memory Module
- iv. Memory Interfacing

b) The figure below show the Intel 8085 Pin configuration. With reference to the diagram below, Give the function of each of the 40 PINS of the Intel 8085 processor chip [16 Marks]

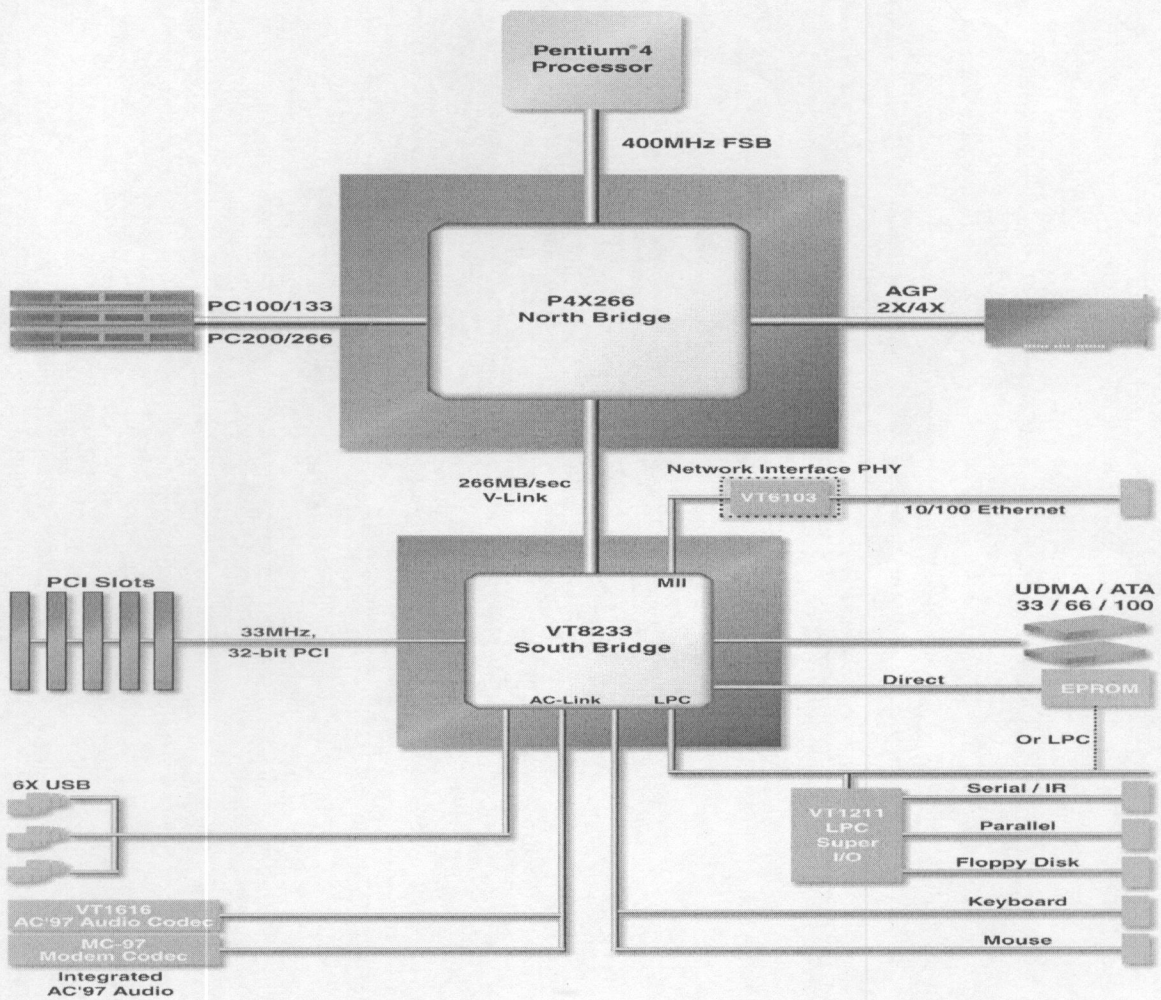


SECTION B

This section has THREE Questions. Choose any two questions

Question I

- a) A chipset is a group of integrated circuits, sold as one unit, designed to perform one or more related functions. The diagram below shows the Apollo Chipset designed for the Pentium (IV) processor. With reference to the diagram below, discuss in details the functions and roles of the chipsets (North Bridge and South Bridge) in relation to the Pentium 4 processor to manage the operation of the computer [10 Marks]

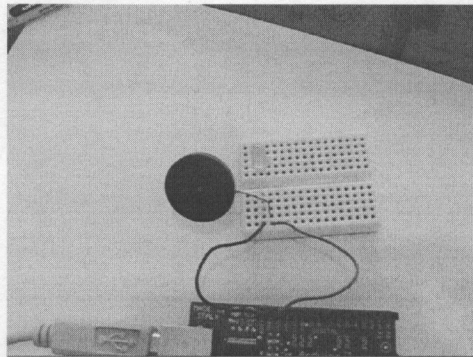


Question II

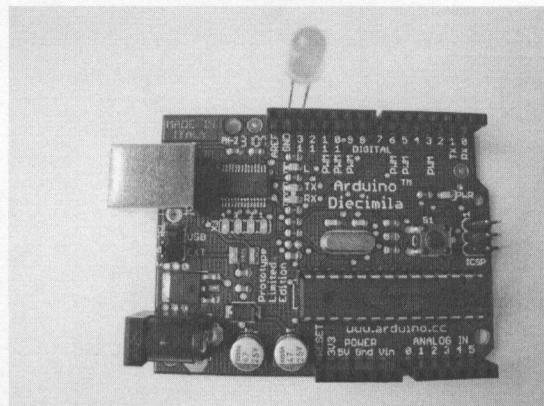
- a) An instruction is a binary pattern designed inside a microprocessor to perform a specific function. The entire group of instructions, called the instruction set, determines what functions the microprocessor can perform. The intel 8085 Instruction set can be classified into the following five functional categories:
- data transfer (copy) operations
 - arithmetic operations
 - logical operations
 - branching operations
 - machine-control operations

Discuss each of the instruction set with at least one example of the actual instruction performed by the intel 8085 microprocessor [10 Marks].

- b) A Piezo is an electronic piece that converts electricity energy to sound. It is a digital output device. You can make white noise or even exact musical notes based on the duration that you iterate between HIGH and LOW signals. Give the full well commented code for the **Arduino Digital Output Sound Piezo** using the setup below by using PIN 13 for the Sound-Piezo in your design [5 Marks]

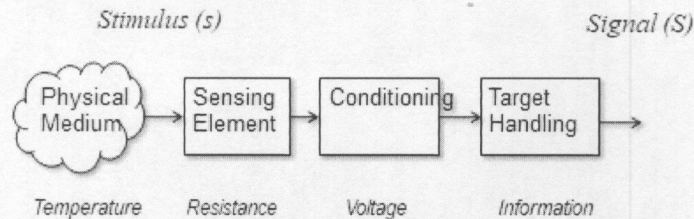


- c) The diagram below shows the setup of the **Arduino Digital Output-LED**. This can either be connected direct on the board or one can use the solderless breadboard. Give the full well commented code that can be used to programme this setup using PIN 13 on the Arduino board [5 Marks]



Question III

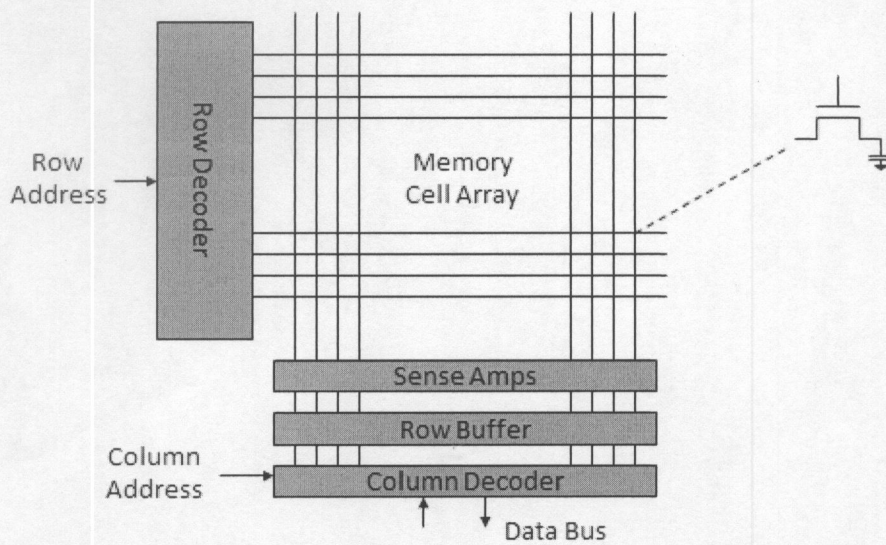
- a) The diagram below shows the basic principles used by sensors to collect and process information [5 Marks].
- Discuss the principle behind sensing technologies
 - List any three examples of sensors and what can be sensed from the physical environment apart from temperature sensors



- b) Typical system uses a number of busses, collection of wires, which transmit binary numbers, one bit per wire. A typical microprocessor communicates with memory and other devices (input and output) using three busses namely [6 Marks]
- Address Bus
 - Data Bus
 - Control Bus

Using the Intel 8085 System Bus, give a brief description of each of three types of the bus systems above

- c) The diagram below shows the basic DRAM Chip Organization. Explain with reference to the diagram below how a computer stores and read data from memory using DRAM as your example. In your discussion make reference to [9 Marks]
- Row Decoder
 - Sensing Amps
 - Row Buffer
 - Column Decoder



End of the Examination

SECTION A
ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION 1 [20 marks]

1. A company is looking to develop a new proprietary software application that can compete amongst current social media platforms. As Chief Analyst, give an outline of the different stages of requirements engineering, and discuss the tools and techniques that you would adopt to derive a complete and consistent requirements specification from the company **[10 Marks]**
2. Discuss why many systems continue to fall below user expectations, despite the established practice of software requirements engineering. **[10 Marks]**

QUESTION 2 [20 marks]

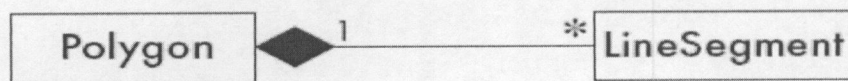
1. You are asked to improve a data entry program used to enter a patient's personal information when he or she is first admitted to a hospital. Admission clerks have to enter each new patient's name, address, telephone number, and various other pieces of data. The customer tells you that the admissions clerks make an unacceptable number of mistakes that contaminate the database and cause administrative problems. You are told that the problem is lack of clarity in the user interface, which leads the clerks to put information in the wrong places. What, however, is the real problem and how might understanding this affect potential solutions? **[5 Marks]**

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2. This is the inverse of the Question 1. This time, you are told by the customer that the problem is, 'the data-entry system is not "high-tech" enough'. Hence you are asked to write a system that scans drivers' licenses and other documents in order to enter a new patient's name and address accurately and quickly. What mistake could you be making if you accept this problem statement and proceed to do exactly what the customer asks? **[4 Marks]**

3. You are developing a system for managing the processes of a small town public library. List all the actors for this system. **[3 Marks]**

4. Justify the use of a composition to represent the association between a polygon and its line segments, as in figure below. **[6 Marks]**



5. Decomposing a system into subsystems reduces the complexity developers have to deal with by simplifying the parts and increasing their coherence. Decomposing a system into simpler parts usually results into increasing a different kind of complexity: Simpler parts also means a larger number of parts and interfaces. If coherence is the guiding principle driving developers to decompose a system into small parts, which competing principle drives them to keep the total number of parts small? **[2 Marks]**

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SECTION B
ANSWER ANY THREE (3) QUESTIONS IN THIS SECTION

QUESTION 3 [20 marks]

Lusaka City Council (LCC) have hired your company to build a bus reservation system for all bus trips taken from Intercity Bus Terminal (IBT).

1. Outline in one paragraph the information you would need to gather in order to perform domain analysis for the LCC IBT bus reservation system.

[7 marks]
2. Requirements can be divided into four major types functional, quality, platform and process. Describe quality requirements and give 2 examples of main categories for quality requirements.

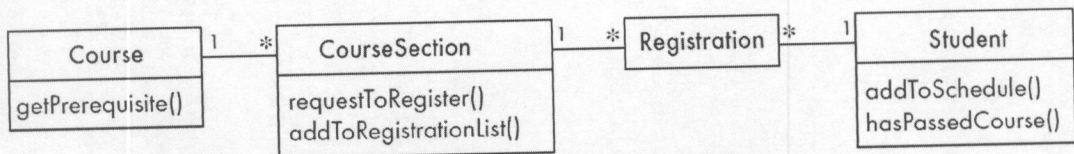
[3 marks]
3. Classify the following aspects of the LCC IBT bus reservation system into F for functional, Q for quality, PL for platform, PR for process, and X for 'should not be a requirement'. Also indicate the subcategory of requirement. For something that should not be a requirement, explain why not.
 1. What information appears on tickets and reports.
 2. How fares are calculated.
 3. The system must be available at all times. Only 2 minutes' downtime a week is to be permitted.
 4. The system must run on any Linux system.
 5. A merge-sort algorithm must be used to sort the flights by departure time.

[5 marks]
4. In describing *simplified use cases* of the LCC IBT bus reservation system, giving the **name** and **steps** of the use cases is enough, however your project manager insists that you describe *complete use cases*. State 5 other components you would add to the description of the use cases of the LCC IBT bus reservation in order to make them complete. Give a short explanation for each component that you state. **[5 marks]**

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QUESTION 4 [20 marks]

1. The diagram below shows the classes involved in a fictitious Student Registration System (SRS) for the University of Zambia (UNZA). It shows the classes involved when a student attempts to register for a course.



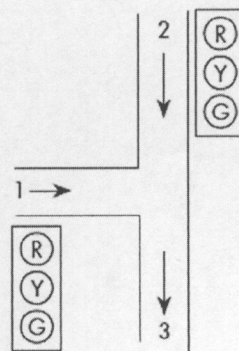
- i. Draw a **simple sequence diagram** based on the given class diagram that shows the interactions that occur in the UNZA SRS when a student attempts to register for a course. [4 marks]

 - ii. Assume that a student is only allowed to register for a course if he has passed the course prerequisites. Draw a new **detailed sequence diagram**, by expanding on your previous answer, showing a *GUI* and *Course* object as well as showing an *optional combined fragment* for the prerequisite. [8 marks]

 - iii. You can use communication diagrams as opposed to sequence diagrams to show the interactions occurring in the UNZA SRS since both types of diagrams contain much of the same information. Describe 4 situations/reasons that make sequence diagrams the better choice when depicting interaction within a software system diagrammatically. [4 marks]
2. Assume the diagram below represents the road layout when exiting the UNZA Main Campus along Great East Road with a vehicle. Assume movement in the direction from 2 to 3 represents vehicles moving on Great East Road from Arcades roundabout to Manali roundabout. Traffic lights have been installed at this junction as follows:

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- i. The traffic light at point 1 has three colors Green, Yellow and Red. When the system starts up the robot is Red.
- ii. After startup, the system indefinitely rotates among Green, Yellow and Red. The Red light only stays on for 30 seconds, at which time the Green light comes on.
- iii. The Green light stays on for 25 seconds, at which time the system changes to Yellow.
- iv. After five more seconds the Yellow light gives way to the Red light again.
- v. Traffic moving from point 2 to 3 always has a Green light unless a vehicle arrives at point 1 and triggers a sensor.
- vi. When the sensor at point 1 is triggered, the robot their changes to Yellow, but only after the traffic coming from point 2 has had at least 25 seconds of Green light. Without this a steady series of vehicles arriving at point 1 would prevent the light at point 2 from staying green long enough for traffic to flow.



Draw a state diagram for the UNZA traffic light system described above, illustrating elapsed-time transitions.

[4 marks]

QUESTION 5 [20 marks]

1. Design patterns are a tool for communication". Explain this statement, using an example. Your explanation should state who is doing the communication and what is being communicated. **[4 marks]**

2. In all organisations where the exam software is used, there is a requirement to store marked exam scripts for future reference. Suppose that this facility already exists, in that

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scripts can be stored in the format required by the University of Zambia (UNZA). However, the Zambia Centre for Accountancy Studies (ZCAS) use a different format, and the University of Lusaka (UNILUS) use yet another, for example. Code exists to store the data in each of these formats, but the interface of that code is different in each case, and incompatible with the project's existing code base.

Draw a UML diagram to show how the Adapter pattern can be used to solve this problem. You should assume that the UoM storage code has a single public operation `storeScripts()` and that the storage code for each organisation can be represented as a single class which you should show on the diagram. **[5 marks]**

3. The **Façade** pattern has some similarities to Adapter. Explain what the similarities and differences are between the two patterns, and briefly discuss whether Façade would be a sensible alternative to **Adapter** for the problem of part 2). **[5 marks]**

4. Somewhere, there needs to be code that decides which adapter to create, depending on the organisation we're storing scripts for. Where would it be sensible to put this code, and how might it make that decision? **[2 marks]**

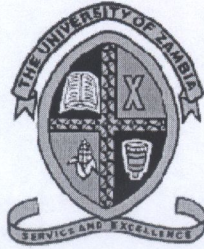
5. What are the consequences of using the Adapter pattern for this task in terms of cohesion and coupling? **[4 marks]**

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QUESTION 6 [20 marks]

1. Design an architecture for the system that conforms to the pipe-and-filter architectural style. You do not need to fully elaborate the architectural design, but you must describe the components, the connectors, and how the system will basically work. State any assumptions you make. **[15 marks]**
2. What are two advantages of a 3-tier client-server architecture over a 2-tier client-server architecture **[5 marks]**

END OF PAPER



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 4642
SOFTWARE QUALITY ASSURANCE

Date: 28th NOVEMBER, 2018
Time: 14:00 – 17:00 hrs
Duration: 3 Hours
Venue: P207

Instructions

- The question paper has TWO SECTIONS (A and B).
 - Section A comprises FOUR (4) questions. Answer any THREE (3).
 - Section B comprises THREE (3) questions. Answer any TWO (2).
 - Answer FIVE (5) questions in total.
 - Clearly number your answers.
 - Use the marks as a guide to the detail required in your answers while keeping your answers concise and relevant
-

SECTION A: ANSWER ANY THREE QUESTIONS [60 Marks]

Question 1

- i. There are three major differences between software products and other industrial products.
 - a. Identify and describe the differences. [6 marks]
 - b. Discuss the ways in which these differences affect SQA. [3 marks]
- ii. According to the IEEE definition of SQA, quality control (QC) is not equated with quality assurance (QA).
 - a. In what respects does QC vary from QA? [3 marks]
 - b. Why can QC be considered part of QA? [1 marks]
- iii. Seven issues characterize the professional software development and maintenance environment.
 - a. Identify and describe these characteristics. [7 marks]

Question 2

- i. What are the three factor categories belonging to McCall's factor model? [3 marks]
- ii. What factors are included in each of the categories identified in (i)? [4 marks]
- iii. The software requirement document for the tender for development of "Super-lab", a software system for managing a hospital laboratory, consists of chapters according to the required quality factors. Below you will find a list of quality requirements taken from the mentioned requirements document.

State the name of the quality factor that best fits each requirement. [10 marks]

- a. *The probability that the "Super-lab" software system will be found in a state of failure during peak hours (9 am to 4 pm) is required to be below 0.5%.*
- b. *The "Super-lab" software system will enable direct transfer of laboratory results to those files of hospitalized patients managed by the "MD-File" software package.*
- c. *The "Super-lab" software system will include a module that prepares a detailed report of the patient's laboratory test results during his or her current hospitalization. (This report will serve as an appendix to the family physician's file.) The time required to obtain this printed report will be less than 60 seconds; the level of accuracy and completeness will be at least 99%.*
- d. *The "Super-lab" software to be developed for hospital laboratory use may be adapted later for private laboratory use.*

- e. *The training of a laboratory technician, requiring no more than three days, will enable the technician to reach level C of "Super-lab" software usage. This means that he or she will be able to manage reception of 20 patients per hour.*
 - f. *The "Super-lab" software system will record a detailed users' log. In addition, the system will report attempts by unauthorized persons to obtain medical information from the laboratory test results database. The report will include the following information: network identification of the applying terminal, system code of the employee who requested that information, day and time of attempt, and type of attempt.*
 - g. *The "Super-lab" subsystem that deals with billing patients for their tests may eventually be used as a subsystem in the "Physiotherapy Center" software package.*
 - h. *The "Super-lab" software system will process all the monthly reports for the hospital departments' management, the hospital management, and the hospital controller according to Appendix D of the development contract.*
 - i. *The software system should be able to serve 12 workstations and eight automatic testing machines with a single model AS20 server and a CS25 communication server that will be able to serve 25 communication lines. This hardware system should conform to all availability requirements as listed in Appendix C.*
 - j. *The "Super-lab" software package developed for the Linux operating system should be compatible for applications in a Windows NT environment.*
- iv. Many organisations do not apply their contract review procedures to internal projects even though they perform comprehensive contract reviews for all their external projects.
- a. List one argument that support this approach. **[1.5 marks]**
 - b. List one argument that opposes this approach. **[1.5 marks]**

Question 3

- i. Referring to the spiral model, describe the four activities to be repeated in each iteration of the development process. Explain why the four activities designated are to be repeated in each. **[8 marks]**
- ii. With respect to verification, validation and qualification:
 - a. Explain the differences among these three aspects of SQA activities.
[6 marks]
 - b. Can a project that successfully passed verification and validation reviews fail the qualification review test? Explain your answer. **[6 marks]**

Question 4

- i. Referring to the model for defect removal efficiency and costs:
 - a. Explain the six assumptions that rest at the foundations of the model? [10 marks]
 - b. Which three of the model's data components are based on published survey results? [6 marks]
- ii. Compare the various review techniques.
 - a. In what aspects are design reviews more formal than inspections? [2 marks]
 - b. In what aspects are inspections more formal than walkthroughs? [2 marks]

SECTION B: ANSWER ANY TWO QUESTIONS [40 Marks]

Question 5

The SQA architecture comprises six components. [20 marks]

- i. Illustrate SQA architecture.
- ii. State the goal of each component.
- iii. Highlight one element of each component.

Question 6

Consider the following program:

```
IF A = 354
THEN IF B > C
  THEN A = B
  ELSE A = C
ENDIF
ENDIF
Print A
```

- i. Develop the Flow Chart for the program. [5 marks]
- ii. Develop the Program Flow Graph for the program. [5 marks]
- iii. Compute the Cyclomatic Complexity of the program. [2 marks]
- iv. Show the set of paths resulting from your computation in (iii). [5 marks]
- v. Comment on the overall complexity of the program based on the Cyclomatic Complexity you computed in (iii). [3 marks]

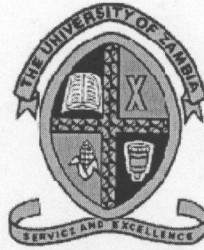
Question 7

A module that calculates movie ticket prices has been developed for a cinema management system. The movie ticket price table is shown below. **Peak time = 8.00 am – 11.00 am; off-peak = 11.01 am – 23.45 pm.**

	Monday-Friday				Saturday-Sunday			
Mode of Payment	Cash	Cash	Card	Card	Cash	Cash	Card	Card
Time of Travel	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Movie Ticket Price - ZMK								
Passenger Years								
Child: 0.00 -12.00	20.00	10.00	19.50	9.50	25.00	15.00	24.50	14.50
Senior Citizen 60.01-120.00	30.00	20.00	29.50	19.50	35.00	25.00	34.50	24.50
Adult: 12.01- 60.00	40.00	30.00	39.50	29.50	45.00	35.00	44.50	34.50
Special Needs Passengers								
	0.00	0.00	0.00	0.00	5.00	5.00	5.00	5.00

- i. What are the variables in the bus ticket system? [2 mark]
- ii. List the valid equivalence classes for the module? [4 marks]
- iii. Suggest representational values for each of the valid equivalence classes from (ii).[4 marks]
- iv. What are the boundary values for valid equivalence classes? [2 marks]
- v. List the invalid equivalence classes for the module? [4 marks]
- vi. Suggest representational values for each of the invalid equivalence classes from (v). [4 marks]

END OF EXAM



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 4765
IT AUDIT AND CONTROLS

Date: 19TH NOVEMBER, 2018
Time: 09:00 – 14:00 HRS
Duration: 3 HRS
Venue: P207

Instructions

- The question paper has THREE SECTIONS (A, B and C).
 - Sections A and C are COMPULSORY. Answer ALL questions.
 - Section B comprises THREE (3) questions. Answer any TWO (2).
 - Answer FIVE (5) questions in total.
 - Clearly number your answers.
 - Use the marks as a guide to the detail required in your answers while keeping your answers concise and relevant
-

SECTION A: ANSWER ALL QUESTIONS [20 Marks]

QUESTION ONE [20 marks]

- i. An IS auditor, performing a review of an application's controls, discovers a weakness in system software, which could materially impact the application. The IS auditor should: **(2 marks)**
- A. Disregard these control weaknesses as a system software review is beyond the scope of this review.
 - B. Conduct a detailed system software review and report the control weaknesses.
 - C. Include in the report a statement that the audit was limited to a review of the application's controls.
 - D. Review the system software controls as relevant and recommend a detailed system software review.
- ii. The MOST effective method for limiting the damage of an attack by a software virus is: **(1 mark)**
- A. software controls.
 - B. policies, standards and procedures.
 - C. logical access controls.
 - D. data communication standards.
- iii. Which of the following BEST describes the early stages of an IS audit? **(1 marks)**
- A. Observing key organizational facilities.
 - B. Assessing the IS environment.
 - C. Understanding business process and environment applicable to the review.
 - D. Reviewing prior IS audit reports.
- iv. An IT auditor has just completed a review of an organisation that has a mainframe and a client-server environment where all production data reside. Which of the following weaknesses would be considered the MOST serious? **(2 marks)**
- A. The security officer also serves as the database administrator (DBA.)
 - B. Password controls are not administered over the client/server environment.
 - C. There is no business continuity plan for the mainframe system's non-critical applications.
 - D. Most LANs do not back up file server fixed disks regularly.
- v. An organisation is proposing to install a single sign-on facility giving access to all systems. The organisation should be aware that: **(2 marks)**
- A. Maximum unauthorised access would be possible if a password is disclosed.
 - B. User access rights would be restricted by the additional security parameters.
 - C. The security administrator's workload would increase.
 - D. User access rights would be increased.
- vi. An IS auditor discovers that an organisation's business continuity plan provides for an alternate processing site that will accommodate fifty percent of the primary processing capability. Based on this, which of the following actions should the IS auditor take? **(2 marks)**
- A. Do nothing, because generally, less than twenty-five percent of all processing is critical to an organisation's survival and the backup capacity, therefore is adequate.
 - B. Identify applications that could be processed at the alternate site and develop manual procedures to backup other processing.

- C. Ensure that critical applications have been identified and that the alternate site could process all such applications.
- D. Recommend that the information processing facility arrange for an alternate processing site with the capacity to handle at least seventy-five percent of normal processing.
- vii. When auditing the requirements phase of a software acquisition, the IS auditor should: **(1 mark)**
- A. assess the feasibility of the project timetable.
 - B. assess the vendor's proposed quality processes.
 - C. ensure that the best software package is acquired.
 - D. review the completeness of the specifications.
- viii. Which of the following is an output control objective? **(1 mark)**
- A. Maintenance of accurate batch registers
 - B. Completeness of batch processing
 - C. Appropriate accounting for rejections and exceptions
 - D. Authorization of file updates
- ix. The extent to which data will be collected during an IS audit should be determined, based on the: **(1 mark)**
- A. availability of critical and required information.
 - B. auditor's familiarity with the circumstances.
 - C. auditee's ability to find relevant evidence.
 - D. purpose and scope of the audit being done.
- x. While developing a risk-based audit program, which of the following would the IS auditor MOST likely focus on? **(1 mark)**
- A. Business processes
 - B. Critical IT applications
 - C. Corporate objectives
 - D. Business strategies
- xi. An IS auditor is auditing the controls relating to employee termination. Which of the following is the MOST important aspect to be reviewed? **(2 marks)**
- A. The related company staff are notified about the termination
 - B. User ID and passwords of the employee have been deleted
 - C. The details of employee have been removed from active payroll files
 - D. Company property provided to the employee has been returned
- xii. Which of the following BEST provides access control to payroll data being processed on a local server? **(1 mark)**
- A. Logging of access to personal information
 - B. Separate password for sensitive transactions
 - C. Software restricts access rules to authorized staff
 - D. System access restricted to business hours
- xiii. IT governance ensures that an organisation aligns its IT strategy with: **(1 mark)**
- A. Enterprise objectives.
 - B. IT objectives.
 - C. Audit objectives.
 - D. Finance objectives.

- xiv. An IS auditor when reviewing a network used for Internet communications, will FIRST examine the: **(1 mark)**
- A. validity of passwords change occurrences.
 - B. architecture of the client-server application.
 - C. network architecture and design.
 - D. firewall protection and proxy servers.
- xv. The PRIMARY purpose of compliance tests is to verify whether: **(1 mark)**
- A. controls are implemented as prescribed.
 - B. documentation is accurate and current.
 - C. access to users is provided as specified.
 - D. data validation procedures are provided.

SECTION B: ANSWER ANY TWO QUESTIONS [40 Marks]

QUESTION TWO [20 marks]

Consider the context of an organisational overall IT control structure.

- i. Explain the reason for performing a cost/benefit analysis in this context. **(2 marks)**
- ii. Explain three criteria that are used to determine how much control is built into a system. **(6 marks)**
- iii. Given the following risk assessment information for an organisation's website:
 - a. The likelihood of physical damage to the website's operations over a one-year period is 5%, with a minimum and maximum loss to the organisation of K20, 000 and K100, 000, respectively.
 - b. The likelihood of data, programs and software loss over a one-year period is 30%, with a minimum and maximum loss to the organisation of K30, 000 and K150, 000, respectively.
 - c. The likelihood of virus attacks over a one-year period is 90%, with a minimum and maximum loss to the organisation of K50, 000 and K170, 000, respectively.
 - d. The likelihood of denial of service attacks over a one-year period is 40%, with a minimum and maximum loss to the organisation of K20, 000 and K200, 000, respectively.
 - e. The likelihood of hacking and site penetrations attacks over a one-year period is 10%, with a minimum and maximum loss to the organisation of K80, 000 and K200,000, respectively.
 - f. The likelihood of Website hijacking, threats and/or extortion attacks over a one-year period is 5%, with a minimum and maximum loss to the organisation of K8, 000 and K20, 000, respectively.

Required:

Calculate the expected annual loss for each exposure. (12 marks)

Note: Prepare your answer using a table with appropriate column headings.

QUESTION THREE [20 marks]

IT governance and enterprise risk management are among the key organisational functions within the scope of IT Audit.

- i. Define the term IT governance? (2 marks)
- ii. Outline the five (5) objectives of IT governance that are applicable to virtually any organisation. (5 marks)
- iii. Define the term risk. (2 marks)
- iv. Discuss the five (5) core processes specified in different risk management frameworks and methodologies. (10 marks)
- v. Mention two other key organisational functions within the scope of IT audit. (1 mark)

QUESTION FOUR [20 marks]

Reporting findings is one of the major steps in the IT Audit process.

- i. What is the source of IT Audit findings?(2 marks)
- ii. Outline ten (10) types of information typically contained in an IT Audit report. 10 marks)
- iii. Distinguish between *audit findings* and *audit conclusions*. (3 marks)
- iv. ISACA IS Auditing Standard S7 provides guidance on reporting so the IS auditor can fulfil this responsibility.
 - a. What is the S7 guidance on communication in the event that the IS auditor finds significant deficiencies in the control environment? (2.5 marks)
 - b. What is the S7 guidance on evaluating appropriate information on previous report findings? (2.5 marks)

SECTION C: ANSWER BOTH QUESTIONS [40 Marks]

Introduction: Fox Industries Co (Fox) manufactures engineering parts. It has one operating site and a customer base spread across Europe. The company's yearend was 30 April 2013. Below is a description of the purchasing and payments system.

Purchasing system

Whenever production materials are required, the relevant department sends a requisition form to the ordering department. An order clerk raises a purchase order and contacts a number of suppliers to see which can dispatch the goods first.

This supplier is then chosen. The order clerk sends out the purchase order. This is not sequentially numbered and only orders above \$5,000 require authorisation.

Purchase invoices are input daily by the purchase ledger clerk, who has been in the role for many years and, as an experienced team member, he does not apply any application controls over the input process. Every week the purchase day book automatically updates the purchase ledger, the purchase ledger is then posted manually to the general ledger by the purchase ledger clerk.

Payments system

Fox maintains a current account and a number of saving (deposit) accounts. The current account is reconciled weekly but the saving (deposit) accounts are only reconciled every two months. In order to maximise their cash and bank balance, Fox has a policy of delaying payments to all suppliers for as long as possible. Suppliers are paid by a bank transfer. The finance director is given the total amount of the payments list, which he authorises and then processes the bank payments.

QUESTION FIVE [20 marks]

Identify and explain the IT general controls that should be adopted by Fox Industries Co.

QUESTION SIX [20 marks]

Identify and explain IT application controls that should be adopted by Fox Industries Co to ensure the completeness and accuracy of the purchasing and payments systems.

END OF EXAM



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 4722
Distributed Systems

Date: 19th November 2019
Time: 09:00hrs – 12:00hrs
Duration: 3 Hours
Venue: Upper Dinning Hall

Instructions

1. There are **two (2) sections** in this exam paper.
2. *Answer all the questions in **Section A** and choose any three (3) questions from **Section B***

SECTION A. Short answers (40 marks)

You are required to answer all questions in this section.

1. What is the differences between partial and total ordering of events? **[2 marks]**
2. What is meant by Remote Procedure Calls(RPC)? **[2 marks]**
3. What is meant by exactly-once-semantics in the context of client/server communication?
[2 marks]
4. Give two advantages of a distributed system compared to a centralized system and also give two advantages of a centralized system compared to a distributed system. **[4 marks]**
5. Outline how a ring-based algorithm for mutual exclusion works by way of an example.
[4 marks]
6. Compare programming using sockets API with RMI. What are the advantages and disadvantages of each approach? **[6 marks]**
7. A client's clock reads 3:20:00. The server's clock reads 3:10:00 when they synchronize using the Berkeley algorithm. Assume message delays are negligible. What is the time at the client after synchronization? **[4 marks]**
8. When programming a server why is the creation of a new socket created in addition to the already existing server socket important? **[4 marks]**
9. What is an IDL (Interface Definition Language) used for in Corba? Why is there no need for an IDL when using Java RMI? **[4 marks]**
10. What is the purpose of middleware in distributed systems? **[4 marks]**
11. What is the difference between a blocking and non-blocking send primitive? What impact does the choice of send primitive have on the performance of a distributed system?
[4 marks]

SECTION B (60 marks)

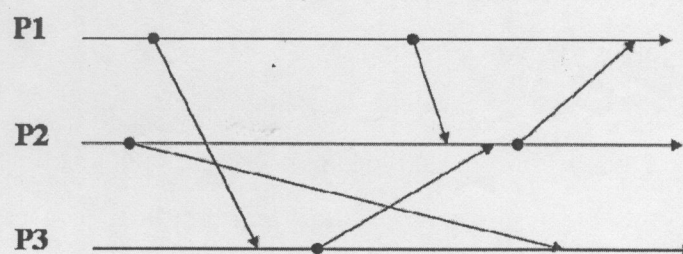
Answer any three (3) of the five (5) questions.

1.

- Explain the differences between a distributed system and a multi-processor system. **[4 marks]**
- When implementing a distributed system, middleware is often used. Explain, with examples, some of the services that middle-ware should provide to the programmer. **[6 marks]**
- Assume you have a Java client/server application that uses TCP. How should the server be implemented to avoid clients from blocking each other? **[4 marks]**
- RPCs in java attempt to give the programmer the illusion that remote procedures are running locally. Using an illustration explain how this is achieved. **[6 marks]**

2. Synchronization is a very important concept in distributed systems.

- Describe how clock synchronization can be done in a system with an external time reference. **[2 marks]**
- Describe how clock synchronization can be done in a system without an external time reference (master clock) and without sudden changes in time. **[2 marks]**
- What problem with Lamport clocks do vector clocks solve? **[4 marks]**
- Consider the following event diagram for processes P1, P2 and P3 executing in a distributed system. Compute the lamport and vector clock that is carried on each message. Show both approaches separately **[12 points]**



3.

- File systems like HDFS and GFS keep multiple replicas of each block, stored on different servers. Joe argues that one advantage of this approach is that the expensive scrubbing performed in most disk array systems is unnecessary. Do you agree? Explain your answer. **[4 marks]**

- b. Many scalable distributed file system designs use multiple data servers but just a single metadata server. Why is this a reasonable approach, despite the fundamental scalability limitation that the single metadata server represents? Explain your answer. **[4 marks]**
- c. With regards to Hadoop explain the following:
- Different types of nodes in a Hadoop cluster **[5 marks]**
 - How map-reduce works **[4 marks]**
 - How files are stored with replication. **[3 marks]**
4. Suppose that we have five processes, P1, P2, P3, P4 and P5. P5 is coordinator. Further, suppose that P1 and P5 crash and P2 detects the crash. Assuming the process IDs have alphanumeric value and that the priority of process P_i is i .
- What are the requirements of an election process? **[2 marks]**
 - Show how an election could proceed using the ring election algorithm and the bully algorithm. **[10 marks]**
 - What would happen if two processes, say P2 and P4 detect the crash at the same time? **[2 marks]**
 - What potential impact does communication latency have on the bully election algorithm and how is this resolved? **[2 marks]**
 - Using an illustration explain how the timestamp prioritized mutual exclusion algorithm work? **[4 marks]**
- 5.
- What are the three types of process scheduling techniques? **[3 marks]**
 - Briefly discuss any five desirable features of a resource scheduling algorithm. **[5 marks]**
 - What are the two main categories of load balancing algorithms and what are the important differences between the two categories? **[6 marks]**
 - What are the six main issues one needs to consider when designing load balancing algorithms? **[6 marks]**

The end of this examination question paper



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 4772
Distributed Systems

Date: 4th DECEMBER 2018
Time: 09:00hrs – 12:00hrs
Duration: 3 Hours
Venue: Upper Dinning Hall

Instructions

1. There are **two (2) sections** in this exam paper.
2. *Answer all the questions in Section A and choose any three (3) questions from Section B*

SECTION A. Short answers (40 marks)

You are required to answer all questions in this section.

1. Distributed systems have continued to grow in popularity and use.
 - a. What is a distributed system? **[3 marks]**
 - b. What are the key characteristics of a distributed system? **[4 marks]**
 - c. How has the role of middleware in a distributed system evolved over time? How is this evolution related to the initial and modern concept of a distributed system? **[6 marks]**
 - d. One of the major goals of a distributed system is transparency. What are the seven forms of transparency in a distributed system? **[7 marks]**

2. Distributed systems implementation techniques have been refined over time. Techniques chosen for implementation heavily depend on the intended usage of the distributed system.
 - a. Briefly explain the three types of distributed systems based on usage. **[6 marks]**
 - b. In a certain system, each process typically uses a critical section many times before another process requires it. Explain why Ricart and Agrawala's mutual exclusion algorithm is inefficient for this case, and describe how to improve its performance if we wanted to use it in such a distributed system. **[4 marks]**
 - c. What are the four properties that a transaction processing model should obey? **[2 marks]**
 - d. What is a nested transaction and what challenges does it introduce in a distributed system environment? **[4 marks]**
 - e. What is the difference between a transaction processing system and enterprise application integration? **[4 marks]**

SECTION B (60 marks)

Answer any three (3) of the five (5) questions.

1.

- a. What is the single most important difference between a distributed system and a uniprocessor system? **[2 marks]**
- b. While developing a distributed system a developer tries to analyze how message passing can be achieved.
 - i. What is the difference between a blocking and non-blocking send primitive? What impact does the choice of send primitive have on the performance of a distributed system? **[4 marks]**
 - ii. What is the difference between buffered and unbuffered primitives? **[2 marks]**
 - iii. What would be the effect of using buffered primitives with blocking and non-blocking primitives? **[4 marks]**
- c. Distributed systems can at times crash and this can lead to all sorts of complications.
 - i. What are orphans? **[2 marks]**
 - ii. How does extermination try to solve the problem of orphaned processes? **[2 marks]**
 - iii. What are the advantages of using gentle reincarnation of orphans over extermination? **[4 marks]**

2. Synchronization is a very important concept in distributed systems.

- a. What is synchronization? **[2 marks]**
- b. Given two events e, e' ;
 - i. Give and explain the three conditions under Lamports' "happens before" partial order that define the relationship $e < e'$. **[6 marks]**
 - ii. Why is it called a partial order? **[2 marks]**
 - iii. Explain, using an illustration, the conditions under which e and e' can be said to be concurrent. **[4 marks]**
- c. With the aid of a diagram explain the limitations of Lamport's timestamp algorithm? **[6 marks]**

3. Cloud computing is impacting businesses in many ways. From storage techniques to business analytics, it is simply the future of big data.

- a. What is cloud computing? **[2 marks]**
 - b. What are the advantages of using cloud computing? **[4 marks]**
 - c. What is Hadoop and why is it ideal for usage in a cloud computing environment?
[4 marks]
 - d. Web services thrive on a cloud computing model.
 - i. What is a Web service and why have Web services continued to grow in popularity? **[4 marks]**
 - ii. Web services can be accessed using either SOAP or REST. What is SOAP and REST? What is the advantage of using one over the other? **[6 marks]**
4. Even though distributed systems thrive when decentralized more often than not there is need for a coordinator. For this, election algorithms are often used.
- a. What are the major assumptions when designing an election algorithm? **[3 marks]**
 - b. Two of the famous election algorithms are the bully and ring election algorithms.
 - i. How do the bully and ring election algorithms work? **[8 marks]**
 - ii. Which one do you think performs better on average and why? **[4 marks]**
 - c. Six processes with process IDs **p1, p2, p3, p4, p5** and **p6** are running in a distributed system with **p6** acting as coordinator. **p2** then detects that **p6** has crashed and starts an election process. With the aid of a diagram explain how the election would proceed if a bully election algorithm is used. **[5 marks]**
- 5.
- a. What is mutual exclusion and why is important in distributed systems? **[4 marks]**
 - b. What are the three major communication scenarios in distributed systems that must be put into consideration when deciding whether to consider mutual exclusion or not.
[6 marks]
 - c. What are the two main types of distributed mutual exclusion algorithms? **[4 marks]**
 - d. How does the Ricart and Agrawala algorithm for mutual exclusion work and what are its weaknesses? **[6 marks]**



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

**FUNDAMENTALS OF DATA MINING & WARE
HOUSING
CSC 4792**

Date: 7th DECEMBER, 2018
Time: 09:00hrs – 12:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. Answer *all* the questions in Section A.
2. Choose *any THREE (3)* questions in Section B.

SECTION A [40 Marks]

INSTRUCTIONS: ANSWER ALL QUESTIONS IN THIS SECTION.

Question 1 [40 Marks]

- i. Imagine you build an image classification model that performs well on the training data but generalizes poorly to new instances. Explain this phenomenon, and the proposed solutions to this problem. [4 Marks]
- ii. Consider the following activities and briefly describe whether or not is a data mining task: [2 Marks each]
 - a. Dividing the customers of a company according to their profitability
 - b. Computing the total sales of a company
 - c. Sorting a student database based on student identification numbers.
 - d. Predicting the outcomes of tossing a (fair) pair of dice.
 - e. Predicting the future stock price of a company using historical records
 - f. Monitoring the heart rate of a patient for abnormalities.
 - g. Monitoring seismic waves for earthquake activities.
 - h. Extracting the frequencies of a sound wave.
- iii. Work out the Perceptron that construct logical NOR and XNOR of their inputs. For each logical operation, provide the following: [10 Marks for each]
 - a. Truth table
 - b. Parameter values (or weights) affecting the influence of input values and the bias on the estimated output value.
 - c. Drawing of the well labeled perceptron with inputs, weights, and activation function and outputs.
 - d. Truth table based on weights you have provided in question (b) above.

SECTION B [60 Marks]

INSTRUCTIONS: There are four questions in this section. Answer ONLY three.
Each question carries a weight of 20 Marks.

Question 2 [20 Marks]

- i. When you embark on any data mining task, the data pre-processing stage is a very important stage. It ensures data quality for data mining tasks. State and briefly describe seven (7) activities involved in the data pre-processing stage of the knowledge discovery in databases process. [7 Marks]
- ii. Discuss what is involved in the post-processing stage of the knowledge discovery in databases. State at least three activities involved. [3 marks]
- iii. Draw a well labelled diagram depicting the process of knowledge discovery in databases (KDD). [5 Marks]
- iv. State and briefly describe five (5) motivating challenges that has brought about development of data mining. [5 Marks]

Question 3 [20 Marks]

- i. How is it that traditional “databases” techniques are unsuitable for data mining tasks? Give five (5) possible reasons. [5 Marks]
- ii. State five (5) challenges that most data mining engineers get to face with data for their data mining tasks? [5 Marks]
- iii. State and briefly describe three (3) characteristics of data sets that have a significant impact on the data mining techniques used. [6 marks]
- iv. State and briefly describe four (4) characteristics that describe attributes of data objects in a given data set. [4 Marks]

Question 4 [20 Marks]

Consider the following algorithm for finding k-nearest neighbors:

for $i = 1$ to the *number of data objects* **do**:

-find the distances of the i^{th} object to all other objects

-sort these distances in decreasing order

(Keep track of which object is associated with each distance)

return the objects associated with the first K distances of the sorted list

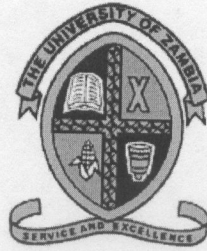
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- i. Describe four (4) potential problems with this algorithm if there are duplicate objects in the dataset. Assume the distance function will return a distance of 0 only for objects that are the same. [10 Marks]
- ii. What are your proposed solutions to the problems you have described in question (i) above. [10 Marks]

Question 5 [20 Marks]

Suppose after graduation you are employed as a data mining consultant for a financial institution like a bank. Describe how data mining can help the company by giving specific examples of how techniques, such as clustering, classification, association rule mining, and anomaly detection can be applied. [20 Marks]

-- End of exam--



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

**CSC 4792 DATA MINING AND
WAREHOUSING**

Date: 22nd NOVEMBER, 2019
Time: 09:00hrs – 12:00hrs
Duration: 3 Hours
Venue: UPPER D/HALL

Instructions

1. There are two (2) Sections in this exam, Section A and Section B.
2. In Section A, Answer all the questions and in Section B choose any three (3) questions.

SECTION A [40 Marks]

INSTRUCTIONS: **ANSWER ALL QUESTIONS IN THIS SECTION.**

Question 1 [40 Marks]

- i. Imagine you build an image classification model that performs well on the training data but generalizes poorly to new instances. Explain this phenomenon, and the propose solutions to this problem. [4 Marks]
- ii. Consider the following activities and briefly describe whether or not is a data mining task: [2 Marks each]
 - a. Dividing the customers of a company according to their profitability
 - b. Computing the total sales of a company
 - c. Sorting a student database based on student identification numbers.
 - d. Predicting the outcomes of tossing a (fair) pair of dice.
 - e. Predicting the future stock price of a company using historical records
 - f. Monitoring the heart rate of a patient for abnormalities.
 - g. Monitoring seismic waves for earthquake activities.
 - h. Extracting the frequencies of a sound wave.
- iii. Briefly enumerate four (4) possible proximity function that can be used in the k-means algorithm to measure distances. [4 Marks]
- iv. For each proximity function you have listed in question (iii) above, state the appropriate measurement of the respective centroid [4 Marks]
- v. State two disadvantages of k-Means, and for each disadvantage explain how the algorithm can/has been improved on to overcome the challenges. [2 Marks]



THE UNIVERSITY OF ZAMBIA
School of Natural Science
Department of Computer Science

FINAL EXAMINATION

**CSC 4812: CLOUD AND HIGH PERFORMANCE
COMPUTING**

Date: Wednesday, 20th November 2019
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: P207

Instructions

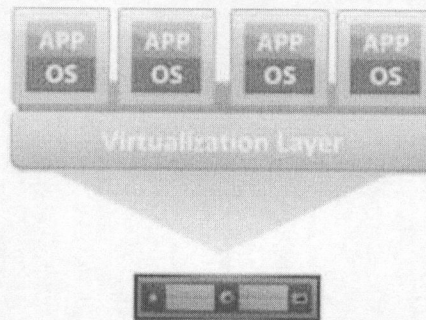
1. There are **six (6) questions** and **two (2) sections** in this paper.
2. Each question carries **20 marks**,
3. You are required to answer a total of Five (5) Questions
 - a. Answer **all the questions in Section A**
 - b. Choose **any two (2) questions from Section B**

SECTION A

This Section has Three Questions. Answer all the questions

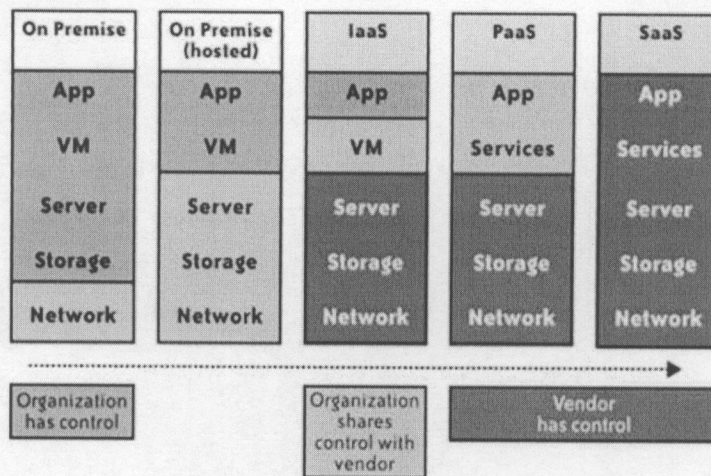
Question I

- a) Briefly discuss each of the following terminologies in relation to Cloud and High Performance Computing. Give at least one example in each case. [4 Marks]
- Grid Computing
 - Cluster Computing
 - Distributed Computing
 - Virtualisation
- b) Cloud computing is the delivery of computing as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a metered service over a network. Cloud computing provides computation, software, data access, and storage resources without requiring cloud users to know the location and other details of the computing infrastructure. The cloud service models can basically be classified as **Software as a Service**, **Platform as a Service** and **Infrastructure as a Service** [10 Marks].
- Draw a well labelled diagram showing the three Cloud Service Models as follows;
 - Software as a Service
 - Platform as a Service
 - Infrastructure as a Service
 - Show how each of the three services above are related to each other.
 - For each of the three service models above,
 - Give a brief description by citing the characteristics of the service model and the benefits that comes with the implementation
 - Give at least one major challenge that comes with each service model
 - Give one example implementation in real life
- c) The diagram below shows a virtual machine implementation [6 Marks].
- What is the Virtual Infrastructure Managers (VIMs)
 - Discuss the Key Features of the Virtual Infrastructure Managers

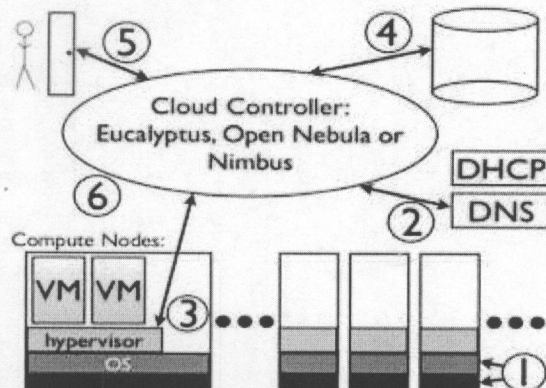


Question II

- a) With the aid of a diagram, describe each of the following Deployment Models of a Cloud [8 Marks]
- Private/Enterprise
 - Dedicated
 - Hybrid/Mixed
 - Cloud/Public
- b) The diagram below shows the impact of cloud computing on the governance structure of Information and Communications Technology (ICT) organizations. Discuss the Cloud Computing organization structures shown in the diagram below [6 Marks].



- c) With reference to the diagram below, discuss each of the key components of the cloud implementation. In your discussion make reference to the following [6 Marks]
- 1 - Instances
 - 2 - Networking
 - 3 - Compute nodes
 - 4 - Storage
 - 5 - User interface
 - 6 - Overall cloud platform



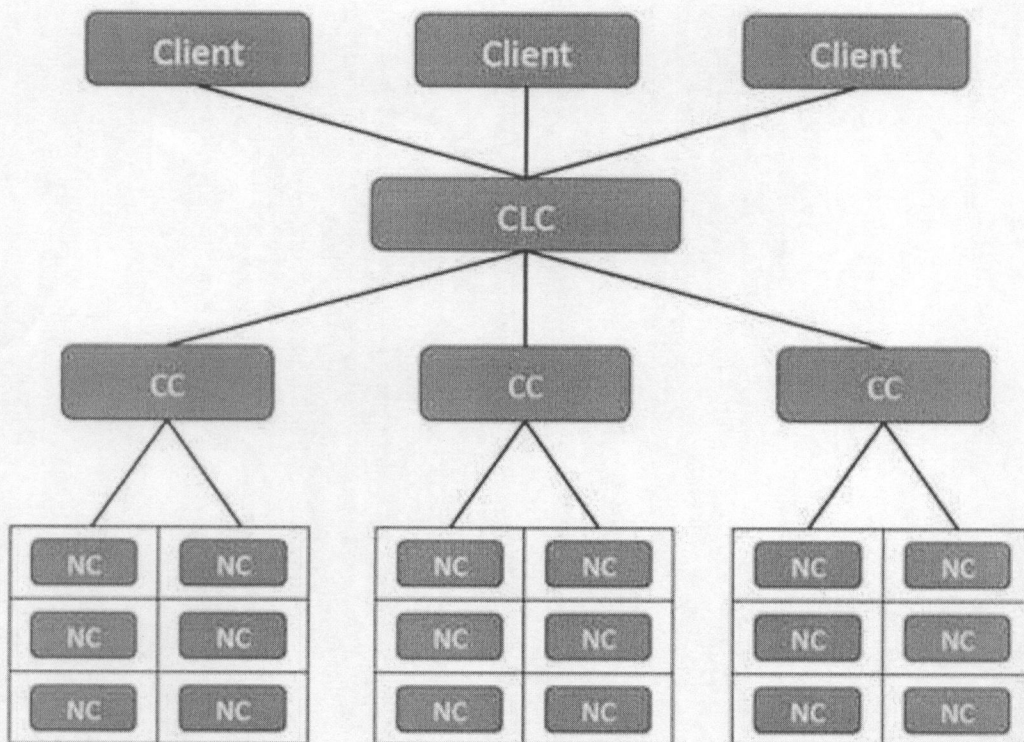
Question III

a) With reference to Cloud Computing discuss each of the following **Cloud Management Services** [10 Marks]

- i. Deployment
- ii. Monitoring
- iii. Reporting
- iv. Service-Level Agreement
- v. Metering Billing

b) The diagram below gives the **Hierarchical Design of Cloud Computing Implementation**. With the help of a diagram, give a brief description and function of each of the following component in the implementation. [10 Marks]

- i. Client
- ii. CLC
- iii. CC
- iv. NC

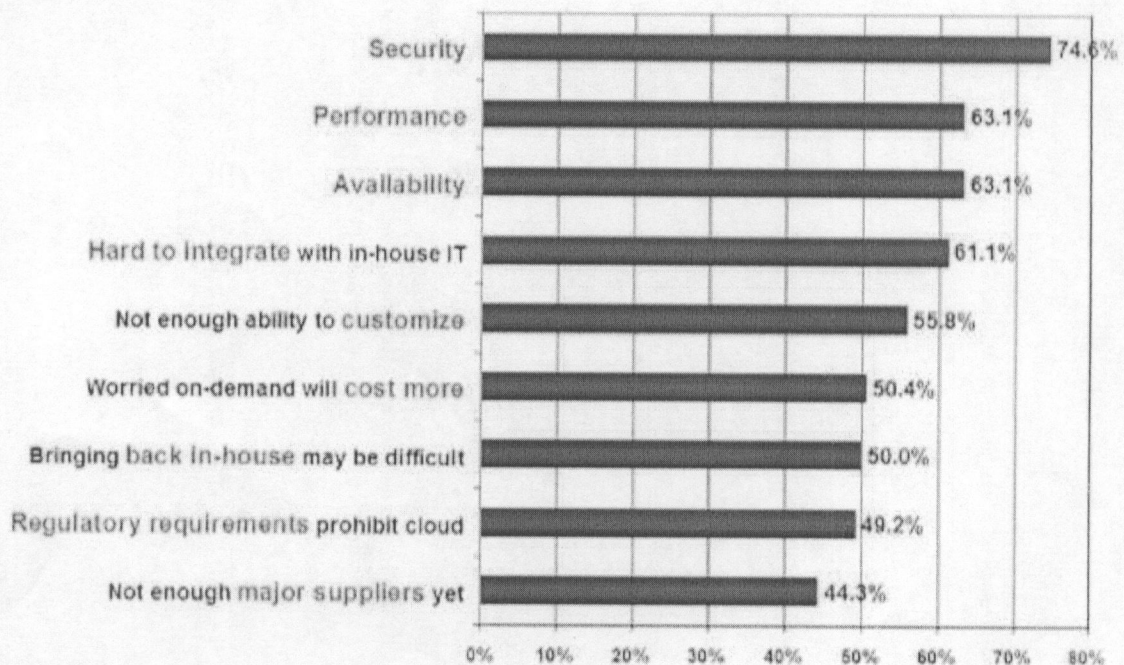


Question II

- a) There are several causes of problems associated with cloud computing. However, most security problems stem from [6 Marks]:
- i. Loss of control
 - ii. Lack of trust (mechanisms)
 - iii. Multi-tenancy
- Discuss each of these challenges and how they are being addressed in cloud implementation
- b) Cloud computing is a compilation of existing techniques and technologies, packaged within a new infrastructure paradigm that offers improved service delivery. Cloud computing definitely makes sense if your own security is weak, missing features, or below average [10 Marks].
- i. List and describe the two key features of cloud computing
 - ii. Describe the four major Attributes of Cloud Computing
 - iii. List and describe any four Essential Characteristics of Cloud Computing
- c) A cluster is a type of parallel or distributed processing system, which consists of a collection of interconnected stand-alone/complete computers cooperatively working together as a single, integrated computing resource [4 Marks]
- i. List and discuss the key characteristics of Cluster Computing
 - ii. Discuss the main motivation in using Clusters Computing

Question III

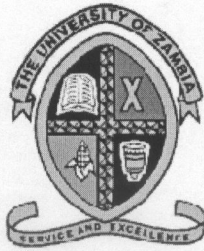
- a) Discuss each of the following in relation to the TAXONOMY OF FEAR [6 Marks]
- i. Confidentiality
 - ii. Integrity
 - iii. Availability
- b) The diagram below shows some of the major reasons why companies are afraid to use cloud services. Briefly discuss each of the following in relation to diagram below. Give at least one example in each case. [9 Marks]
- i. Cloud Threat Model
 - ii. Cloud Confidentiality
 - iii. Cloud Security



- c) In order to address the security challenges above and ensure that data is secure, that it cannot be accessed by unauthorized users or simply lost, and that data privacy is maintained, cloud providers attend to the following areas [5 Marks]
- i. Identity management
 - ii. Availability
 - iii. Privacy
 - iv. Legal issues
 - v. Application security

Discuss each of the above in relation to cloud computing security

End of the Examination



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 4822
ROUTING AND SWITCHING
TECHNOLOGIES

Date: 21st NOVEMBER 2018
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. There are **two (2) Sections** in this exam, **Section A** and **Section B**.
2. In Section A, **answer all the questions** and in Section B **choose any three (3) questions**.

SECTION A [40 marks]

ANSWER ALL QUESTIONS IN THIS SECTION

Question 1 [20 marks]

- a) A switch can be configured in one of three VTP modes. Name the modes. **[3 marks]**
- b) Name two ways in which a host can be assigned an IP address? **[2 marks]**
- c) Router memory is classified as volatile or non-volatile. What is volatile memory? **[1 mark]**
- d) Name two primary functions of a router. **[2 marks]**
- e) Name two things that console access requires? **[2 marks]**
- f) Most network capable devices (e.g., computers, tablets, and smartphones) require the components to operate. List three common components. **[3 marks]**
- g) Which command do you use when you want to name the device? **[1 mark]**
- h) What is the AD of OSPF? **[2 marks]**
- i) Which command do you use when you want to activate an interface? **[2 marks]**
- j) Which command displays the contents of the IPv4 routing table stored in RAM? **[2 marks]**

Question 2 [20 marks]

- a) When do we use the default static routes? **[2 marks]**
- b) What is the metric of RIP? **[1 mark]**
- c) A router can learn about remote networks in one of two ways. Name the ways. **[2 marks]**
- d) When can multiple static routes can be summarized into a single static route? **[1 mark]**
- e) List three main components of dynamic routing protocols. **[3 marks]**
- f) Why is a separate VLAN needed to support Voice over IP (VoIP)? **[2 marks]**
- g) Which command do you use to disable and eliminate RIP? **[1 mark]**
- h) Name two switch forwarding methods? **[2 marks]**
- i) Sending out unneeded updates on a LAN impacts the network in three ways in the case of passive interfaces. List the ways. **[3 marks]**
- j) List three types of VLANs. **[3 marks]**

SECTION B [60 marks]

ANSWER ANY THREE (3) QUESTIONS IN THIS SECTION

Question 3 [20 marks]

- a) Routers support three packet-forwarding mechanisms. Discuss the mechanisms.[5 marks]
- b) Differentiate static from dynamic routing.[5 marks]
- c) Discuss the purpose of dynamic routing protocols.[5 marks]
- d) Borderless switched network design guidelines are built upon four principles. Name the principles.[5 marks]

Question 4 [20 marks]

- a) Discuss the primary uses of static routing.[5 marks]
- b) Networks have had a significant impact on our lives. They have changed the way we live, work, and play. There are many key structures and performance-related characteristics referred to when discussing networks. Explain briefly about these characteristics.[5 marks]
- c) Discuss five important characteristics of switches that contribute to alleviating network congestion. [5 marks]
- d) Discuss the disadvantages of static routing. [5 marks]

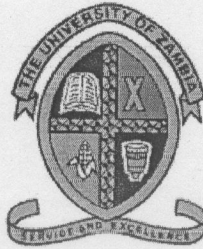
Question 5 [20 marks]

- a) User productivity and network adaptability are important for business growth and success. VLANs make it easier to design a network to support the goals of an organization. Discuss the primary benefits of using VLANs[5 marks]
- b) EtherChannel technology was originally developed by Cisco as a LAN switch-to-switch technique of grouping several Fast Ethernet or Gigabit Ethernet ports into one logical channel. When an EtherChannel is configured, the resulting virtual interface is called a port channel. The physical interfaces are bundled together into a port channel interface. EtherChannel technology has many advantages. Discuss these advantages.[5 marks]
- c) There are various types of switches used in business networks. It is important to deploy the appropriate types of switches based on network requirements. Discuss the types. [5 marks]
- d) EtherChannels can be formed through negotiation using one of two protocols, PAgP or LACP. Discuss the protocols PAgP and LACP.[5 marks]

Question 6 [20 marks]

- a) There are guidelines and restrictions that you must use when configuring EtherChannel. Discuss the guidelines and restrictions. **[5 marks]**
- b) Routing protocols can be compared based on the number characteristics. Discuss the characteristics. **[5 marks]**
- c) Explain briefly the difference between IGRP and EIGRP. **[5 marks]**
- d) In 1993, RIPv1 was updated to a classless routing protocol known as RIP version 2 (RIPv2). RIPv2 included a number of improvements. Discuss the improvements. **[5 marks]**

THE END



THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

FINAL EXAMINATION

CSC 4822
ROUTING AND SWITCHING
TECHNOLOGIES

Date: 6th NOVEMBER 2019
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: P207

Instructions

1. There are **two (2) Sections** in this exam, **Section A** and **Section B**.
2. In Section A, **answer all the questions** and in Section B **choose any three (3) questions**.

Q4 (a) (i) The expression for the transmission of X-rays is written as

$$I = I_0 e^{-\mu x} . \quad [5]$$

Explain the meaning of all symbols appearing in this equation.

(ii) Using the expression cited in (i), obtain the thickness of a material of attenuation coefficient = 0.4 cm^{-1} that would absorb 75% of the intensity of X-rays falling on it. [5]

(b) (i) The expression below shows the decay of radioactive substances is written as

$$N = N_0 e^{-\lambda t}$$

Explain what the symbols N, N_0, λ and t stand for, [4]

(ii) In 2.00 days, the activity of a sample of unknown type radioactive material decreases to 84.2% of the initial activity. Determine the half-life of this material. [6]

Q5 (a) In the planetary model of the atom as proposed by Rutherford, the motion of an electron in the hydrogen atom describes an orbit of radius r . Given that the angular frequency of the motion is ω , show that the magnetic moment, μ of such a current is given by [4]

$$\mu = \frac{\pi r^2 \omega e}{2} . \quad \mu = \frac{e \omega r^2}{2}$$

Where e is the electronic charge.

(b) (i) Distinguish between *soft* and *hard* magnetic materials and give one example of each. [4]

(ii) A toroid wound with 60.0 turns/m of wire carries a current of 5.0A.

The torus is made out of aluminium for which $\chi = 2.3 \times 10^{-5}$ under the given conditions. Compute the values of \mathbf{B}, \mathbf{H} and \mathbf{M} in this setup. [8]

- Q3 (a) (i) Figure 1 shows the spectrum of light emitted by a firefly. Determine the temperature of a black-body that would emit radiation peaked at the same frequency. [3]

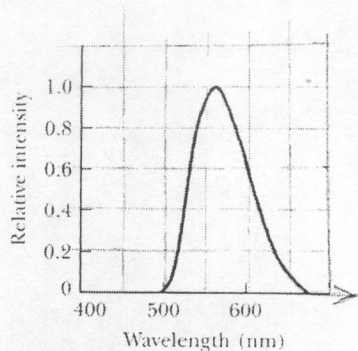


Figure 1

- (ii) Given that the hydrogen atom absorbs a photon and is made to transition from the state $n = 2$ to $n = 5$ state. Determine the wavelength of the absorbed photon. [5]
- (b) In our galaxy, there are a number of gas clouds which emit radiation with maximum intensity at a wavelength of $10\mu\text{m}$. Assuming that these clouds act as spherical black bodies with the same power as the Sun, estimate
- (i) their surface temperature, [2]
- (ii) their radius [7]
- (c) Calculate the binding energy of the electron in hydrogen in joules and in eV when it resides in a shell with $n = 3$ and $n = \infty$. Note: mind the signs. [3]

Q1 (a) The question whether radiation was particulate or a wave was settled by a number of experiments. Briefly cite one experiment that supported the particulate nature of radiation and another that supported the wave nature of radiation. [6]

(b) Photons of wavelength 450 nm are incident on a metal surface. It is observed that the most energetic electrons ejected from the metal are bent into a circular arc of radius 20.0 cm when they enter a magnetic field of magnitude $2.00 \times 10^{-5} \text{T}$. What is the work function of the metal? [9]

(c) Find the de Broglie wavelength of an electron that has a kinetic energy of 3.00 eV. [5]

Q2 (a) What is the difference between *hard* and *soft* X-rays? [4]

(b) (i) X-rays of wavelength 0.140 nm are reflected from a certain crystal, and the first order maximum occurs at an angle of 14.4° . What value does this give for the inter-planar spacing of the crystal? [3]

(ii) Suppose an electron is accelerated through a potential difference V in an X-ray tube. Show that the minimum wavelength, λ_{min} of the X-rays produced is given by [5]

$$\lambda_{min} = \frac{1.242}{V} \mu\text{m}$$

(c) X-rays of wavelength $\lambda = 0.200 \text{ nm}$ are scattered from a block of material. The scattered x-rays are observed at an angle of 45° to the direction of the incident beam. Calculate [8]

(i) the wavelength of the x-rays scattered at this angle,

(ii) the fractional change in the energy of a photon in this collision.



THE UNIVERSITY OF ZAMBIA
School of Natural Science
Department of Computer Science

FINAL EXAMINATION

CSC 4842
CLOUD AND HIGH PERFORMANCE COMPUTING

Date: Friday, 5th December 2018
Time: 14:00hrs – 17:00hrs
Duration: 3 Hours
Venue: P 207

Instructions

1. There are **six (6) Questions** and **two (2) Sections** in this paper.
2. Each question carries **20 marks**,
3. You are required to answer a total of Five (5) Questions
 - a. Answer **all** the questions in **Section A**
 - b. Choose **any three (3)** questions from **Section B**

SECTION A

This Section has Two Questions. Answer ALL the Questions

Question I

- a) Give a brief description for each of the following [2 Marks]
- Cloud Computing
 - Utility Computing
- b) The diagram below shows the service model of cloud computing [12 Marks].
- With the aid of a diagram, discuss each of the following services
 - SaaS
 - PaaS
 - IaaS
 - Give an example implementation of each of the above services above in real life

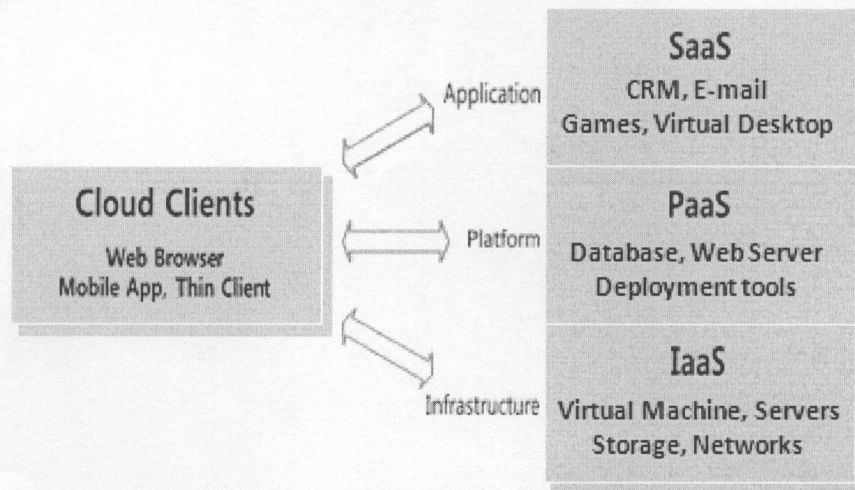


Figure 1: Cloud Computing Service Model

- c) The cloud management services contain deployment, monitoring, reporting, service-level agreement, and metering billing. Discuss each one of these services in detail [6 Marks]
- Monitoring
 - Service-Level Agreement
 - Metering Billing

Question II

a) The diagram in Figure 2 below shows the **Deployment Models of a Cloud Computing** [12 Marks]

- i. With the aid of a diagram, **discuss** each of the models deployment below
- ii. Give the advantages and disadvantages of each deployment.
- iii. Give 1 example in real-life of such deployment

Dedicated physical server Virtual server instance

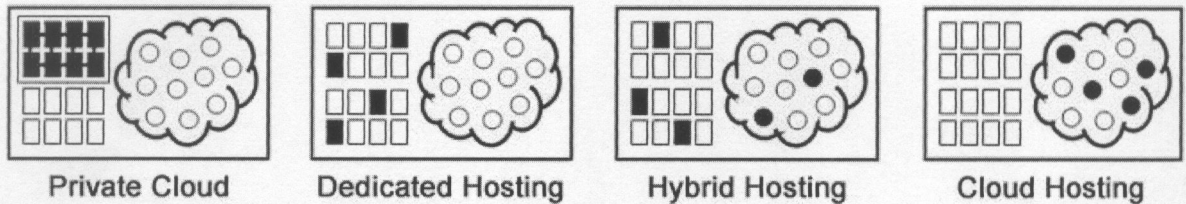


Figure 2: Cloud Computing Model

b) Virtual machine technology allows multiple virtual machines to run on a single physical machine as shown in Figure 3 below. This technology is very key in the implementation of cloud infrastructure [8 Marks]

- i. Give three (3) advantages of virtual machines
- ii. Give three (3) reason why cloud-sourcing is becoming a Big Deal
- iii. What are some of the major concerns of cloud sourcing

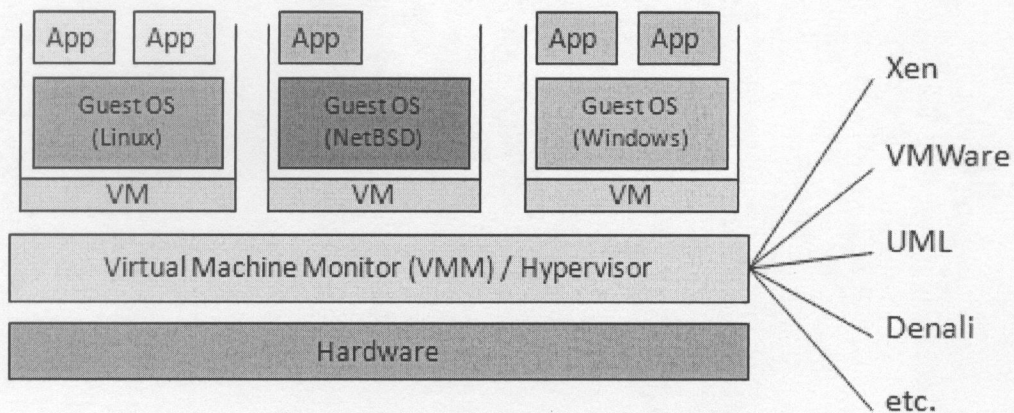


Figure 3: Virtual machine technology

SECTION B

This section has four Questions. Choose any three questions

Question I

a) The cloud acts as a big black box. Nothing inside the cloud is visible to the clients. The clients have no idea or control over what happens inside a cloud. Even if the cloud provider is honest, it can have malicious system admin who can tamper with the Virtual Machines and violate confidentiality and integrity. Some of the major causes of problems associated with cloud computing include the following;

- i. Loss of control
- ii. Lack of Trust (Mechanisms)
- iii. Multi-Tenancy

Discuss each of these causes in detail [10 Marks]

b) A distributed system consists of collection of autonomous computers, connected through a network and distributed operating system software, which enables computers to coordinate their activities and to share the resources of the system - hardware, software and data, so that users perceive the system as a single, integrated computing facility as shown in the diagram below. This is key in the implementation of clouds. Some of the characteristics of distributed systems include;

- i. Resource Sharing
- ii. Concurrency
- iii. Scalability
- iv. Fault tolerance
- v. Transparency

Briefly discuss each of the characteristics of distributed systems above in relation to the figure below [10 Marks].

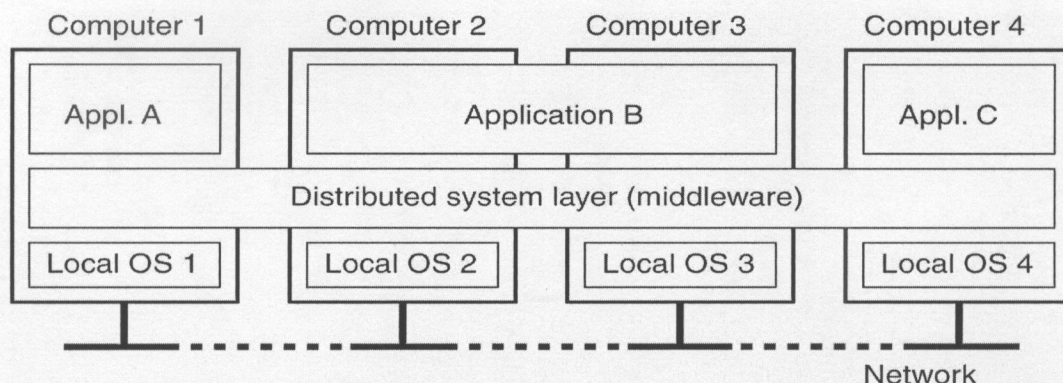


Figure 4: A distributed system organized as middleware which extends over multiple machines, and offers each application the same interface

Question II

- a) Discuss the following cloud computing issues with regards to [6 Marks]
- i. Privacy
 - ii. Security
 - iii. Legal
- b) List and Discuss any four (4) disadvantages of Cloud Computing [4 Marks]
- c) You have just joined the University of Zambia (UNZA) as a new graduate. UNZA would like to create a cloud platform but based on a grid environment. This requires the implementation of a single system image (SSI) which is the illusion, created by software or hardware, that presents a collection of resources as one, more powerful resource. A SSI makes the cluster appear like a single machine to the user, to applications, and to the network [10 Marks].
- i. Discuss the major benefits of a Single System Image implementation
 - ii. Name and discuss the desired Single System Image Services

Question III

- a) In relation to cloud computing, discuss each of the following [4 Marks]
- i. Interoperability
 - ii. Data Migration

- b) There are three ways to improve performance. These can be classified as follows
- i. Work Harder
 - ii. Work Smarter
 - iii. Get Help

Give and discuss the Computer Analogy for each of the three classifications above [6 Marks]

- c) Discuss the following advantages of Cloud Computing [10 Marks]
- i. Lower computer costs
 - ii. Improved performance
 - iii. Instant software updates
 - iv. Unlimited storage capacity
 - v. Increased data reliability

Question IV

- a) There are different ways to classify parallel computers. One of the more widely used classifications, in use since 1966, is called Flynn's Taxonomy. Flynn's taxonomy distinguishes multi-processor computer architectures according to how they can be classified along the two independent dimensions of Instruction and Data. Each of these dimensions can have only one of two possible states, Single or Multiple. Name and describe each of the four (4) classes [4 Marks]
- b) Briefly discuss each of the open source cloud-based services [8 Marks]
- i. Eucalyptus,
 - ii. Open Nebula,
 - iii. Nimbus
 - iv. Enomaly
- c) A threat model helps in analyzing a security problem, design mitigation strategies, and evaluate solutions. Discuss the steps required in implementing the Threat Model and the basic components of the Model which include the following. [8 Marks]
- i. Attacker Modelling
 - ii. Attacker motivation and capabilities
 - iii. Attacker goals
 - iv. Vulnerabilities / threats

End of the Examination

The University of Zambia Examination 2018
School of Natural Science
Digital Electronics CS3120

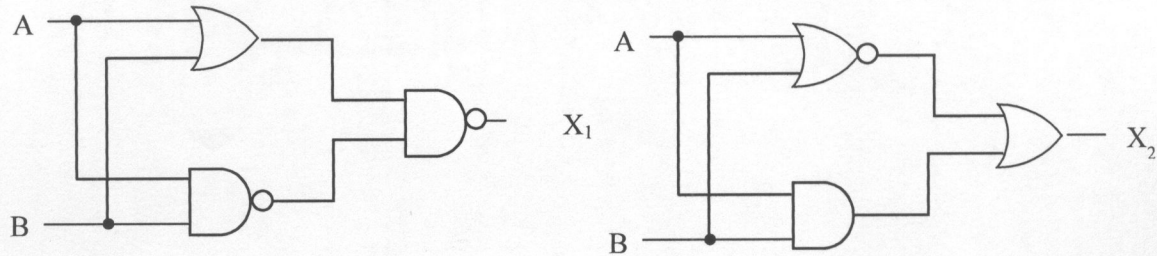
Time: 3 Hours

Instructions: Answer any 5 questions

All questions carry 20 marks

1.

- a. Using De Morgan's theorem and Boolean algebra, prove that the two circuits shown are equivalent.



- b. Prove that the two circuits are an implementation of an XNOR (Exclusive NOR)

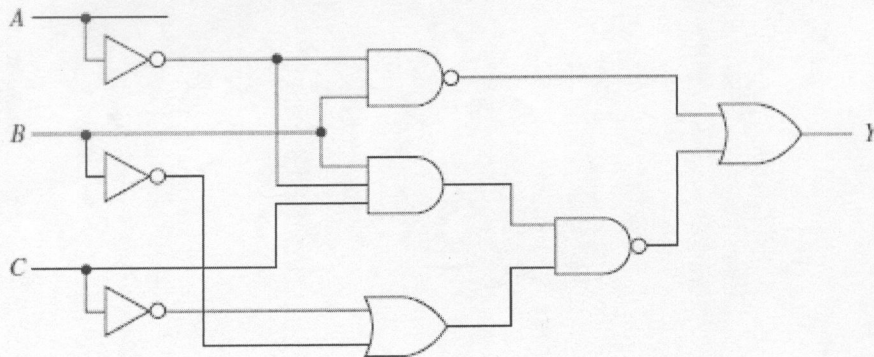
2.

- a. Design a circuit that outputs a HIGH when the binary value of ABCD (D is LSB) is < 12 . Draw the circuit using the least number of gates.
- b. Implement the circuit using only NAND gates.

3.

Simplify the circuit using

- a. Demorgan's theorem and Boolean algebra.
- b. Confirm the result in part a. by using K-maps to simplify the circuit.



4.

a. Convert the following decimal numbers to two's-complement form and perform the operation indicated.

$56 - 85 = \underline{\hspace{2cm}}$

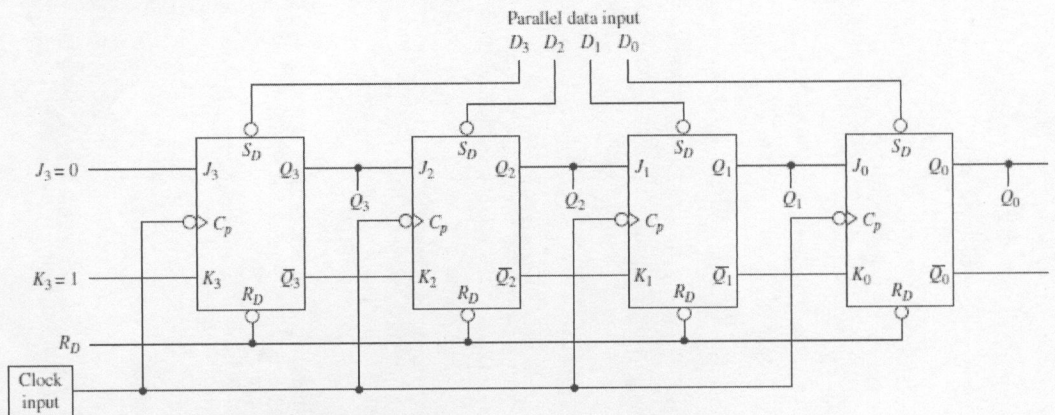
b. Draw the block diagram of a 4-bit full-adder using *four full-adders*.

c. Draw the circuit for an active-LOW output octal (1-of-8) decoder.

5.

a. Design a MOD-6 synchronous binary up-counter using J-K flip flops.

b. If the register of Figure below is initially parallel loaded with 1011 what will the output at Q_3 to Q_0 be after two clock pulses? After four clock pulses?



6. The truth table below represents a voting system for a tribunal. A motion is accepted if at least two of the three judges vote yes (1). A, B and C represent each of the judge's votes and Y represents the output (1 for yes)

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

- Make a K-Map to represent this truth table.
- From the K-Map derive the simplified Boolean expression.
- Draw the circuit.

END OF EXAMINATION

CANDIDATE'S COMPUTER NUMBER:

**THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES**

**2018/19 ACADEMIC YEAR FINAL EXAMINATIONS
GES 2411: MAPPING AND FIELD TECHNIQUES IN GEOGRAPHY**

PAPER I: THEORY

TIME: Three Hours

INSTRUCTIONS: Answer **ALL** questions in Sections A and B and any other **ONE** from Section C. The use of a certified calculator is allowed and candidates are encouraged to use illustrations wherever appropriate.

MATERIALS PROVIDED:

A4 Graph Paper

FOR USE BY EXAMINER

Question	Examiner's Mark	Moderator's Mark
1		
2		
3		
4		
Total		

IMPORTANT

Please read the instructions before attempting any question on this examination paper
Failure to follow instructions will lead to automatic loss of marks

SECTION A: MULTIPLE CHOICE [30 Marks]
(Circle the letter of the correct response on this question paper)

1. According to McKnight (1984), What term broadly describes the sophisticated technology that permit precision recording instruments that operate from high altitude vantage points providing a remarkable new set of tools for the study of the earth?
 - (a) Aerial photography
 - (b) Remote sensing
 - (c) Geographic Information System (GIS)
 - (d) Satellite imagery

2. Which one of the following is a quantitative method of showing relief on a map?
 - (a) Hachuring
 - (b) Layer Colouring
 - (c) Hill Shading
 - (d) Hill Shadowing

3. What are landscape symbols?
 - (a) Symbols that show vegetation, drainage, spot heights, latitude and longitude
 - (b) Symbols show features that are objects of the ground
 - (c) Symbols show things that are not real and do not exist in reality.
 - (d) Symbols show features that are not objects of the ground

4. When is an aerial photograph said to have high spatial resolution?
 - (a) When it shows fine spatial detail objects
 - (b) When it shows shadows of objects
 - (c) When it shows the horizon
 - (d) When it shows sensitivity in all parts of the electromagnetic spectrum

5. Which one of the following map features are not normally drawn to scale?
 - (a) Water Features
 - (b) Relief Features
 - (c) Cultural and human-made Features
 - (d) Vegetation and Land use Features

6. Which one of the following drainage patterns is a characteristic of maturely dissected domes which have alternating belts of strong and weak rocks encircling them and they have a ring like pattern?
- (a) Centripetal
 - (b) Barbed
 - (c) Annular
 - (d) Radial
7. The information provided on an aerial photograph includes among many others, a chronometer and a level bubble. What is the importance of showing a level bubble on the vertical aerial photograph?
- (a) To indicate the time of exposure
 - (b) To indicate the height at which the photograph was taken
 - (c) To indicate the focal length of the camera used
 - (d) To indicate whether the flight path was horizontal with no tilt of aircraft
8. What is the name of a device for viewing two overlapping aerial photographs taken at the same time but from slightly different points of view?
- (a) Stereoscopic model
 - (b) Stereos
 - (c) Stereoscope
 - (d) Stereo-pair
9. Which one of the following statements is not an advantage of aerial photographs over maps?
- (a) Aerial photographs show all land surface details that are large enough to be recorded on film
 - (b) Aerial photographs show the actual earth's surface
 - (c) Aerial photographs can be taken of impenetrable or remote areas which cannot be visited by ground surveys
 - (d) Human error cannot be eliminated because air photos are captured by cameras operated by humans

10. The scale of air photographs is calculated using the formula $1/SF = d/D$ or $1/SF = f/H$ in these equations, SF is equal to
- (a) $SF = D/d$ or $S = H/f$
 - (b) $SF = d/D$ or $S = f/H$
 - (c) $SF = d \times D$ or $S = f \times H$
 - (d) $SF = 1/SF = d/D = f/H$
11. The area of an irregular polygon on a topographic map can be calculated using all but one of the following. Which one is the exception?
- (a) The Strip Method
 - (b) The Geometric Method
 - (c) The Squares Method
 - (d) Method of Similar Triangles
12. The scale of a vertical air photograph is very easy to calculate where the ground or terrain is fairly flat. However, the challenge arises where the terrain is undulating. What formula can one use in calculating scale in the case where the flying height is above the mean altitude of the terrain?
- (a) $S = f/H$
 - (b) $S = f/H - h$
 - (c) $S = f/H + h$
 - (d) $S = f/H + d/D$
13. Which one of the following statements about cadastral maps is false?
- (a) They are one of the earliest permanent maps
 - (b) They are basically a type of thematic maps
 - (c) They are generally large scale maps which show individual properties
 - (d) They permit the portrayal of all normal map features true to scale
14. With reference to a fractional scale, which one of the following statements is false?
- (a) A fractional scale is expressed as a fraction or as a ratio
 - (b) A fractional scale compares map and ground distances proportionally
 - (c) Fractional scale only refers to the scale of 1: 50 000
 - (d) The same unit of measurement is used in the numerator and the denominator

15. Most map projections can be grouped into just a few families based on their derivation. Projections in the same family generally have similar properties and related distortion characteristics. Which one in the given examples does not belong to the stated family?
- (a) Cylindrical – Mercator's Central Perspective Projections
 - (b) Elliptical – Aitoff's and Mollweide's Projections
 - (c) Azimuthal – Gnomonic Projections
 - (d) Conic – Sinusoidal Projections
16. Which one of the following statements about aerial photography is false?
- (a) The optical axis is the line through the projection centre perpendicular to the film plane
 - (b) The principal point is found where the optical axis hits the film plane
 - (c) The distance between the principal point and the projection centre is the focal length of the camera.
 - (d) The focal length of the camera used on most metric cameras is fixed
17. Which one of the following drainage patterns roughly resembles a tree-like pattern that consists of random merging of streams with tributaries joining larger streams irregularly, but always at acute angles?
- (a) Parallel
 - (b) Dendritic
 - (c) Trellis
 - (d) Barbed
18. Which one of the following statements about globes is false?
- (a) Globes are too cumbersome for almost any use other than class room study
 - (b) Globes unlike maps are very limited in number and variety
 - (c) Only half the globe can be viewed at any one time
 - (d) Globes require the use of a map projection when being constructed

19. Which one of the following air photo interpretation clues takes into account the relationship between other recognizable objects or features in proximity to the target of interest?
- (a) Tone
 - (b) Pattern
 - (c) Association
 - (d) Shape
20. A relief feature that is described as a high long steep slope at the edge of a plateau forming a line of junction of two surfaces sloping upwards towards each other with two distinct slopes is known as:
- (a) An escarpment
 - (b) A spur
 - (c) A ridge
 - (d) A dissected plateau
21. What term is given to streams that are often short tributaries of subsequent streams and commonly flow in the opposite direction of the consequent stream?
- (a) Insequent streams
 - (b) Obsequent streams
 - (c) Misfit Streams
 - (d) Resequent streams
22. Which elements of a good map do not normally apply to sketch maps?
- (a) Map title and map legend
 - (b) Map scale and date
 - (c) Date and direction
 - (d) Direction and legend
23. What is the central problem in constructing or choosing a map projection?
- (a) To provide correct size
 - (b) To provide correct shape
 - (c) To portray distance and area on a map accurately
 - (d) To find out which aspects to emphasise – size or shape

24. Which one of the following slopes does not match with the description given?
- (a) 1:1 Climbing country
 - (b) 1:2 A difficult scramble
 - (c) 1:3 Steepest for roads
 - (d) 1:20 Too steep for the steepest roads
25. When maps are classified according to function, which one of the following maps does not fall in that classification?
- (a) General maps
 - (b) Thematic maps
 - (c) Charts
 - (d) Plans
26. Which one of the following is not a characteristic of good map symbol?
- (a) Distinctiveness
 - (b) Neatness
 - (c) Legibility
 - (d) Small in size
27. Which one of the following statements about map projections is false?
- (a) Equivalence is an instance where angle ratio between map and reality is the Same
 - (b) Each map projection is designed as a compromise from reality
 - (c) No map projection is perfect
 - (d) Each map projection has some advantages over others but also has its own peculiar limitations.
28. Which one of the following is not a factor that could lead people choosing a particular site for settlement?
- (a) Good and pure water supply
 - (b) Availability of green spaces
 - (c) Fertile soil
 - (d) Dry and firm sites

29. Which one of the following statements is false about Natural Forests (NF) in an air photograph?
- (a) They have no pattern
 - (b) They are associated with non arable land
 - (c) They have well defined often straight boundaries
 - (d) They are more or less rough in texture because of mixed species and uneven canopy
30. Which one of the following statements about maps is not true?
- (a) A map serves as a surrogate for a part of the Earth's surface that one wishes to portray
 - (b) A map is a representation of an area at a reduced scale in which only selected data are shown
 - (c) A map is a two – dimensional representation of the spatial distribution of all ground phenomena
 - (d) A map is always smaller, usually extremely smaller than the portion of the surface it is represented

SECTION B: SHORT ANSWER [25 Marks]

(Write your responses in the spaces provided on this examination question paper)

31. What is the difference between elevation and relief on a map? [2 marks]

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32. What are stereoscopic pairs? [2 marks]

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33. What are the two major sources of distortion on vertical aerial photographs? [2 marks]

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34. What is a vertical aerial photograph and how does it differ from an oblique air photograph? [2 marks]

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35. Explain why a vertical aerial photograph has no definite scale? [2 marks]

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36. Explain the importance of a level bubble on a vertical aerial photograph. [2 marks]

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37. Why are vertical air photographs taken with forward and lateral overlaps? [2 marks]

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38. With the help of examples, explain the difference between large and small scale maps. [2 marks]

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39. What is an index contour and what is its importance ? [2 marks]

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40. Why is the vertical scale on a profile always exaggerated? [2 marks]

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41. What is the difference between vertical rise and vertical interval on a map? [2 marks]

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42. Distinguish between conformal and equivalent map projections. [4 marks]

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43. What is the difference between Four Figure and Six Figure Grid References?
[4 marks]

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44. Describe the soil texture characteristics when wet for the given soils as indicated in Table 1 [10 marks]

Table 1: Soil texture characteristics when wet

Soil type	Texture characteristics when wet
Sand	
Sandy loam	
Loam clay	
Clay loam	
Clay	

SECTION C: SHORT ESSAY QUESTIONS (25 marks)

(Answer one question only from this Section in the examination answer book provided)

45. With the help of an annotated sketch map, explain the importance of each of the five elements of a good map.
 46. With the help of diagrams, explain how a map reference number is derived.
 47. With the aid of diagrams explain the differences between vertical and oblique air photographs and briefly comment on their use in map making.
-

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
2018/2019 ACADEMIC YEAR FINAL EXAMINATIONS
GES 3151: REGIONAL PLANNING AND DEVELOPMENT

TIME: Three hours

INSTRUCTIONS: Answer questions **1** and any other **two**. All questions carry equal marks. You are encouraged to use illustrations wherever possible

1. Write short explanatory notes on ALL of the following:
 - a) A functional region
 - b) Gini coefficient
 - c) Economic base multiplier
 - d) Multifacility economic zones
 - e) Devolution as a form of decentralisation.

 2. Explain occupational structure as a measure of economic development status of regions.

 3. Describe each step in Nurkse's vicious cycle of poverty and how they relate.

 4. Explain the stages in Rostow's model of development.

 5. Discuss the impacts of globalisation on regional planning in developing countries.
-

END OF EXAMINATION

**THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES**

2018/2019 ACADEMIC YEAR FINAL EXAMINATIONS

GES 3441: REMOTE SENSING

TIME: Three Hours

INSTRUCTIONS: Answer questions 1 and any other **two**. All questions carry equal marks. Candidates are advised to make use of illustrations and examples wherever appropriate.

1. Write short explanatory notes on all of the following:
 - a) Confusion Matrix
 - b) Geometric restoration
 - c) Image classification
 - d) Remote sensing system
 - e) Light Detection and Ranging (LIDAR)
 - f) Atmospheric window.
 2. Discuss five remote sensing vegetation indices
 3. Discuss how you would go about assessing urban sprawl for Kabwe District
 4. Describe how remote sensing imagery can be applied in three specific fields for national development. For each field, give specific examples of the actual tasks that remote sensing imagery can deliver to achieve the intended goals.
 5.
 - a) Distinguish between imager and sounder in weather satellites
 - b) Briefly describe the different types of resolutions of interest in remote sensing applications
 - c) Distinguish between Whiskbroom and Pushbroom scanners
 - d) Distinguish between Sun-synchronous and Geostationary satellite orbits
 - e) The main differences between SPOT and Landsat imagery.
-

END OF EXAMINATION

**THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES**

**2018/19 ACADEMIC YEAR FINAL EXAMINATIONS
GES 4181: URBAN GEOGRAPHY AND PLANNING**

TIME: Three hours

INSTRUCTIONS: Answer Questions 1 and any other two. All questions carry equal marks.
Candidates are encouraged to make use of illustrations wherever possible.

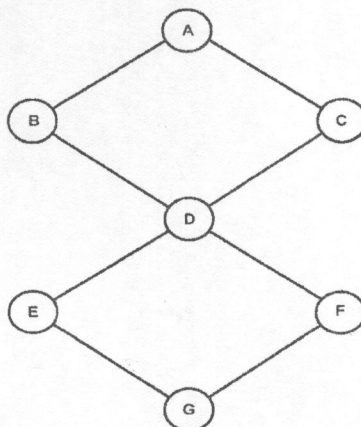
1. Write short explanatory notes on ALL of the following:

- a) Stages of urban development (Urban Life Cycle)
- b) Industrial urbanization
- c) Ways government can intervene in urban housing
- d) Dependent urbanization
- e) System-maintaining planning.

2. Figure 1 can be used to describe a city's competitive position within economic flows. Identify and Explain:

- a) Cities that are competitors
- b) Cities that are not competitors
- c) Cities that are partial competitors
- d) Cities that are the most powerful in this network

Figure 1: Cities competitive position



Source: Hypothetical

3. Using a cross-section graph, explain the Transport and Land Trade-Off theory in determining housing location.
 4. Discuss Ebenezer Howard's garden city concept with reference to the development of Lusaka
 5. Explain the stages involved in a Rapid Urban Environmental Assessment.
-

End of Examination

The University of Zambia
School of Natural Sciences
Department of Mathematics & Statistics

2018/19 Academic Year Final Examinations

MAT1100 – Foundation Mathematics

4th November, 2019

-
- INSTRUCTIONS:**
- (1) Write down your **Computer number** and the **TG number** on each answer booklet used. (**Do not write your name**)
 - (2) There are seven (7) questions in this paper. **Answer any Five (5)**.
 - (3) Show all essential working to score full marks.
 - (4) Write down the **number** of each question attempted on the cover of the main answer booklet.
 - (5) Calculators are **not allowed** in this Examination.

TIME ALLOWED: Three (3) hours.

- Q1. (a) (i) By completing the square, find the centre and radius of the circle given by

$$x^2 + y^2 - 2x + 6y + 6 = 0.$$

(4 marks)

- (ii) Hence, from part (i), find the equation of the tangent to the circle at

$$(2, \sqrt{3} - 3).$$

(3 marks)

- (b) Let $A = \begin{pmatrix} 1 & 0 & 3 \end{pmatrix}$ and $B = \begin{pmatrix} 1 \\ 2 \\ 4 \end{pmatrix}$. Find the following products:

(i) AB

(2 marks)

(ii) BA .

(2 marks)

(c) Let $A = \begin{pmatrix} 1 & 0 & 2 \\ 1 & 1 & 2 \\ 0 & 1 & 1 \end{pmatrix}$.

- (i) Find A^{-1} .

(5 marks)

- (ii) Hence or otherwise, solve the following system of equations:

$$x + 2z = 1$$

$$x + y + 2z = 2$$

$$y + z = 3.$$

(4 marks)

- Q2 (a) (i) Simplify the set $((B - A) \cap C)'$, given that all the sets A, B and C intersect. (2 marks)
- (ii) Given the sets $A = [-2, 6), B = (-5, 3), C = [-1, 8]$ and that $U = [-10, 10]$ is the universal set, find the set $A \cup (B' \cup C)'$. (2 marks)
- (b) (i) Express $2.5\overline{34}$ in the form $\frac{p}{q}$ where p and q are integers and $q \neq 0$, in its lowest terms. (3 marks)
- (ii) Express $\frac{3+\sqrt{3}}{(\sqrt{3}-1)^2}$ in the form $p + q\sqrt{3}$, where p and q are rational numbers. (3 marks)
- (iii) Given that $\frac{1-2i}{z} = 2 + 5i$, find z in the form $a + ib$, where a and b are real numbers. (3 marks)
- (c) (i) Let $*$ be a binary operation on the set of real numbers defined by
- $$a * b = ab - (a + b).$$
- Determine whether the binary operation $*$ is commutative. (2 marks)
- (ii) Using the definition of $*$ in part (i) evaluate $2 * (3 * 4)$. (2 marks)
- (iii) If $f(x) = 2x - 3$ and $g(x) = \frac{x+1}{2x}$, find $(f \circ g)^{-1}(x)$ and state its domain and range. (3 marks)
- Q3. (a) (i) Complete the square of the quadratic function $f(x) = 3 + 2x - x^2$ and sketch its graph, indicating its turning point and the x - and y - intercepts. (5 marks)
- (ii) Find the range of values of k for which the quadratic equation
- $$x^2 + (2 - k)x + 1 - 2k = 0$$
- has complex roots. (3 marks)
- (b) Solve each of the following equations:
- (i) $\sqrt{2x + 1} = \sqrt{x} + 1$ (3 marks)
- (ii) $|2x - 3| = 3x - 5$. (3 marks)
- (c) Solve each of the following inequalities:
- (i) $\frac{5}{x-2} > \frac{2}{x+1}$ (3 marks)
- (ii) $\left| \frac{x-2}{x+1} \right| \leq 3$. (3 marks)

- Q4. (a) (i) Find the term independent of x in the expansion of $\left(x - \frac{1}{x}\right)^{12}$. (3 marks)
- (ii) Use Binomial expansion to express $\frac{1}{1-2x}$ as a series up to and including the term in x^3 , and state the range of values of x for which the expansion is valid. (3 marks)
- (iii) Using part (ii), find the approximate value of $\frac{1}{0.98}$, giving your answer correct to 5 decimal places. (2 marks)
- (b) (i) The polynomial $p(x) = 3x^3 - 2x^2 + px - q$ is divisible by $(x - 1)$ and leaves a remainder of 10 when divided by $(x + 1)$. Find the values of p and q . (3 marks)
- (ii) Solve the equation
- $$x^3 - 3x^2 + 4 = 0. \quad (3 \text{ marks})$$
- (c) Prove each of the following by the principle of mathematical induction, for all positive integers n :
- (i) $1^3 + 2^3 + 3^3 + \dots + n^3 = \frac{1}{4}n^2(n+1)^2$. (3 marks)
- (ii) $3^{2n} - 1$ is divisible by 8. (3 marks)
- Q5. (a) (i) Express as a single logarithm $2 \log_4(2x + 3) - \log_4 x - \log_4(2x - 1)$. (2 marks)
- (ii) Hence, solve the equation
- $$2 \log_4(2x + 3) = 1 + \log_4 x + \log_4(2x - 1). \quad (3 \text{ marks})$$
- (b) (i) Given the function $f(x) = 1 - 2 \sin\left(\frac{1}{2}x - \frac{\pi}{6}\right)$, find the amplitude, period, phase shift and vertical shift and sketch its graph in the interval $[0, 2\pi]$. (5 marks)
- (ii) Prove that
- $$\sec \theta - \cos \theta = \sin \theta \tan \theta. \quad (3 \text{ marks})$$
- (c) Solve each of the following equations
- (i) $2 \cos^2 x - \sqrt{3} \cos x = 0$, for $0 \leq x \leq 360^\circ$. (3 marks)
- (ii) $4(3^{2x+1}) + 17(3^x) - 7 = 0$. (4 marks)

Q6. (a) Evaluate each of the following limits:

(i) $\lim_{x \rightarrow 2} \frac{x^2 - 4}{x^3 - 8}$ (3 marks)

(ii) $\lim_{x \rightarrow \infty} \frac{3x^3 + 5}{5 - x^2 - 3x^3}$ (3 marks)

(b) (i) Given that $y = \frac{(5x^2 - 4)^3}{e^{5x}}$, find $\frac{dy}{dx}$ at $x = 0$. (2 marks)

(ii) Find the equation of the normal to the curve $xy + x - 2y - 1 = 0$, at the point $(1, 0)$, expressing it in the form $ax + by + c = 0$, where a , b and c are constants. (3 marks)

(c) (i) Given the function $f(x) = \frac{1}{3}x^3 + \frac{1}{2}x^2 - 6x + 8$, find the intervals on which it is increasing and decreasing, and sketch its graph stating its local minima and maxima. (5 marks)

(ii) An open cylindrical tank with circular base is to be constructed of sheet metal so as to contain a volume πa^3 of water. Find the height and the radius of the base in terms of a so that the quantity of sheet metal required may be minimal. (Curved surface area of a cylinder is $2\pi rh$). (4 marks)

Q7. (a) Evaluate each of the following integrals:

(i) $\int \frac{x}{\sqrt{4-x^2}} dx$ (3 marks)

(ii) $\int x^2 \ln x dx$. (3 marks)

(b) Find the following definite integrals:

(i) $\int_2^3 \frac{4x+5}{(x+2)(x-1)} dx$. (3 marks)

(ii) $\int_0^{\frac{\pi}{2}} \sin^3 x dx$. (4 marks)

(c) (i) Sketch the region enclosed by the graph of $f(x) = \sin x$ and $g(x) = \frac{2}{\pi}x$ in the interval $[-\frac{\pi}{2}, \frac{\pi}{2}]$. (3 marks)

(ii) Hence, find the area of the region enclosed by the graphs of $f(x) = \sin x$ and $g(x) = \frac{2}{\pi}x$. (4 marks)

END OF EXAMINATION

The University of Zambia
Department of Mathematics & Statistics
2018/2019 Academic Year, Final Examinations
MAT1110: Foundation Mathematics & Statistics for Social Sciences
Tuesday, 5 November 2019

Time Allowed: 3 hours

Instructions:

1. There are **Seven** (7) questions in this examination paper. Attempt **any five** (5).
2. Indicate your **computer number** on all your answer booklets.
3. **Full credit** will only be given when **all necessary working** is shown.
4. **Calculators** are **Not** allowed.

This examination has (5) pages of questions.

-
1. (a) i. Let \mathbb{R} be the universal set, $A = (-3, 11]$ and $B = [0, 5)$. Find the set

$$A \cap B^c,$$

and display your answer on the number line.

- ii. Let A and B be sets such that $A \cap B = \emptyset$. Express the following in its simplest form:

$$A - (A^c \cap B^c).$$

- (b) Let $z = 6 + 4i$ and $\omega = 1 + i$ be complex numbers.

- i. Express

$$\frac{z}{\omega}$$

in the form $x + iy$, where x and y are integers.

- ii. Hence, or otherwise, solve the equation

$$\frac{z}{\omega} = x + ix + y + i^3y.$$

B; BZOB

(c) Let $f(x) = \frac{7x}{3x+1}$ and $g(x) = 4 - x$.

- i. On the same set of axes, sketch the graphs of $f(x)$ and $g(x)$.
- ii. Find the coordinates of the points of intersection of $f(x)$ and $g(x)$.
- iii. Hence, or otherwise, solve the inequality

$$\frac{7x}{3x+1} < 4 - x.$$

[8, 7, 10]

2. (a) Given that

$$f(x) = 6x^3 - 17x^2 - 4x + 3,$$

- i. Show that $(2x + 1)$ is a factor of $f(x)$.
- ii. Hence, or otherwise, factorize $f(x)$ completely.

(b) Solve each of the following equations;

i.

$$9^{2x+3} = \left(\frac{1}{27}\right)^{3x+1}$$

ii.

$$\log_5 6 + \log_5 2x^2 = \log_5 48.$$

(c) On the same set of axes, sketch the graphs of

$$f(x) = 1 - \left(\frac{1}{4}\right)^x$$

and

$$g(x) = \log_{\frac{1}{4}} \left(\frac{1}{x}\right) + 1.$$

(d) Evaluate

$$\lim_{x \rightarrow 5} \frac{\sqrt{x-1} - 2}{x-5}.$$

[6, 6, 8, 5]

3. (a) Solve each of the following equations for $0 \leq x \leq 2\pi$.

i.

$$\sqrt{3} \sin x - 2 \sin x \cos x = 0.$$

ii.

$$2 \sin x - 1 = \csc x.$$

(b) Prove each of the following identities:

i.

$$\cos^2 x \equiv \frac{\csc x \cos x}{\tan x + \cot x}.$$

ii.

$$\frac{\csc x}{\sin x} - \frac{\cot x}{\tan x} \equiv 1.$$

(c) Given that

$$f(x) = 3 \sin 2(x + 30^\circ) \text{ for } 0^\circ \leq x \leq 360^\circ,$$

i. Find the period, amplitude and phase shift.

ii. Hence, or otherwise, sketch **one revolution (cycle)** of the graph of $f(x) = 3 \sin 2(x + 30^\circ)$ for $x \geq -30^\circ$.

[11, 8, 6]

4. (a) i. Use the **first principle** to differentiate

$$f(x) = \frac{1}{1 - \sqrt{x}}.$$

ii. Show that if

$$y = \frac{\ln(e^{2x^2})}{(e^{x^2})^2},$$

then

$$\frac{dy}{dx} = \frac{ax - bx^3}{e^{cx^2}},$$

where a , b and c are integers to be found.

(b) i. Integrate

$$\int \frac{(x-2)(x+3)}{\sqrt{x}} dx.$$

ii. Show that

$$\int_0^{\frac{\pi}{2}} e^{(\cos x + 1)} \sin x dx = e^2 - e.$$

(c) Find the area of the region bounded by graphs of $f(x) = x^2$ and $g(x) = 4$.

[11, 9, 5]

$\lambda = \frac{2\pi}{3}$
 $\frac{2\pi}{3}$

5. (a) Let A and B be events with non-zero probability.
- When are events A and B said to be Independent?
 - State the **Bayes' theorem**.
- (b) Events A and B are such that $P(A) = 0.3$, $P(B) = 0.4$ and $P(A \cap B) = 0.1$
- Are events A and B independent? Give a reason for your answer.

Find

- $P(A^c \cup B^c)$.
 - $P(A^c \cap B)$.
- (c) In a survey, to investigate the effects of SHISHA smoking on University students, 30% of males and 45% of females said that they did not smoke. The Proportion of females to males was 40 : 60. If a person is chosen at random and found to be a smoker, what is the probability that this person is a male?
- (d) Given that

$$f(x) = \frac{4 - 2x}{(2x + 1)(x + 1)(x + 3)},$$

evaluate

$$\int_0^2 f(x) dx$$

leaving your answer in the form $\ln k$, where k is a constant.

[4, 7, 7, 7]

6. (a) Events A and B are such that $P(A|B) = \frac{2}{5}$, $P(B) = \frac{1}{4}$ and $P(A) = \frac{1}{5}$. Find
- $P(A \cap B)$
 - $P(B|A)$
 - $P(A \cup B)$

- (b) A group of boys at a school is entered for Advanced Level Mathematics Examinations.

Each boy takes only As examination or A2 examination or both As and A2 examinations.

The probability that a boy is taking A2 given that he is taking As is $\frac{1}{5}$.

The probability that a boy is taking As given that he is taking A2 is $\frac{1}{3}$.

Find the probability that

- a boy selected at random is taking both As and A2 examinations.
- a boy selected at random is taking only As.

- (c) Let

$$P(x) = x(100 - 2x),$$

where x is the number of items sold, be the profit function in dollars, for a small scale company. Find the value of x that maximizes the profit and determine the corresponding profit.

Handwritten calculations:

$$4 \frac{50}{20} = \frac{100}{20} = 5$$

$$\frac{100}{20} = 5$$

$$\frac{1}{5} + \frac{1}{4} = \frac{4+5}{20} = \frac{9}{20}$$

$$\frac{1}{5} + \frac{1}{3} = \frac{3+5}{15} = \frac{8}{15}$$

$$\frac{1}{5} \times \frac{1}{10} = \frac{1}{50}$$

$$\frac{1}{10} = \frac{2}{20}$$

$$\frac{1}{2} = \frac{10}{20}$$

(d) The grouped frequency distribution below shows the masses, to the nearest gram, of 84 letters delivered by the postman.

Mass(g)	1 - 20	21 - 40	41 - 60	61 - 80	81 - 100
Number of letters	10	18	24	14	18

i. Complete the frequency distribution table below.

Mass(g)	Interval width	Frequency	Frequency density
$0.5 \leq x < 20.5$	20	10	0.5

2000

ii. Which interval represents the modal class.

[7, 7, 5, 6]

7. (a) The following are test marks for a group of 120 MAT1110 students.

Mass(g)	0 - 9	10 - 19	20 - 29	30 - 49	50 - 79
Number of letters	8	21	53	28	10

i. Complete the frequency distribution table below.

Mass(g)	Interval width	Frequency	Frequency density
-0.5 - 9.5	10	8	0.8
9.5 - 19.5	10	21	2.1

ii. Draw a histogram to show the distribution of the test marks.

(b) Given that

$$f(x) = \frac{x+1}{x-1}$$

i. find $f \circ f(x)$ leaving your answer in simplest form.

ii. find $f^{-1}(x)$.

iii. state the range of $f^{-1}(x)$.

(c) Integrate

$$\int x^2 e^{-2x} dx.$$

(d) Solve the equation

$$4x^3 + 8x^2 - x - 2 = 0.$$

Handwritten calculations:
 $\frac{180}{20} = 9$
 $\frac{200}{20} = 10$
 $\frac{200}{20} = 10$
 $\frac{140}{20} = 7$

[8, 6, 6, 5]

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS AND STATISTICS
2018/ 2019 ACADEMIC YEAR
FINAL EXAMINATION
ECONOMICS FOR ACTUARIAL SCIENCE (MAT 2012)
29TH NOVEMBER 2019

TIME ALLOWED: THREE (3) HOURS
TIME: 09:00 – 12:00 HOURS

INSTRUCTIONS TO THE CANDIDATE

1. *Enter your COMPUTER NUMBER on the answer booklet. Do NOT write your name.*
2. *You must not start writing your answers in the booklet until you are told to do so by the invigilator*
3. *Attempt all questions*
4. *Candidates should show calculations and well labelled graphs where appropriate to earn full marks*

- 1) If Goods X and Y are substitutes, a reduction in the price of Good X will have the following effect on the demand for Good Y:
 - a. a movement along the demand curve such that quantity demanded declines
 - b. a movement along the demand curve such that quantity demanded increases
 - c. a shift to the right of the demand curve
 - d. a shift to the left of the demand curve
- 2) When there is a surplus of a good or service:
 - a. consumers wish to purchase more of the product at the market price than is offered for sale
 - b. the quantity actually traded at the market price is determined by the supply curve
 - c. the market price is below the equilibrium price
 - d. the quantity actually traded at the market price is determined by the demand curve
- 3) The substitution effect of a price decrease causes an individual to purchase more units of a normal good because:
 - a. the change in price causes a decline in purchasing power
 - b. the good becomes more expensive relative to all other products
 - c. the change in price causes an increase in purchasing power
 - d. the good becomes less expensive relative to all other products
- 4) Revenues from the sale of a good will increase if:
 - a. income falls and the good is normal
 - b. income increases and the good is inferior
 - c. its price rises and demand is elastic
 - d. its price rises and demand is inelastic
- 5) When marginal product is decreasing, which of the following is true of marginal cost?
 - a. It increases initially, then eventually decreases.
 - b. It is decreasing.
 - c. It decreases initially, then eventually increases.
 - d. It is increasing.
- 6) Which of the following is NOT a feature of monopolistic competition?
 - a. Each firm faces a horizontal demand curve.
 - b. There is freedom of entry and exit to the industry.
 - c. There are many firms supplying the market.
 - d. Firms can change their actions without influencing the behaviour of other firms.

- 7) A profit maximising monopolist is currently operating at a level of output where marginal revenue is K20 and marginal cost is K12. In order to increase profits the monopolist should:
- increase output and reduce price
 - reduce price and output
 - increase price and output
 - reduce output and increase price
- 8) The prisoners dilemma, applied to a situation involving two oligopolists, illustrates that:
- in avoiding the worst possible outcome the firms will fail to reach the best possible outcome
 - each firm will not take account of its rivals reactions when making its decision
 - the price set by one firm will not influence the price of the other firm
 - in avoiding the worst possible outcome the firms will succeed in reaching the best possible outcome
- 9) A perfectly competitive firm is not maximising profit if:
- total revenue is maximised
 - marginal cost equals price and price is above minimum average total cost
 - marginal cost equals average revenue
 - marginal cost equals marginal revenue
- 10) According to the kinked demand curve theory of oligopoly, at the quantity corresponding to the kink the firms:
- marginal revenue curve is discontinuous
 - average cost curve is discontinuous
 - marginal cost curve is discontinuous
 - average revenue curve is discontinuous
- 11) The multiplier is higher:
- the lower is the marginal propensity to consume and the lower is the marginal propensity to import
 - the higher is the marginal propensity to consume and the lower is the marginal propensity to import
 - the lower is the marginal propensity to consume and the higher is the marginal propensity to import

- d. the higher is the marginal propensity to consume and the higher is the marginal propensity to import
- 12) Which one of the following is NOT a function of money?
- A medium of exchange.
 - A measure of liquidity.
 - A store of value.
 - A unit of account.
- 13) Which one of the following accurately describes the opportunity cost of producing Good X?
- The cost of producing Good X in money terms.
 - The foregone output from the next best alternative use to which factors of production used to produce Good X could be put.
 - The stream of services provided by Good X over its entire lifetime.
 - The production of Good X foregone in the previous year to enable Good X to be produced this year.
- 14) The demand curve for Good X describes the amount of Good X that:
- buyers can but are not willing to purchase at different prices
 - buyers are both willing and able to purchase at different prices
 - buyers are both willing and able to purchase at one particular price
 - will be supplied at different prices
- 15) The law of diminishing marginal utility applied to consumption of Good X implies that the:
- more one consumes of Good X, the less utility one derives from the first unit of consumption of Good X
 - total utility derived from the consumption of Good X increases by smaller amounts for each extra unit of Good X consumed
 - marginal utility derived from the consumption of an extra unit of Good X falls if the price of Good X falls
 - marginal utility derived from the consumption of an extra unit of Good X falls if the price of Good X rises
- 16) The price of Good X will not change following an increase in the demand for Good X if the price elasticity of:
- supply is zero
 - demand is zero

(iii) From the calculations in part (ii), explain the reason why aluminium is not used as an electromagnets. [2]

(c) From the information given in part (a) would you rate aluminium to be a paramagnetic or diamagnetic material? [2]

Q6 (a) The compact form of a nuclear reaction is written as



State the significance of all the symbols appearing in this expression.

(b) Suppose ${}^{10}_5B$ is struck by an alpha particle, releasing a particle of mass number 1 and atomic number 1 and a product nucleus in the reaction. Write down this reaction in symbols and identify the product nucleus. [4]

(c) A radioactive sample contains $3.54\mu\text{g}$ of pure ${}^{11}_6C$, which has a half-life of 20.4 min.

(i) How many moles of ${}^{11}_6C$ are present initially? [1]

(ii) Determine the number of nuclei present initially. [2]

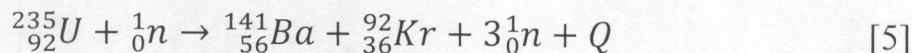
(iii) What is the initial activity of the sample at $t = 0$ and at $t = 2.00$ hours? [9]

$$\text{Molar mass } {}^{11}_6C = 11.$$

Q7 (a) When nuclear fission takes place in ${}^{235}_{92}U$, it collides with a slow neutron, and a lot of energy is produced.

(i) What is nuclear fission as understood in nuclear physics? [2]

(ii) Calculate the total energy, Q , released in the following reaction:



(iii) Explain what is meant by a slow neutron. [2]

$$\text{Data: } {}^{235}_{92}U = 235.043923\text{u}; {}^{141}_{56}Ba = 140.903496\text{u}$$

- b. has a discontinuity in its marginal cost curve
 - c. has a discontinuity in its average revenue curve
 - d. has a discontinuity in its marginal revenue curve
- 23) The short run supply curve for a firm in a perfectly competitive industry is its:
- a. average cost curve
 - b. average variable cost curve
 - c. marginal cost curve above the lowest point of the average total cost curve
 - d. marginal cost curve above the lowest point of the average variable cost curve
- 24) The marginal propensity to consume out of disposable income is 0.8 and the tax rate is 50 per cent of all income. The government decides to increase public spending by K100 million. According to the simple Keynesian model what is likely to be the total change in national income resulting from this increase in government expenditure?
- a. K200 million
 - b. K500 million
 - c. K1,000 million
 - d. K166 million
- 25) Which one of the following is most likely to lead to a rise in aggregate demand?
- a. A decrease in government expenditure.
 - b. An increase autonomous savings.
 - c. A increase in the rate of interest.
 - d. A decrease in the income tax rate.
- 26) Discuss with the aid of a diagram how a successful one-off advertising campaign is likely to affect sales of a product in the short, medium and long run.
- 27) Explain the two main characteristics of a public good, giving an example for each.
- 28) Explain with the aid of a diagram the four phases of the business cycle. In your diagram make clear the distinction between the full capacity output trend and the actual trend in economic output.
- 29) Explain, with the use of a diagram, the circular flow of income in an open economy with a government, financial/banking and a foreign sector, making clear which are the withdrawals and which are the injections in the system.

- 30) The government in a closed economy undertakes expenditure on goods and services of K200 million. Investment expenditure is K100 million and the rate of direct taxation is 25 per cent of all income. The consumption function is given by the equation:

$$C = 0.8 Yd$$

where C is planned consumption and Yd is disposable income (i.e. after deduction of income tax).

- (i) Calculate the level of national income at which the government has a balanced budget.
 - (ii) Calculate the government budget deficit/surplus if national income were K600 million.
 - (iii) Calculate the increase in the national income if government expenditure is increased from K200 million to K300 million.
 - (iv) Calculate the level of government expenditure required to achieve the full employment level of income of K900 million.
- 31) With the aid of aggregate supply and demand curves, explain the distinction between demand pull and cost push inflation.
- 32) Give two examples of the factors that can cause each type of inflation in **question 31** above.
- 33) Outline the main items that are recorded in the current account of the balance of payments and the macroeconomic significance of a large current account deficit.
- 34) Outline some of the costs of unemployment to individuals, firms and the economy.
- 35) Explain the problem of adverse selection and how it might be dealt with by insurance companies.
- 36) Explain the problem of moral hazard and how it affects the price of insurance.
- 37) Explain how an expansionary monetary policy and the associated low short term interest rates can be useful in expanding economic activity in an open economy.
- 38) Explain the difference between actual and potential economic growth.
- 39) Draw a diagram to show a typical monopolistically competitive firm, such as a coffee shop, which is wishing to operate but is making a loss. Your diagram should show all the relevant cost and revenue curves and the area corresponding to the firm's losses.
- 40) Discuss, with the use of examples, two factors that influence the price elasticity of demand for a good.

END OF FINAL EXAMINATION

The University of Zambia
Department of Mathematics & Statistics
2018/2019 Academic Year Examinations
MAT2100 - Analytic Geometry and Calculus

Time allowed : Three (3) hrs

Full marks : 100

-
- Instructions:**
- There are seven (7) questions in this paper. Attempt any five (5) questions. All questions carry equal marks.
 - Full credit will only be given when all essential working is shown.
 - Indicate your computer number on all answer booklets.
-

1. a) Prove that the length of the latus rectum of a hyperbola

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$

is $\frac{2b^2}{a}$. [8 marks]

- b) Identify and sketch the curve $73x^2 + 72xy + 52y^2 + 30x - 40y - 75 = 0$.
[12 marks]

2. a) A curve is given by the equation $y = x(x - 1)^2$. Calculate
- i) the radius of curvature about the point $(0, 0)$. [4 marks]
 - ii) the circle of curvature about the point $(0, 0)$. [5 marks]
- b) Use the method of upper sums to calculate the area bounded by the curve $f(x) = x^2$ and the x -axis between the limits $x = 1$ and $x = 4$. [6 marks]
- c) Calculate the volume of the solid formed by revolving the region bounded by the graphs of $y = \sqrt{x}$ and $y = x^2$ about the x -axis. [5 marks]

3. a) Find the following integrals

i) $\int \frac{dx}{\sqrt{6x-x^2}}$ [3 marks]

ii) $\int \frac{dx}{1+\cos x}$ [4 marks]

b) Find the fourth degree Taylor polynomial of $f(x) = \sin x$ at the point $x = \frac{\pi}{3}$. [8 marks]

c) Calculate the area of the surface formed by revolving the graph of $f(x) = x^2$ on the interval $[0, \sqrt{2}]$ about the y -axis. [5 marks]

4. a) i) Find the parametric equations and the symmetric equations of the line L which passes through the points $P(-2, 1, 0)$ and $Q(1, 3, 5)$. [3 marks]

ii) Calculate the general equation of the plane which contains the points $P(2, 1, 1)$, $Q(0, 4, 1)$ and $R(-2, 1, 4)$. [4 marks]

b) Find the arc length of the curve $y = \frac{x^3}{6} + \frac{1}{2x}$ on the interval $[\frac{1}{2}, 2]$. [6 marks]

c) Let $I_n = \int \tan^n x dx$.

i) Find the reduction formula of the integral I_n . [3 marks]

ii) Hence or otherwise, calculate the integral $\int_0^{\pi/4} \tan^6 x dx$. [4 marks]

5. a) Use the limit definition of derivative to find $\frac{\partial f}{\partial x}$ for $f(x, y) = \sqrt{x+y}$. [5 marks]

b) i) State Euler's theorem for a homogeneous function of n variables. [2 marks]

ii) Verify Euler's theorem for the degree five homogeneous function

$$f(x, y) = x^3y^2 + 2x^2y^3 - xy^4 + 3y^5.$$

[3 marks]

c) Find and classify the stationary points of $f(x, y) = x^2 - 2xy + \frac{1}{3}y^3 - 3y$.

[10 marks]

6. a) i) Discuss the continuity at the origin of

$$f(x, y) = \begin{cases} \frac{y^2}{x^2+y^2}, & \text{if } (x, y) \neq (0, 0) \\ \frac{1}{2}, & \text{if } (x, y) = (0, 0) \end{cases}$$

[4 marks]

ii) Evaluate $\lim_{(x,y) \rightarrow (1,1)} \frac{x^2 - 2xy + y^2}{x-y}$. [2 marks]

b) Use total differential to estimate the value of

$$\frac{1 - (3.08)^2}{(5.98)^2}$$

correct to 2 decimal places. [7 marks]

c) Show that $(2x + y^3)dx + (3xy^2 - e^{-2y})dy = 0$ is exact and hence, find its general solution. [7 marks]

7. a) Find the general solution of

i) $(x^2 + 1)\frac{dy}{dx} = x(y + 1)$. [4 marks]

ii) $\frac{dy}{dx} - \frac{3}{x}y = x^2$. [4 marks]

b) Solve the initial value problem (IVP)

$$y'' + 2y' - 8y = e^{3x}; \quad y(0) = 1, y'(0) = \frac{3}{7}$$

[12 marks]

End of Examination!

The University of Zambia
School of Natural Sciences
Department of Mathematics & Statistics
Differed Examinations - 2018
MAT 2100 - Analytic Geometry and Calculus

Time allowed : Three (3) hrs

Full marks : 100

Instructions:

- Indicate your **computer number** on all answer booklets.
- Attempt **any (5) five** questions. All questions carry equal marks.
- **Full credit** will only be given when **necessary work** is shown.

This paper consists of 4 pages of questions.

1. (a) (i) Find the equation of the hyperbola with vertices (0, 6) and (6, 6); foci 10 units apart.

(ii) Sketch the graph of the hyperbola in a(i), showing the equations of the asymptotes, vertices, foci and center.

(b) Convert the polar equation

$$r = \frac{6 \sec \theta}{2 \sec \theta - 1}$$

to a rectangular equation.

Turn Over/...

- (c) Show that $f_x(0,0)$ and $f_y(0,0)$ both exist, but the function is not differentiable at $(0,0)$, where f is defined as

$$f(x, y) = \begin{cases} \frac{2x^2y^2}{x^4+y^4} & \text{if } f(x, y) \neq (0, 0) \\ 0 & \text{if } f(x, y) = (0, 0) \end{cases}$$

[8,6,6]

2. (a) Use the $\epsilon - \delta$ definition to prove that

$$\lim_{x \rightarrow 5} \frac{1}{x-1} = \frac{1}{4}$$

- (b) (i) State Rolle's Theorem.

(ii) Show that the hypothesis of Rolle's Theorem are satisfied by the function $f(x) = \cos x$ on the interval $\left[\frac{\pi}{2}, \frac{3\pi}{2}\right]$.

(iii) For the function in (ii), find the value c which satisfies Rolle's Theorem.

- (c) Solve the following second order differential equation

$$y'' + 4y = \csc 2x$$

[7,5,8]

3. (a) Solve the following Bernoulli's differential equation

$$\frac{dy}{dx} + y = (xy)^2.$$

- (b) Find the sum of the following convergent series

$$\sum_{k=0}^{\infty} \frac{5}{4^k}.$$

Turn Over/...

(c) Let $z = f(x, y)$, where $x = r \cos \theta$ and $y = r \sin \theta$. Show that

$$\left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2 = \left(\frac{\partial z}{\partial r}\right)^2 + \frac{1}{r^2} \left(\frac{\partial z}{\partial \theta}\right)^2.$$

[7,5,8]

4. (a) Evaluate the following integral

$$\int \frac{x^2}{\sqrt{4-x^2}} dx.$$

(b) Find the arc length of $y = \frac{1}{3}\sqrt{x}(3-x)$ for $0 \leq x \leq 3$.

(c) The differential equation $y^2 dx + (xy - 1) dy$ is **NOT** exact. Find an integrating factor for this differential equation and **solve it**.

[5,8,7]

5. (a) For the space curve given by

$$x(t) = e^t \cos t, \quad y(t) = e^t \sin t, \quad z(t) = e^t,$$

find

(i) The unit tangent vector $\mathbf{T}(t)$ at $t = 0$.

(ii) The unit normal vector $\mathbf{N}(t)$ at $t = 0$.

(b) Find the volume of the solid generated when the region between the graphs of the equations $y = 2 + x^2$, $x = 0$, $x = 4$ and $y = x$ is revolved about the x -axis.

(c) Find the centroid of the region under the curve

$$y = \sin x, \quad 0 \leq x \leq \pi.$$

[7,7,6] Turn Over/...

6. (a) Let $f(x, y) = x^3 + y^3 - 3x - 3y$. Find all critical points for $f(x, y)$ and determine their nature, that is, whether they are minimum, maximum or saddle points.

- (b) Show that the function

$$f(x, y) = y^4 + x^3ye^{\frac{y^2}{x^2}}$$

is homogeneous of degree 4.

- (c) (i) State Euler's Theorem on homogeneous functions.
(ii) Show that the function

$$f(x, y) = y^4 + x^3ye^{\frac{y^2}{x^2}}$$

satisfies the Euler's Theorem on homogeneous functions.

[8,4,8]

7. (a) Find the **first five** terms of the Maclaurin series for

$$\int \sqrt{1+x^4} dx.$$

- (b) Find

$$\lim_{x \rightarrow 0^+} (x+1)^{\cot x}.$$

- (c) Let $u = x^3y$. Find $\frac{du}{dt}$ if $x^4 + y = t$ and $x^2 + y^3 = t^2$.

[6,7,7]

END!

The University of Zambia
School of Natural Sciences
Department of Mathematics & Statistics
2017/2018 Deferred Examinations - December 24, 2018
MAT 2110 - Engineering Mathematics I

Time allowed : Three (3) hrs

Full marks : 100

Instructions:

- Indicate your **computer number** on all answer booklets.
- There are seven (7) questions in this examination. Attempt **any five (5)** questions. All questions carry equal marks.
- **Full credit** will only be given when **necessary work** is shown.

This paper consists of 4 pages of questions.

1. (a) The polar equation of a conic section with one focus at the origin is given by

$$r(2 - \sqrt{3} \sin \theta) = 20.$$

- (i) Identify the conic section by finding its eccentricity.
(ii) Find the equation of the directrix. Hence, sketch the conic section, clearly stating the centre, focus or foci and directrix or directrices.
- (b) Find a basis for the set of vectors in R^3 lying on the line given symmetrically by

$$x = \frac{y}{2} = z.$$

- (c) Evaluate the integral

$$\int_0^{\frac{\pi}{2}} (\sec x - \tan x) dx.$$

[11,2,7]

Turn Over/...

2. (a) Find the reduction formula for

$$\int (x^2 + 1)^n dx,$$

where n is an integer and use it to evaluate each of the following integrals:

(i) $\int (x^2 + 1)^2 dx$

(ii) $\int \frac{1}{(x^2 + 1)^2} dx.$

(b) Find the sum of each of the following convergent series:

(i) $\sum_{n=0}^{\infty} \left(\frac{2^n}{3^{n+2}} \right)$

(ii) $\sum_{n=3}^{\infty} \left(\frac{3}{(n-2)(n+1)} \right).$

(c) Evaluate the limit

$$\lim_{x \rightarrow 0} \left(\frac{2 \sin x - \sin 2x}{2e^x - 2 - 2x - x^2} \right).$$

[9,7,4]

3. (a) Find the general solution of the following differential equations:

(i) $(2xy - 2xy^2) dx + (1 - 2y) dy = 0$

(ii) $\frac{d^4 y}{dx^4} - \frac{d^2 y}{dx^2} - 2y = 0$

(iii) $x^2 \frac{d^2 y}{dx^2} - x(x+2) \frac{dy}{dx} + (x+2)y = x^3,$

given that $y = x$ and $y = xe^x$ are linearly independent solutions of the homogeneous equation.

Turn Over/...

(b) Use row operations to find the inverse of the matrix

$$\begin{pmatrix} 1 & 0 & 1 \\ 0 & 2 & 1 \\ 5 & 1 & -1 \end{pmatrix}.$$

[16,4]

4. (a) (i) Find the equation of the line passing through the point $(5, 0, -1)$ and perpendicular to the plane $x - y + z = -5$.

(ii) Find the point where the line in **a(i)** above meets the xy -plane.

(b) Given that

$$\arctan x = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \dots (-1)^{n-1} \frac{x^{2n-1}}{2n-1} + \dots, |x| \leq 1,$$

evaluate the integral

$$\int_0^1 \frac{\arctan(x^2)}{x} dx,$$

giving your answer such that the error is positive and does not exceed 0.01.

(c) A rectangular board is 16 metres by 20 metres.

(i) How far from the centre of the board should the foci be located in order to cut the largest elliptical tabletop from the board?

(ii) What is the equation of the ellipse?

(ii) Find its eccentricity.

[5,10,5]

5. (a) (i) Show that the conditions of the Rolle's theorem are satisfied for the function

$$f(x) = x^6 - 10x^4$$

on the interval $[0, \sqrt{10}]$. Hence, find a real number c in the interval $(0, \sqrt{10})$ that satisfies the conclusion of the theorem.

(ii) Evaluate the integral

$$\int \csc \theta \cot^3 \theta d\theta.$$

Turn Over/...

- (b) Find the equation of the plane containing the line

$$\frac{x-5}{1} = \frac{y}{-1} = \frac{z+1}{1}$$

and its normal vector is perpendicular to the two lines

$$x = t + 15, \quad y = 2, \quad z = 3$$

and

$$x = 25, \quad \frac{y-19}{2} = \frac{z}{1}.$$

- (c) If

$$f(x, y) = 2^{xy^2} \log_3(xy) - \cos(\arcsin x) + y + 1,$$

find $f_x(x, y)$.

[12,5,3]

6. (a) Express $v = 14x^3 - x^2 + 7x - 2$ as a linear combination of

$$u_1 = x + 1, \quad u_2 = x^2 - 2x + 1, \quad u_3 = 7x^3 + 2x - 1.$$

- (b) Find the volume of the solid formed by revolving the region bounded by the curves

$$y = \ln x, \quad y = 0$$

from $x = 0$ to $x = e$ about the x -axis.

- (c) The arc of the curve $y = \frac{1}{2}x^2$ lying between $x = 0$ and $x = 1$ is rotated about the x -axis. Find the area of the surface generated.

[5,4,11]

7. (a) Find the equation of the line tangent to the surface

$$z = \arctan\left(\frac{x}{y}\right)$$

at the point $(\sqrt{3}, 1, \frac{\pi}{6})$ that lies in the plane $x = \sqrt{3}$.

- (b) Find the maximum value and the minimum value of

$$f(x, y, z) = xyz$$

subject to $x^2 + z^2 = 1$ and $x = y$.

[3,17]

END OF EXAMINATION!

The University of Zambia
School of Natural Sciences
Department of Mathematics & Statistics
2018/2019 Academic Year
End of Year Final Examinations
MAT 2110 - Engineering Mathematics I

Time allowed : Three (3) hrs

Full marks : 100

Instructions:

- Indicate your **computer number** on all answer booklets.
- There are seven (7) questions in this examination. Attempt **any five (5)** questions. All questions carry equal marks.
- **Full credit** will only be given when **necessary work** is shown.

This paper consists of 4 pages of questions.

1. (a) A conic section is given by

$$12x^2 - 12x - 4y^2 + 8y - 37 = 0$$

- Identify the conic section.
 - Find the centre, focus or foci, vertex or vertices, asymptotes and directrices of the conic section.
 - Sketch the conic section.
- (b) Find the principle unit normal vector if

$$R(t) = \sqrt{3}ti + e^tj + 3k$$

at $t = 0$.

[14,6]

Turn Over/...

2. (a) Find the function $g(x)$ so that the function

$$f(x) = \begin{cases} \frac{\sqrt{x} - \sqrt{y}}{x^2 - y^2}, & x \neq y \\ g(x), & x = y \end{cases}$$

is continuous at the point where $x = y > 0$.

(b) Solve the Initial Value Problem (IVP)

$$y''' - y'' - 5y' - 3y = e^{-x}, \quad y''(0) = 0, \quad y'(0) = 1, \quad y(0) = 14.$$

[5,15]

3. (a) A line L_1 passing through the point $(-1, 1, 0)$ is parallel to the line L_2 given parametrically as

$$L_2 : x = \pi + 2t, \quad y = 1, \quad z = t.$$

(i) Find the equation of L_1 .

(ii) Find the cross product of the direction vectors of the lines L_1 and L_2 .

(b) Show that

$$I(x, y) = \frac{1}{x^2 + y^2}$$

is an integrating factor of the differential equation

$$[y + x(x^2 + y^2)^2] dx + [y(x^2 + y^2)^2 - x] dy = 0.$$

Hence, or otherwise, solve the differential equation.

(c) Determine the convergence or divergence of the following series:

(i) $\sum_{n=1}^{\infty} \left(\frac{(-1)^{n+1}}{2n-1} \right)$

(ii) $\sum_{n=1}^{\infty} \left(\frac{3}{2} \right)^n$

(iii) $\sum_{n=1}^{\infty} \left(\sqrt{\frac{1}{n^5}} \right)$

[3,10,7]

4. (a) Find the eigenvalues and corresponding eigenvectors of the matrix

$$\begin{pmatrix} 0.8 & 0.3 \\ 0.2 & 0.7 \end{pmatrix}$$

Turn Over/...

(b) (i) Find the point of intersection P , of the lines

$$L_1 : x + 1 = \frac{y + 4}{2} = \frac{z}{5}$$

and

$$L_2 : x = \frac{y - 2}{-2} = -(z - 11)$$

(ii) Find the equation of the plane passing through P , $Q(1, 1, 1)$ and $R(0, 1, 0)$. [8,7,5]

5. (a) Find the n^{th} derivative of the function

$$f(x) = x^k, \quad k \geq 1, n \leq k.$$

Hence, find the 4^{th} derivative when $k = 4$.

(b) The polar equation of a conic section with one focus at the origin is given by

$$r = \frac{2}{2 + \cos \theta}$$

Identify the conic section by finding its eccentricity. Hence, find its centre, focus or foci and directrix or directrices.

(c) Given that

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \dots (-1)^n \frac{x^{2n+1}}{(2n+1)!} + \dots, \quad |x| < \infty,$$

evaluate the definite integral

$$\int_0^1 \sin(x^8) dx,$$

giving your answer such that the error is positive and does not exceed 0.0005. [5,8,7]

6. (a) The function

$$f(x) = e^x(1 + \cos x)$$

satisfies the hypotheses of the Rolle's theorem in the interval $[-\pi, 3\pi]$.

(i) Find numbers c in $(-\pi, 3\pi)$ that satisfy the conclusion of the theorem.

Turn Over/...

- (ii) Choose one c in $(-\pi, 3\pi)$ such that the L'Hôpital's rule can be applied to evaluate

$$\lim_{x \rightarrow c} \frac{f(x)}{g(x)},$$

where $g(x) = \sin x$ and evaluate the limit.

- (b) The rate at which radioactive nuclei decay is represented by

$$\frac{dy}{dt} = -ky,$$

where y is the amount of radioactive nuclei present after t years and k is a constant of proportionality. The number of radioactive nuclei initially present is 1200 and half of that amount disintegrates after 20 years. Find the amount present after 50 years.

- (c) A region is bounded by the curve $y = x^2 - 2x$ and the line $y = 2x$. Find the volume of the solid generated by rotating this region about the line $y = 10$.

[9,5,6]

7. (a) Evaluate the following integrals:

(i) $\int_2^{\infty} \frac{1}{x^3} dx,$ (ii) $\int \frac{dx}{1 + \cos x + \sin x}$

- (b) Find the radius and interval of convergence of the series

$$\sum_{n=1}^{\infty} n! (x - 3)^n$$

- (c) A space probe in shape of the ellipsoid $4x^2 + y^2 + 4z^2 = 16$ enters the Earth's atmosphere and its surface begins to heat. After one hour, the temperature at the point (x, y, z) on the probe's surface is

$$T(x, y, z) = 8x^2 + 4yz - 16z + 600.$$

Find the hottest point on the probe's surface and the temperature at this point.

[6,4,10]

END OF EXAMINATION!

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS & STATISTICS

2018 Academic Year Final Examinations
MAT 2200 Linear Algebra

20th August, 2018

Total time allowed: Three (3) hours

Instructions:

- There are seven questions in this paper; answer any five (5).
 - Show detailed working to earn full marks.
-

1. (a) Define the following terms:

- (i) A singular matrix,
- (ii) a symmetric matrix.

(b) Re-write the matrix $B = \begin{pmatrix} 1 & -2 & 3 & 1 \\ 2 & -4 & 6 & 2 \\ 3 & -6 & 9 & 3 \\ 1 & -2 & 4 & 3 \end{pmatrix}$ into reduced row-echelon form.

(c) Prove that for any value of x , the matrix $D = \begin{pmatrix} \cos x & -\sin x \\ \sin x & \cos x \end{pmatrix}$ is orthogonal.

(d) Use the matrix $A = \begin{pmatrix} 2 & -4 \\ -3 & 1 \end{pmatrix}$ to verify that for any square matrix A , the matrix AA^t is symmetric.

2. (a) Define the following terms:

- (i) a linearly independent set,
- (ii) an orthogonal matrix.

(b) Given that $A = \begin{pmatrix} 2 & 2 & 0 \\ -1 & 2 & 4 \\ 0 & 1 & -3 \end{pmatrix}$, use elementary row operations to find the inverse of A if it exists.

(c) Use Cramer's Rule to solve the system of linear equations below.

$$\begin{aligned}x + 2y - 2z &= 7 \\2x - y + 3z &= 13 \\3x + z &= -1\end{aligned}$$

3. (a) Define the following terms:
- (i) a square matrix,
 - (ii) a linear transformation.
- (b) Given that a 3×3 matrix D has characteristic polynomial $f(\lambda) = \lambda^3 + 2\lambda^2 - 9\lambda - 18$, find all the eigenvalues of the matrix D .
- (c) Given that $A = \begin{pmatrix} 4 & -8 & 6 \\ 2 & 2 & 2 \\ 6 & 0 & -4 \end{pmatrix}$, find a symmetric matrix B and a skew-symmetric matrix C such that $A = B + C$.
4. (a) When do we call a subset S of a vector space V a basis for V ?
- (b) Given that $A = \begin{pmatrix} 2 & 4 \\ 0 & -1 \end{pmatrix}$, find the following:
- (i) the characteristic polynomial of A ,
 - (ii) the eigenvalues of A ,
 - (iii) the eigenvectors of A corresponding to each eigenvalue of A .
- (c) If possible write the vector $x = (-6, 4, -8)$ as a linear combination of the vectors $u_1 = (1, 2, 3)$, $u_2 = (0, 1, 2)$ and $u_3 = (-2, 0, 1)$ in \mathbb{R}^3 .
5. (a) Define the following terms:
- (i) the norm of a vector u in an inner product space V .
 - (ii) An eigenvalue of a square matrix A .
- (b) Determine whether the subset $S = \{(1, 4, 0), (0, 1, 1), (-1, -3, 1)\}$ of \mathbb{R}^3 is a linearly independent set or a linearly dependent set.
- (c) Let f and g be real-valued continuous functions in the vector space $C[0, 1]$. Then the function

$$\langle f, g \rangle = \int_0^1 f(x)g(x)dx$$

defines an inner product on $C[0, 1]$. Given that $f(x) = 3x + 1$ and $g(x) = \cos x$, find the following:

- (i) $\langle f, g \rangle$
- (ii) $\|g\|^2$

6. (a) Define an elementary matrix.
- (b) Find the standard matrix for the linear transformation $T: \mathbb{R}^4 \rightarrow \mathbb{R}^4$ defined by

$$T(w, x, y, z) = (2w + y, x - y, -3y + z, w - z).$$

- (c) Calculate the determinant of the 4×4 standard matrix obtained in part (b) of this question above.
7. (a) Define an eigenvector of a square matrix A .
- (b) For polynomials $p = a_0 + a_1x + \cdots + a_nx^n$ and $q = b_0 + b_1x + \cdots + b_nx^n$ in the vector space P_n , the function defined by

$$\langle p, q \rangle = a_0b_0 + a_1b_1 + \cdots + a_nb_n$$

is an inner product. Given the vectors $g(x) = 4 - 2x + 3x^2$ and $h(x) = 1 + x + x^2$ in P_2 , use this inner product to find

- (i) $\|g\|^2$
- (ii) $\langle g, h \rangle$

- (c) Given that $A = \begin{pmatrix} 4 & 0 & 0 \\ 1 & -1 & 0 \\ 0 & 0 & 3 \end{pmatrix}$, find the following:

- (i) the characteristic polynomial of A ,
- (ii) all the eigenvalues of A ,
- (iii) the eigenvectors corresponding to each eigenvalue of A .

END OF EXAM

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS & STATISTICS

2019 Academic Year Final Examinations
MAT 2200 Linear Algebra

18th November, 2019

Total time allowed: Three (3) hours

Instructions:

- There are seven questions in this paper; answer any five (5).
 - Show detailed working to earn full marks.
 - Leave your answers as simplified fractions or surds and NOT decimals.
-

1. (a) (i) Let u and w be vectors in an inner product space V . Then define the orthogonal projection of u onto w .
(ii) State the Rank Nullity Theorem.
 - (b) Let $u = (2 - 3i, 2 + 4i)$ and $w = (1 + i, 1 - i)$ be vectors in the inner product space \mathbb{C}^2 . Use the standard inner product on \mathbb{C}^2 to find the orthogonal projection of u onto w .
 - (c) Use the Gauss-Jordan Elimination method to solve the system of linear equations below:
$$\begin{aligned} 2x + 4y &= 2 \\ 3x + 2y + z &= 8 \\ 5x - 3y + 7z &= 15 \end{aligned}$$
 - (d) Prove that if A and B are similar matrices, then they have the same characteristic polynomial. [5, 4, 6, 5]
2. (a) Define a Hermitian matrix.
 - (b) State Cayley-Hamilton Theorem.
 - (c) The function defined by $\langle A, B \rangle = \text{tr}(AB^t)$ is an inner product on the vector space $M_{22}(\mathbb{R})$. Let $P = \begin{pmatrix} 1 & 1 \\ 0 & 0 \end{pmatrix}$ and $Q = \begin{pmatrix} 0 & -1 \\ 3 & 2 \end{pmatrix}$.
Then find the following:

- (i) the norm of Q (ii) $d(P, Q)$

(d) Given that $A = \begin{pmatrix} 4 & 0 & 1 \\ -1 & -6 & -2 \\ 5 & 0 & 0 \end{pmatrix}$. Find the following:

(i) the characteristic polynomial of A simplified to the form $C_A(x) = x^3 + ax^2 + bx + c$.

(ii) all the eigenvalues of A .

(iii) the eigenspace of each eigenvalue of A . [3, 3, 4, 10]

3. (a) (i) Define a diagonalizable matrix.

(ii) State the Fundamental Theorem of Symmetric Matrices.

(b) Use Cramer's Rule to solve the system of linear equations below:

$$x + 2y + z = 3$$

$$2x + 3y - z = -6$$

$$3x - 2y - 4z = -2$$

(c) Consider the linear transformation $T : \mathbb{R}^3 \rightarrow \mathbb{R}^3$, defined by $T(x, y, z) = (x - y, 0, x + y + z)$. Then find the following:

(i) the kernel of T ,

(ii) the image of T .

(d) Prove that the symmetric matrix $M = \begin{pmatrix} a & w \\ w & b \end{pmatrix}$ is diagonalizable.

[5, 6, 4, 5]

4. (a) Define the following terms:

(i) the basis for a vector space,

(ii) the minimal polynomial of a matrix.

(b) Find the standard matrix of the linear transformation $T : \mathbb{R}^3 \rightarrow \mathbb{R}^3$ defined by $T(x, y, z) = (8x + y - z, x - 4y, 7x + 5y - z)$ and hence use the standard matrix to determine whether or not the linear transformation T is invertible.

(c) Find the matrix P which diagonalises the matrix $B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{pmatrix}$.

(d) Let $S = \{v_1, v_2, \dots, v_n\}$, with $n \geq 2$, be a subset of a vector space V . Prove that S is a linearly dependent set if and only if at least one of the vectors v_j can be written as a linear combination of the other vectors in S . [5, 4, 6, 5]

5. (a) (i) Define an eigenvalue of a matrix.
(ii) State the Real Spectral Theorem.
- (b) Use elementary row operations to find the inverse of the matrix

$$M = \begin{pmatrix} 1 & 2 & 11 \\ 0 & -1 & -4 \\ 0 & 0 & -1 \end{pmatrix}.$$
- (c) Determine whether or not the matrix $A = \begin{pmatrix} 1 & 1 \\ 0 & 0 \end{pmatrix}$ is similar to the matrix $B = \begin{pmatrix} 0 & 0 \\ 2 & 2 \end{pmatrix}$.
- (d) Consider the vector space \mathbb{R}^3 . Find the change of basis matrix from the basis $D = \{(1, 2, 11), (0, -1, -4), (3, 0, -1)\}$ to the basis $E = \{(4, 0, 4), (0, 1, 1), (-3, 1, 6)\}$. [5, 3, 4, 8]
6. (a) Define the following terms:
(i) An upper triangular matrix,
(ii) the distance between two vectors in an inner product space.
- (b) Use the method of cofactors to find the inverse of the matrix

$$N = \begin{pmatrix} 0 & 0 & -1 \\ 1 & 0 & 0 \\ 0 & 1 & 1 \end{pmatrix}.$$
- (c) Let $f(x) = x^2$, $g(x) = e^x$ and $h(x) = \sin^2 x$ be elements in the vector space $C[0, \pi]$. Use the standard inner product in $C[0, \pi]$ to find the following:
(i) $\langle f, g \rangle$ (ii) $\|h\|^2$
- (d) Let A be an $m \times n$ matrix. Then prove that the function $T : \mathbb{R}^n \rightarrow \mathbb{R}^m$ defined by $T(w) = Aw$ is a linear transformation from \mathbb{R}^n into \mathbb{R}^m . [4, 6, 6, 4]
7. (a) (i) Define the geometric multiplicity of an eigenvalue.
(ii) State the Cauchy-Schwarz Inequality.
- (b) Given that $E = \begin{pmatrix} 4 & 0 & -1 \\ 0 & 3 & 0 \\ 1 & 0 & 2 \end{pmatrix}$. Find the minimal polynomial of the matrix E .
- (c) Use the Gram-Schmidt Orthogonalization Procedure to construct an orthogonal set from the set $S = \{(-2, 2, 3), (1, 1, 0), (2, 0, 0)\}$

- (d) Let $S = \{w_1, w_2, \dots, w_n\}$ be a basis for a vector space V . Then prove that every vector in V can be written in one and only one way as a linear combination of vectors in S . [4, 6, 6, 4]

END OF EXAM

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS AND STATISTICS

2018/19 ACADEMIC YEAR
END OF YEAR FINAL EXAMINATIONS

MAT2602 INTRODUCTION TO STATISTICS

Time Allowed: Three (3) Hours

- Instructions:
1. There are Six (6) Questions in this paper. Answer any **Five (5)** Questions.
 2. Show All Essential Working.
 3. Statistical Tables are provided.
 4. Calculators are Allowed.
-

1. (a) Explain the difference between Completely Randomized Block design and Randomized Block design in experimental design.
- (b) The table below shows the distribution of marks in MAT 2602 test.

Class interval	frequency
1 – 5	1
6 – 10	3
11 – 15	4
16 - 20	2

- (i) Calculate the mean of this distribution.
 - (ii) Calculate the standard deviation of this distribution
 - (iii) Verify that the deviations from the mean in (i) add up to zero.
 - (iv) Construct a frequency polygon.
- (c) A scientist, working in an agricultural research, believes there is a relationship between the hardness of the shells of eggs laid by chickens and the amount of a certain food supplement put into the diet of the chickens. He selects ten chickens of the same breed and collects the data given in the table below. (Hardness is measured on a 0 – 10 scale, 10 being the hardest. There are no units attached).
- (i) Calculate the equation of the regression line of y and x .
 - (ii) Calculate the product moment correlation coefficient.
 - (iii) Do you believe that his linear model will continue to be appropriate no matter how large or small x becomes? Just your reply.

Chicken	A	B	C	D	E	F	G	H	I	J
Amount of food supplement x (g)	7.0	9.8	11.6	17.5	7.6	8.2	12.4	15.5	9.5	19.5
Hardness of shells y	1.2	2.1	3.4	6.1	1.3	1.7	3.4	6.2	2.1	7.1

2. (a) Write four fallacies in the interpretation of the correlation coefficient, r .
- (b) In an experiment to find the strength for a brass wire eleven pairs of values x (suspended mass in kg) and y (length of wire in mm) given in the table below are obtained.

x	1	1.5	2	2.5	3	3.5	3	2.5	2	1.5	1
y	-1.1	-0.6	0	0.4	0.9	1.5	1.0	0.6	0.1	0.5	-0.9

The equation connecting x and y is assumed to take the form $y = a + bx$ where a and b are estimates of α and β respectively.

- (i) Obtain the least squares estimate values for α and β .
- (ii) Use this equation to find the value of y when $x = 1.35$.
(Hint: $\sum x^2 = 57.25$, $\sum y^2 = 7.22$, $\sum xy = 10.0$)
- (c) It is known that the true response Y in a certain chemical experiment is a linear function of the operating temperature X . However, the experimental determinations of Y are subject to random errors, so that when an experiment is performed at temperature x_i the observed response y_i is such that $y_i = \alpha + \beta x_i + e_i$, where $\alpha + \beta x_i$ is the true response and e_i is the error.

Temperature(X)	30	30	40	40	50	50
Observed response(Y)	14	12	10	11	7	6

The table above gives the observed responses in six experiments. Use the data to obtain the least squares estimate of the linear relationship between X and Y .

3. (a) Define the following statistical terms
- (i) Independence and uncorrelatedness and explain how they are related.
- (ii) Latin Square design
- (iii) The product moment correlation coefficient and with the use of a scatter diagram explain how you would interpret values of 0 and 1.

- (b) A stimulus-response experiment involving three treatments was laid out in a randomized block design using four subjects. The response was the

Subjects			
1	2	3	4
① 1.7	③ 2.1	① .1	② 2.2
③ 2.3	① 1.5	② 2.3	① 0.6
② 3.4	② 2.6	③ 0.8	③ 1.6

length of time to reaction measured in seconds. The data, arranged in blocks, are shown in the table above. The treatment number is circled and shown above each observation. Do the data present sufficient evidence at 5% level of significance to indicate a difference in the mean response for

- (i) stimuli (treatments)?
 (ii) Subjects?

4. (a) State the following:
 (i) two properties of the normal curve.
 (ii) central limit theorem.
- (b) Nine patients suffering from Alzheimer's disease were given a test on word pronunciation and the number of pronunciation errors counted. A year later the same patients were given the same test and the number of pronunciation errors counted again. The following results were obtained:

First time	0	1	1	2	5	0	4	7	6
Second time	4	2	1	1	7	6	8	10	3

- (i) Compute a 95% confidence interval for the difference in the mean number of pronunciation errors.
 (ii) Are the number of pronunciation errors higher after a one-year period? Test at the 10% level of significance.
 (iii) What assumption(s) are needed for (i) and (ii) to be valid?
- (c) A random sample of 52 customers who drive luxury cars showed that the average distance driven between oil changes was 5129 km with a standard deviation of 67.1 km. Another random sample of 48 customers who drive

compact lower-priced cars resulted in an average distance of 5172 km with a standard deviation of 80.5 km.

- (i) Construct a 90% confidence interval for the mean distance between oil changes for luxury cars.
- (ii) Is the mean distance between oil changes for luxury cars significantly different from 5000km? Explain.
- (iii) Is there sufficient evidence to indicate that the mean distance between oil changes is lower for luxury cars? Test using a 1% level of significance.

5. (a) Define the following:

- (i) dependent samples.
- (ii) type II error.

(b) A study was conducted to compare the effectiveness of two drugs in curing malaria in babies. Among 120 babies given drug A, 36 were cured within two days while 70 out of 280 babies on drug B were cured within two days.

- (i) Construct a 96% confidence interval for the proportion of babies cured of malaria within two days on drug B.
- (ii) Determine whether there is a significant difference in the effectiveness of the two drugs. Use $\alpha = 0.05$.
- (iii) How large a sample is required in order to be 99% confident that the estimate of the proportion cured on drug A within two days is less than 0.1 units of the true value?

(c) The following are data on 150 chickens, divided into two groups according to breed and into three groups according to yield of eggs:

		Yield		
		High	Medium	Low
Breed	A	45	28	29
	B	27	6	15

Test whether these data are consistent with the hypothesis that the type of breed does not affect the yield of eggs. Use a 5% level of significance.

6. (a) Define the following:

- (i) power of a test.
- (ii) sampling distribution.

(b) A committee was formed to study traffic conditions in an industrial complex. The committee wanted to determine whether the modes of transportation used to get to work changed over a period of 5 years. Five years before, 65% of the workers used public transportation, 22% used company transportation, 10% used personal vehicles and the rest used other

modes. The committee obtained the following information from a sample of 500 workers.

Transportation mode	Number of people
Public transport	320
Company transport	130
Personal vehicle	35
Other means	15

Is there sufficient evidence to indicate that the modes of transportation used to get to work have changed? Use $\alpha = 0.05$.

- (c) A sample of 13 cans of brand A diet soda gave a mean number of 23 calories with a standard deviation of 3 calories. Another independent sample of 11 cans of brand B diet soda had a mean of 25 calories with a standard deviation of 5 calories. Assume the amounts of calories of diet soda are normally distributed.
- (i) Is there a difference in the mean number of calories for the two brands? Carry out a test using a 5% level of significance assuming the variances of the two brands are equal.
 - (ii) Test whether the standard deviation of brand A diet soda is significantly different from 4 calories. Use a 10% level of significance.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS AND STATISTICS
2018/2019 ACADEMIC YEAR DEFERRED EXAMINATION
MAT3011 – PRINCIPLES OF FINANCE AND FINANCIAL REPORTING

Time Allowed: THREE (3) hours

INSTRUCTIONS

1. Answer ALL Questions
 2. Show all your workings to earn full credit
 3. Indicate your computer number on ALL answer booklets
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Question One

[20 Marks] – MULTIPLE CHOICE – [2 marks each]

- 1 Which of the following statements best explains the role of the external auditor from an agency perspective?
- A The auditor enables the shareholders to rely on the financial statements prepared by the directors.
- B The auditor ensures that the company is well managed.
- C The auditor provides the directors with independent advice on accounting and financing matters.
- D The shareholders can task the external auditor to examine particular areas of concern.
- 2 Which of the following statements best describes the driver of the market price of a quoted company?
- A Expectations of future revenues.
- B Expectations of future dividends.
- C Historical trends of reported profits.
- D Historical trends of dividend payments.
- 3 Martin has just been admitted to a long established business partnership. He has bought 20% of the partnership equity, although he has not paid for this yet. He will be entitled to 15% of the partnership profit. If the firm incurs any liability, what proportion of that liability will be Martin's legal responsibility?
- A 0%
- B 15%
- C 20%
- D 100%
- 4 When does a bondholder receive the nominal value of a bond?
- A At the time of purchase.
- B Annually.
- C Whenever coupon payments are made.
- D At maturity.
- 5 Which of the following statements describes the agency problem?
- A Agents may feel that they cannot trust their principals.
- B Agents may have insufficient authority to manage their principals' affairs.
- C Principals may feel that they cannot trust their agents.

D Principals may not have the necessary expertise to manage their own businesses.

6 Kumuzi is a 100% subsidiary of the Ndiyepano Group. Ndiyepano is a major quoted Corporation. Kumuzi has serious cash flow problems and is struggling to meet its immediate liabilities. Which of the following statements is correct?

A Ndiyepano has no reason to support Kumuzi.

B Ndiyepano is forbidden from supporting Kumuzi unless there is a contractual reason for doing so.

C Ndiyepano is required by law to support Kumuzi and settle the liabilities.

D Ndiyepano will make a commercial decision as to whether it will support Kumuzi.

7 A parent company's only asset is an K8 million investment in a 60% subsidiary. The subsidiary's assets are valued at K25 million. What value will be attributed to group assets in the consolidated financial statements?

A K8 million

B K15 million

C K25 million

D K33 million

8 A newly formed company was funded by an equity injection, in which the shareholders purchased a total of 10,000 K1 fully-paid shares for K2.50 each. Which of the following figures will appear in the company's statement of financial position?

<i>Share capital (K)</i>	<i>Share premium (K)</i>
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A 10,000	15,000
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B 10,000	25,000
----------	--------

C 25,000	0
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D 25,000	15,000
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9 Which of the following statements best describes the purpose of the depreciation charge?

A The depreciation charge creates a reserve for the replacement of assets when they reach the end of their useful lives.

B The depreciation charge ensures that asset values remain realistic.

C The depreciation charge ensures that businesses obtain tax relief on the consumption of assets' values.

D The depreciation charge reflects the consumption of an asset's value during the period that benefits from that consumption.

10 You have been asked to determine the internal rate of return (IRR) of a project that has an initial cash outflow, followed by seven years of net cash inflows. The project's net present value was + \$500,000 when determined at 11% and - \$500,000 when determined at 16%.

Which of the following statements concerning the project's IRR is correct?

A The IRR is approximately 13.5%.

B The IRR is exactly 13.5%.

C The IRR is greater than 16%.

D The IRR is less than 11%.

Question Two**[Total 20 Marks]**

You have been provided with the following trial balance as at 31 May 2018 for a limited liability company called Sowelani.

	<i>K'000</i>	<i>K'000</i>
Bank	50	
Inventory at 1 June 2017	1,200	
General expenses	600	
Heating and lighting	90	
Marketing and advertising expenses	248	
Wages	490	
Buildings at cost	5,000	
Motor vehicles at cost	160	
Plant and equipment at cost	700	
Retained earnings at 1 June 2017		280
Trade receivables	438	
Purchases	2,200	
Loan note interest paid	30	
5% Loan note		600
Revenue		5,876
Discounts received		150
Trade payables		500
K1 ordinary shares		1,500
Accumulated depreciation at 1 June 2017:		
Buildings		2,000
Motor vehicles		60
Plant and equipment		240
	<u>11,206</u>	<u>11,206</u>

The following notes are relevant.

- (a) Inventory at 31 May 2018 was valued at K800,000.
- (b) Marketing and advertising expenses include K6,000 paid in advance for a marketing campaign which will begin in June 2018. Marketing and advertising expenses should be allocated to administrative expenses.
- (c) There are wages outstanding of K10,000 for the year ended 31 May 2018.
- (d) A customer ceased trading owing the company K38,000; the debt is not expected to be recovered.
- (e) An allowance for receivables is to be established amounting to 5% of trade receivables.
- (f) Depreciation is to be provided for as follows.
 - (i) Buildings at 5% per annum on their original cost, allocated 50% to cost of sales, 20% to distribution costs and 30% to administrative expenses.
 - (ii) Motor vehicles at 25% per annum of their written down value, allocated to distribution costs.
 - (iii) Plant and equipment at 20% per annum of their written down value, allocated to cost of sales.
- (g) No dividends have been paid or declared.
- (h) Income tax of K250,000 is to be provided for the year.
- (i) The audit fee accrual is estimated to be K20,000.
- (j) The expenses listed below should be apportioned as follows.

	Cost of sales	Distribution costs	Administrative expenses
	%	%	%
General expenses	10	40	50
Heating and lighting	50	30	20
Wages and salaries	60	30	10

Required

Prepare the following financial statements for the year ended 31 May 2018 for Sowelani Limited, showing workings where appropriate.

- A. An income statement [10 marks]
 B. A statement of financial position [10 marks]

Question Three [Total 20 Marks]

(a) Discuss the need for formal and transparent procedures to determine the policy for directors' remuneration in a quoted company. [5 marks]

(b) The partners who own an actuarial consultancy are considering moving to a larger and more prestigious office, despite the fact that doing so has a negative net present value on the basis of a five-year cash flow projection.

Discuss the possibility that the move might be justified on the basis of strategic fit. [5 marks]

(c) National tax systems often have the objectives that the tax burden is fair and reasonable. Explain how these objectives are achieved. [5 marks]

(d) Define the term Eurobonds and give two advantages and two disadvantages of this form of government borrowing. [5 marks]

Question Four [Total 20 Marks]

Ukambachani is a major quoted company that manufactures timber products. The company has suffered a major setback during the past few months. The company's largest supplier was unable to meet Ukambachani's timber requirements because volcanic activity close to the supplier's forests caused forest fires which severely disrupted transport routes. Ukambachani was able to purchase timber from alternative sources, but paid much more than usual because Ukambachani receives a substantial discount from its usual supplier.

Most of Ukambachani's board members are concerned that the shareholders will blame them for allowing the company to become so heavily dependent on a single supplier.

The Production Director disagrees, though, on the basis that the Capital Asset Pricing Model (CAPM) suggests that shareholders diversify, which protects them from unsystematic risks. The volcanic disruption is an unsystematic risk and so the shareholders were protected. In any case, the Production Director had considered the risk of disruption due to the volcano and had concluded that the risk of an eruption in any given year was less than 5%.

Ukambachani has a high gearing ratio. The Production Director proposes that the board should determine the company's ungeared beta in order to determine whether the shareholders are earning a satisfactory return on their investment, despite the costs associated with the volcano.

(a) Discuss the Production Director's argument that holding diversified portfolios would have protected Ukambachani's shareholders from the volcanic disruption and so the shareholders will not blame the board. [8 marks]

(b) Discuss the Production Director's proposition that the risk had been evaluated and so the board should not be criticised. [7 marks]

(c) Discuss the respective relevance of Ukambachani's geared and ungeared betas to its shareholders. [5 marks]

Question Five

[Total 20 Marks]

Serene Hotels is a family-owned company that is in the process of recovering from a major corporate scandal. Serene Hotels is a substantial business that is not quoted. None of its shareholders owns more than 5% of the equity shares. None of the shareholders is able to take an active role in the company's management.

Serene Hotels' directors were all forced to step down because of the discovery that the directors had been overstating reported profits, which had the effect of inflating their profit-related bonuses. The directors also provided themselves with lavish lifestyles at the company's expense. For example, the company provided chauffeur-driven limousines to transport the directors on both business and personal travel.

The entire board of Serene Hotels has resigned. The shareholders have met and have appointed a new chairman and a chief executive. Neither of these appointees have had anything to do with Serene Hotels in the past. They have both agreed that their first priority is to appoint a new board and to structure the management arrangements so that the shareholders' confidence is restored.

The chairman has suggested that the new board should be structured as follows:

- The chairman will work on a part-time basis and will be responsible for the management of the board, including chairing board meetings. The chairman will be paid a fixed annual salary that offers an appropriate rate for the time that he is expected to commit to the company.
- The chief executive will be employed on a full-time basis to manage the company itself and will receive both a substantial salary and a profit-related bonus.
- Four additional full-time directors will be appointed to take charge of particular areas such as marketing and finance. Each will receive a similar package to the chief executive.
- Two part-time directors will be appointed to participate in board meetings and to review corporate strategy. They will be paid a fixed salary.

- The chief executive and each of the full-time directors will receive a 5% shareholding after satisfactorily completing three years on Serene Hotels' board.
- The chairman and the two part-time directors will appoint a new larger and more reputable external audit firm to replace outgoing auditor and will pay a larger fee for the new auditor's services.

(a) Discuss the suitability of each of the proposals above from the perspective of maintaining shareholder confidence. [10 marks]

An advisor has recommended that the new team of executives seek a stock exchange quotation and commit in their prospectus to have a specific dividend pay-out ratio.

(b) Evaluate the decision to list the company at this particular moment. [4 marks]

(c) Outline the various factors to be considered in deciding on the dividend policy for Serene Hotels post listing. [6 marks]

..... **END OF EXAMINATION**.....

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS AND STATISTICS
2018/2019 ACADEMIC YEAR MID YEAR EXAMINATION
MAT3011 – PRINCIPLES OF FINANCE AND FINANCIAL REPORTING
12TH JULY 2019

Time Allowed: THREE (3) hours

INSTRUCTIONS

1. Answer ALL Questions from both Section A and B
 2. Show all your workings to earn full credit
 3. Indicate your computer number on ALL answer booklets
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Question One

[20 Marks] – MULTIPLE CHOICE – [2 marks each]

1. Which of the following is legally responsible for the commitment owed by a limited company to the company's lenders?

- A The company's directors.
- B The company's external auditor.
- C The company's shareholders.
- D The company's treasurer, who negotiated the terms of the loan with the lenders.

2. Which of the following best explains the problems arising from information asymmetry?

- A Directors do not always have sufficient information with which to reach sound managerial decisions.
- B Shareholders cannot process all of the information that is available to them.
- C Shareholders feel that they do not have sufficient information to evaluate the behaviour of the directors.
- D Some shareholders are better informed than others.

3. Which of the following is most likely to explain a company's decision to issue subordinated debt?

- A A lower rate of interest will be available.
- B Existing lenders may have the right to prevent the issue of further senior debt.
- C Subordinated debt may offer tax advantages.
- D The shareholders will feel more secure if the company issues subordinated debt rather than senior debt.

4. A company wishes to issue convertible stock with a conversion date in five years' time.

Which of the following proposals for the conversion terms is likely to be the most attractive to investors?

- A Compulsory conversion to equity shares at the end of year five.
- B Investors can choose to convert to equity shares at the end of year five. If they do not convert then their securities will continue as loan stock indefinitely.

C Investors can choose to convert to equity shares at the end of year five. If they do not convert then their securities will continue as loan stock that will be redeemable after a further five years.

D Investors can choose to convert to equity shares at the end of year five. If they do not convert then their securities will be converted to preference shares.

5. A quoted company's statement of financial position shows equity shares worth K10m, retained earnings of K20m and non-current liabilities in the form of a K15m nominal loan paying 7% pa interest.

The shares have a total market value of K48m and the non-current liabilities have a market value of K18m.

The company's cost of equity has been determined as 17% and the cost of debt as 8%.

What is the company's weighted average cost of capital?

- A 11.60%
- B 14.00%
- C 14.27%
- D 14.55%

6. A speculator has a policy of investing all of his cash in a single company for a short period in the hope of achieving a capital gain. The speculator is presently looking for a company whose shares have a high beta coefficient.

Which of the following is the most rational explanation for the speculator's desire to identify a high beta security?

- A High beta securities tend to increase in value.
- B Specific risks can be diversified away and only systematic risks matter.
- C The speculator expects stock market prices to strengthen.
- D The speculator expects stock market prices to weaken.

7. A company's earnings before interest and tax is K400,000. It has one million K1 shares in issue, fully paid, and retained earnings of K800,000. Long term liabilities are K500,000.

What is the entity's return on capital employed?

- A 17.4%
- B 22.2%
- C 26.7%
- D 30.8%

8. How will the components of the return on capital employed ratio be affected if a company charges depreciation too slowly?

- A Return will be understated and capital employed will be overstated.
- B Return will be overstated and capital employed will be overstated.
- C Return will be overstated and capital employed will be understated.

D Return will be understated and capital employed will be understated.

9. Which of the following best explains why liquidity ratios based on a company's published accounts are unlikely to be useful for credit control purposes?

- A The figures are likely to be based on historical costs.
- B The figures are likely to be inaccurate.
- C The figures are likely to be manipulated by creative accounting.
- D The figures are likely to be out of date.

10. Which of the following best describes the need for the consistency concept in financial reporting?

- A All similar transactions should input into the bookkeeping records in the same way throughout the accounting period.
- B Financial statements prepared by an entity should be comparable from year to year.
- C Financial statements prepared by different entities should be comparable.
- D The users of financial statements should use consistent criteria for interpreting accounting information.

Question Two

[Total 20 Marks]

(a) Brighton works in a factory owned by Global Manufacturing ("Global"), a quoted company. Global grants employees who have been employed by the company for more than five years the right to purchase up to 1,000 shares every year at a 5% discount to the share price at the date of purchase. Global's current share price is K4.70 per share.

Discuss the advantages and disadvantages to Brighton of taking up the right to purchase shares under this scheme. [5 marks]

(b) A quoted company is planning to make a rights issue on the basis of one new share for every seven shares currently held. The present share price is K5.20. The rights issue will be priced at K4.50. The directors intend to use the funds raised to fund a project that they are confident will increase the company's present market capitalisation by 20%.

(i) Calculate the expected price per share after the rights issue. [3 marks]

(ii) Comment on whether the stock will trade above or below the price in (i) [2 marks]

(c) National tax systems often have the objectives that the tax burden is fair and reasonable. Explain how these objectives are achieved. [5 marks]

(d) Define the term Eurobonds and give two advantages and two disadvantages of this form of government borrowing. [5 marks]

Question Three**[Total 20 Marks]**

The following information has been extracted from the books of Tubombe, a limited liability company, as at 31 October 2018.

	<i>Dr</i> <i>K'000</i>	<i>Cr</i> <i>K'000</i>
Cash	15	
Insurance	75	
Inventory at 1 November 2017	350	
General expenses	60	
Energy expenses	66	
Marketing expenses	50	
Wages and salaries	675	
Discounts received		50
Share premium account		200
Retained earnings at 1 November 2017		315
Allowance for receivables at 1 November 2017		40
Sales revenue		5,780
Telephone expenses	80	
Property expenses	100	
Bank		94
Returns inward	95	
Trade payables		290
Loan note interest	33	
Trade receivables	900	
Purchases	3,570	
7% loan notes		470
Irrecoverable debts	150	
K1 ordinary shares		1,800
Accumulated depreciation at 1 November 2017		
Buildings		360
Motor Vehicles		80
Furniture and equipment		420
Land at cost	740	
Buildings at cost	1,500	
Motor vehicles at cost	240	
Furniture and equipment at cost	1,200	
	<u>9,899</u>	<u>9,899</u>

You have also been provided with the following information:

- a) Inventory at 31 October 2018 was valued at K275,000 based on its original cost. However, K45,000 of this inventory has been in the warehouse for over two years and the directors have agreed to sell it in November 2018 for a cash price of K20,000.
- b) The marketing expenses include K5,000 which relates to November 2018.
- c) Based on past experience the allowance for receivables is to be increased to 5% of trade receivables.
- d) There are wages and salaries outstanding of K40,000 for the year ended 31 October 2018.
- e) Buildings are depreciated at 5% of cost. At 31 October 2018 the buildings were professionally valued at K1,800,000 and the directors wish this valuation to be incorporated into the accounts.
- f) Depreciation is to be charged as follows:

- (i) Motor vehicles at 20% of written down value
- (ii) Furniture and equipment at 20% of cost
- g) No dividends have been paid or declared.
- h) Tax of K150,000 is to be provided for the year.
- i) During October 2018 a bonus issue of one for ten shares was made to ordinary shareholders. This has not been entered into the books. The share premium account was used for this purpose.

Required

Prepare the following statements, for internal use:

- A. The statement of profit or loss for the year ended 31 October 2018. [10 marks]
- B. The statement of financial position as at 31 October 2018. [10 marks]

Question Four

[Total 20 Marks]

Agness Hotels is a family-owned company that is in the process of recovering from a major corporate scandal. Agness Hotels is a substantial business that is not quoted. None of its shareholders owns more than 5% of the equity shares. None of the shareholders is able to take an active role in the company's management.

Agness Hotels' directors were all forced to step down because of the discovery that the directors had been overstating reported profits, which had the effect of inflating their profit-related bonuses. The directors also provided themselves with lavish lifestyles at the company's expense. For example, the company provided chauffeur-driven limousines to transport the directors on both business and personal travel.

The entire board of Agness Hotels has resigned. The shareholders have met and have appointed a new chairman and a chief executive. Neither of these appointees have had anything to do with Agness Hotels in the past. They have both agreed that their first priority is to appoint a new board and to structure the management arrangements so that the shareholders' confidence is restored.

The chairman has suggested that the new board should be structured as follows:

- The chairman will work on a part-time basis and will be responsible for the management of the board, including chairing board meetings. The chairman will be paid a fixed annual salary that offers an appropriate rate for the time that he is expected to commit to the company.
- The chief executive will be employed on a full-time basis to manage the company itself and will receive both a substantial salary and a profit-related bonus.
- Four additional full-time directors will be appointed to take charge of particular areas such as marketing and finance. Each will receive a similar package to the chief executive.
- Two part-time directors will be appointed to participate in board meetings and to review corporate strategy. They will be paid a fixed salary.

- The chief executive and each of the full-time directors will receive a 5% shareholding after satisfactorily completing three years on Agness Hotels' board.
- The chairman and the two part-time directors will appoint a new larger and more reputable external audit firm to replace outgoing auditor and will pay a larger fee for the new auditor's services.

(a) Discuss the suitability of each of the proposals above from the perspective of maintaining shareholder confidence. [10 marks]

An advisor has recommended that the new team of executives seek a stock exchange quotation and commit in their prospectus to have a specific dividend pay-out ratio.

(b) Evaluate the decision to list the company at this particular moment. [4 marks]

(c) Outline the various factors to be considered in deciding on the dividend policy for Agness Hotels post listing. [6 marks]

Question Five

[Total 20 Marks]

(a) Didier plc is a quoted company. Its directors are reviewing the company's long term financial strategy. The company has been criticised for being financed largely by equity. It has no significant long term borrowings. The board has asked for some calculations to enable them to decide whether the company should consider borrowing in the future. The next phase of expansion will require the company to raise K200m and will involve a general expansion of the existing lines of business.

The following information has been obtained:

Current cost of Equity	11%
Current corporation tax rate	30%
Equity capital	K1,000m
Probable gross interest rate on debt	7%

(i) Calculate Didier plc's expected WACC AFTER the new finance has been raised assuming that the finance is raised by borrowing. Comment on your result. [3 marks]

(ii) Use capital structure theories to explain the relevance of the WACC figure to the decision to use equity or debt for the new finance. [7 marks]

(b) Pentact is an actuarial consultancy. Pentact has owned a two floor office block for the past 20 years.

Improvements in technology mean that Pentact has reached the point where the whole of the upper floor is left unoccupied.

Pentact's directors are considering using the free space in the building to launch a new consultancy venture. This would involve taking on new consultants with relevant expertise, as well as equipping the floor with suitable IT equipment.

The initial investment in the IT equipment will be K15 million.

Over the next five years, Pentact predicts that the fees earned from the new consultancy venture, minus the cash outflows associated with wages and other running costs, will have a net present value of K40 million.

Pentact's directors believe that they should allow something for the building in deciding whether to proceed with this venture. Four possible arguments have been put forward by four members of the board:

1. The building cost K20 million when it was acquired and it has been depreciated by K8 million since. That leaves a net book value of K12 million, of which K6 million could be attributed to the upper floor.
2. The cost of the building is a sunk cost and it should not be incorporated into the project appraisal.
3. The upper floor could be sold to a third party for K27 million.
4. The upper floor could be rented out over the next five years, with rental income yielding a net present value of K9 million.

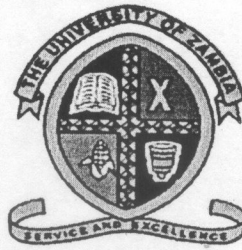
The debate over the building has been heated because it could affect the decision to go ahead with the project.

- (i) Outline the logic of each of the four arguments concerning the building. [4 marks]

Critics of the net present value (NPV) technique state that it has a fundamental flaw in that it is possible to justify either the acceptance or rejection of almost any project by manipulating estimates and assumptions in the evaluation of NPV.

- (ii) Evaluate the assertion that this project illustrates this fundamental flaw in the net present value criterion. [6 marks]

..... **END OF EXAMINATION**.....



THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS & STATISTICS
2018/2019 ACADEMIC YEAR FINAL EXAMINATION
MAT3022 – INVESTMENT ANALYSIS AND PORTFOLIO MANAGEMENT

Time Allowed: THREE (3) hours

INSTRUCTIONS

1. Answer ALL FOUR (4) questions
 2. Show all your workings to earn full credit
 3. Indicate your computer number on ALL answer booklets
-

Question One [Total 25 Marks]

- (a) Distinguish between operational and allocative efficiency [2 marks]
- (b) Outline the three forms of the Efficient Markets Hypothesis (EMH). [3 marks]
- (c) Explain what is meant by “excessive volatility” of share prices. [2 marks]
- (d) State two examples of empirical evidence of the “under-reaction” of share prices to events. [3 marks]
- (e) Briefly describe the implications of the price-volume relationship on market efficiency. [3 marks]
- (f) Define an index tracker fund and describe how you could create such a portfolio on the Lusaka Stock Exchange (LuSE). [5 marks]
- (g) Discuss the methodology of the following approaches to security analysis.
- (i) Fundamental analysis [4 marks]
- (ii) Technical analysis [3 marks]

Question Two [Total 25 Marks]

(a) Outline the key findings in behavioural finance. [8 marks]

(b) You are given the following results and data for Securities 1, 2 and 3 in Table 1 for the single index model.

$$E_i = \alpha_i + \beta_i E_M$$

$$V_i = \beta_i^2 V_M + V_{\epsilon i}$$

and $C_{ij} = \beta_i \beta_j V_M$

Table 1: Single Index Model parameter values

Security	1	2	3
α_i	0.0	2.0	-2.2
β_i	1.3	0.8	2.0
$V_{\epsilon i}$	2.2	1.3	1.2

You are given that:

- the expected return and standard deviation of the market return are 6% and 10% respectively
- the returns of each security can be modelled using an appropriate single-index model.

(i) Calculate the expected return and standard deviation of return for each security. [3 marks]

(ii) Calculate the covariance of returns between each pair of securities. [2 marks]

(iii) Explain the difference between the single-index model and the Capital Asset Pricing Model. [2 marks]

(iv) A suggestion has been made to use a multi-index model instead of single-index model. Outline any two multi-index model choices available and how they can be fit to the data to predict future security price moves. [6 marks]

(c) State the assumptions in coming up with a budget line and describe its effect on consumer choice.

(d) Suppose that Elliot and Kaumba each have a log utility function and an initial wealth of 150 and 450 respectively. Both are offered a gamble such that they will receive a sum equal to 30% of their wealth should they win, whereas they will lose 10% of their wealth should they lose. The probability of winning is $\frac{1}{4}$.

(i) Calculate Elliot's certainty equivalent for the gamble alone and comment briefly on your answer. [2 marks]

(ii) Repeat part (i) in respect of Kaumba and compare your answer with that in part (i). [2 marks]

Question Three**[Total 25 Marks]**

(a) The probability density function $f(x)$ of the 2 parameter Burr distribution is:

$$f(x; c, k) = ckx^{c-1}(1 + x^c)^{-(k+1)}; \text{ where } x > 0, c > 0 \text{ and } k > 0$$

You are given that the cumulative distribution function of the above distribution is given by:

$$F(x; c, k) = 1 - (1 + x^c)^{-k}$$

You have very limited knowledge of an investor's utility function.

Three investment portfolios A, B and C provide returns that follow Burr distribution with the following parameters.

Table 2: Burr Distribution Parameters

Portfolio	c	k
A	1	1
B	1	2
C	2	1

(i) Ascertain if an investor who prefers more to less would choose A over B? [4 marks]

(ii) Show that the investor will not be able to choose between A and C based on first order stochastic dominance. [3 marks]

(iii) What can be deduced about second order stochastic dominance between A and C [3 marks]

(b) Describe the following active management styles.

(i) Momentum

(ii) Rotational [4 marks]

(c) List any two domestic equities sector categories that are evident on our local LuSE and briefly describe the investment characteristic of each. [2 marks]

(d) The following information relates to the performance of two investment trusts and their equivalent benchmark index over a three year period. The annual risk-free rate of return over this period was 4% per annum.

Table 3: Investment Trusts and Benchmark Index Performance

	Trust A	Trust A	Benchmark Index
Return	9.0% p.a.	8% p.a.	7% p.a.
Standard Deviation	13.5% p.a.	9.5% p.a.	6.5% p.a.
Correlation with benchmark	0.36	0.75	1.0

(i) Calculate three different risk adjusted performance measures for each trust. [6 marks]

(ii) Comment on the results from part (i), stating any limitations that apply to them. [3 marks]

You are given that:

$$\beta_p = \frac{\rho_{p,m} \sigma_p \sigma_m}{\sigma_m^2}$$

Treynor measure, Sharpe measure and Jensen measure

$$T_p = \frac{(\bar{r}_p - \bar{r}_f)}{\beta_p}, \quad S_p = \frac{(\bar{r}_p - \bar{r}_f)}{\sigma_p}, \quad \alpha_p = \bar{r}_p - [\bar{r}_f + \beta_p(\bar{r}_p - \bar{r}_f)]$$

Question Four [Total 25 Marks]

(a) Let X be a random variable denoting the rate of return on the fund ABC. The distribution of X is $N(\mu, \sigma^2)$.

(i) Define $VaR_\alpha(X)$ with $\alpha \in [0, 1]$. [1 mark]

(ii) Show that: $VaR_\alpha(X) = -(\mu + \sigma \Phi^{-1}(\alpha))$

where Φ denotes the cumulative Normal distribution function.

(Hint: Consider the probability that X is less than VaR_α). [4 marks]

(iii) An investor holds K350m invested in ABC, the expected return on the fund is 10% and the standard deviation of that return is 25%. Use the above results to calculate the $VaR_{0.05}$. [2 marks]

(b) A farmer has a small apple tree which produces one harvest of apples per year. The number of apples the tree produces follows a Binomial with parameters; $N = 10$ and $p = 0.6$.

Determine the expected shortfall below a harvest of 5 apples. [3 marks]

(c) Consider a market with N securities. Let x_i denote the weight of security i in a portfolio, V_i the variance of the return on security i and C_{ij} the covariance between the returns on security i and security j .

(d)

(i) State the main assumptions of modern portfolio theory [2 marks]

(ii) Describe how an efficient portfolio can be found under mean-variance portfolio theory. [You do not have to include details of the partial derivatives and their solutions.] [4 marks]

(e) A market comprises 2 risky assets A and B and a risk free Asset C; with the following returns in different states of the world.

Table 4 Asset Returns in different states of the world

State	Probability	Asset A	Asset B	Asset C
1	0.2	-1%	-2%	3%
2	0.4	3%	5%	3%
3	0.4	6%	8%	3%
Market Capitalisation		25,000	75,000	

(iii) State the equation of the capital market line under the CAPM and use the data in Table 4 above to calculate the market price of risk. [4 marks]

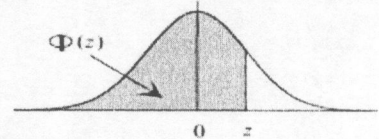
(f)

(i) Show that investors can diversify away specific risk by investing equal amounts in an increasing number of independent securities. [3 marks]

(ii) Without making any calculations, explain whether the result in part (iii) still holds true when the securities are correlated. [2 marks]

*****END OF EXAMINATION*****

TABLE 1: AREAS UNDER THE NORMAL CURVE



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

$\alpha = 1 - \Phi(z_\alpha)$	
α	z_α
0.10	1.2816
0.05	1.6449
0.025	1.9600
0.010	2.3263
0.005	2.5758
0.001	3.0902
0.0005	3.2905
0.0001	3.7190
0.00005	3.8906
0.00001	4.2649