TOTAL MARKS [   ]

NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2019

INFORMATION TECHNOLOGY: PAPER I

EXAMINATION NUMBER [   ]

Time: 3 hours   180 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 31 pages and an Appendix of 3 pages (i–iii). Please check that your question paper is complete.

2. Read the questions carefully and make sure that you answer all parts of each question.

3. Answer on the question paper. Please make sure that you write your examination number in the blocks above.

4. Answer ALL questions – there are no options in this paper.

5. Show all working where applicable.

6. A non-programmable calculator may be used.

7. It is in your own interest to write legibly and to present your work neatly.

8. There are four blank pages at the end of this paper. In case you run out of space when answering a question, use these pages. Clearly indicate the number of the question you are working on.

FOR MARKER'S USE ONLY

Question	1	2	3	4	5	6	7	8	**Total**
Marks	10	10	40	23	25	16	19	37	**180**
Obtained									

SECTION A   SHORT QUESTIONS

QUESTION 1   DEFINITIONS

Give the most appropriate term for each of the following expressions:

1.1   Permanent software programmed into a form of read-only or flash memory.

1.2   The process of reorganising the contents of a hard disk drive into the smallest number of contiguous regions.

1.3   An extension of a private network across a public network to allow remote access.

1.4   A software component that adds a specific feature to a browser.

1.5   A small piece of data sent from a website and stored on the user's computer.

1.6   An open source, high-performance, small-footprint, SQL compliant transactional database.

1.7   A search technique which aims to improve search accuracy by understanding the searcher's intent and the search context.

1.8   A cryptographic key that can be obtained and used by anyone to encrypt messages intended for a particular recipient.

1.9   A signal sent to a processor indicating an event that needs immediate attention.

1.10   The process of replacing or adding devices in a computer system without stopping or shutting down the system.

[10]

QUESTION 2   MATCHING COLUMNS

For each of the terms in Column A below, you should select the **most correct** definition in Column C, matching the letter to the question number. You should merely write down the appropriate letter in Column B. An example is shown as Question 2.0, using "W" as the correct answer.

Column A	Column B	Column C	
2.0	W		
2.1 Biometric input		A	A method of storing the same data in different places on multiple hard disks
2.2 SaaS		B	An event which disrupts the normal program flow
2.3 Topology		C	Used to help detect errors in manually entered data, such as bank account numbers
2.4 Bluetooth		D	Data input using human characteristics
2.5 Check digit		E	A network device that selects the best possible path
2.6 Router		F	A data backup technique
2.7 SMTP		G	Computers connected in a bus
2.8 INSERT		H	A method of software delivery and licensing in which software is accessed online via a subscription
2.9 RAID		I	A protocol used to send email
2.10 Exception		J	An error in source code
		K	The physical layout of a network
		L	A wireless technology standard for exchanging data over short distances
		M	A SQL command used to add data to a table
		N	A protocol used to send and receive email
		O	Used to check the number of even or odd number of bits in a transmission
		P	A SQL command to alter data in a database

[10]

SECTION B   SYSTEM TECHNOLOGIES

Consider the following scenario when answering the rest of the examination paper, unless the questions are of a general nature or otherwise stated.

> **MobiHealth** is a company which provides mobile health services to various communities, ranging from highly populated urban communities with modern, up to date technology and rural communities where traditional beliefs prevent the use of any modern technologies. Mobile clinics which visit the communities are staffed by a doctor and two nurses.

QUESTION 3

Mobile clinics which visit urban areas are equipped with two laptops: one for the doctor and one for a nurse who takes down the details of each patient on arrival.

At the end of the day, all the data accumulated on the laptops is uploaded to the servers at the **MobiHealth** regional offices.

The laptop has the following specifications:

- Intel® i5 7200U processor 2.50Ghz, 3MB cache
- 8GB RAM
- 1TB HDD
- 15.6 inch HD LED display
- 4 USB 3.0 ports
- Optional 6 cell battery pack

3.1   Intel® is a manufacturer of CPUs and graphics cards. Name one other well-known manufacturer of CPUs.

_____

(1)

3.2   The laptop has 8GB of RAM. What is the purpose of RAM in a laptop?

_____

(2)

3.3   The maximum screen resolution supported by the display is 4096 × 2304 pixels.

3.3.1   Is this a high or low resolution?

_____

(1)

3.3.2   Name one other hardware component, not mentioned in the specification list, that will be needed to ensure that images can be viewed on the display.

_____

(1)

3.4   The optional 6 cell battery pack will give the laptop up to 16 hours of usage.

    3.4.1   Motivate why the clinic chose to include this in the specification rather than the standard battery. You should mention TWO facts in your answer which relate to the scenario.

Fact 1: _____

_____

Fact 2: _____

_____

(2)

    3.4.2   One of the nurses has suggested that the CPU could be overclocked to improve laptop performance.

      (a)   What is meant by overclocking?

_____

_____

_____

_____

(2)

      (b)   Give TWO reasons why, if the CPU is overclocked, this would have a negative effect on overall power consumption of the laptop.

Reason 1: _____

_____

Reason 2: _____

_____

(2)

    3.4.3   The hard disk drive (HDD) could be replaced by a solid state drive (SSD). Give TWO reasons why this would help reduce the power consumption of the laptop compared to using the hard disk drive.

Reason 1: _____

_____

Reason 2: _____

_____

(2)

3.5   The CPU has a 3MB cache.

3.5.1   What type of RAM is used in a processor cache? Name ONE characteristic of this type of RAM which makes it ideal for the task.

Type of RAM: _____

_____
                                                                    (1)

Characteristic: _____

_____
                                                                    (1)

3.5.2   Justify why 3MB is a sufficient size for a processor cache on a laptop with 8GB of RAM. Your answer should include:

- an explanation of what type of data is stored in the processor cache; and
- why 3MB is large enough compared to 8GB of RAM.

_____

_____

_____

_____

_____

_____

_____
                                                                    (3)

3.6   There is no operating system mentioned in the specifications of the laptop.

3.6.1   What are the three main functions of any operating system?

Function 1: _____

_____

Function 2: _____

_____

Function 3: _____

_____
                                                                    (3)

      3.6.2 What operating system would you recommend be used on this laptop? Justify your answer with TWO reasons which relate to the scenario.

Operating System: _____

Reason 1: _____

_____

Reason 2: _____

_____

(3)

3.7   **MobiHealth** has decided to encrypt the data on the hard drives on all their laptops.

      3.7.1 Give TWO possible reasons why **MobiHealth** may have decided to encrypt the hard drives.

Reason 1: _____

_____

Reason 2: _____

_____

(2)

      3.7.2 The encryption software which **MobiHealth** uses makes use of 256 bit encryption.

          (a)   Explain what is meant by 256 bit encryption.

_____

_____

_____

_____

(2)

          (b)   Do you believe that 256 bit encryption is secure enough for the data which is being kept by **MobiHealth**? Justify your answer with ONE reason.

_____

_____

_____

_____

(2)

3.8 Some of the leaders in the rural communities view technology with great suspicion, for this reason **Mobihealth** chooses to respect the leaders' views and not bring the laptops to the rural clinics.

When a patient visits the mobile clinic in a rural area, one of the nurses will write down on a piece of paper details about the patient. The doctor uses the same piece of paper when he treats the patient. At the end of the day, when the mobile clinic returns to the main offices of **MobiHealth**, all the information on the pieces of paper is captured into a computer system at the regional office.

3.8.1 Give TWO examples of the patient information that might be written down on the piece of paper.

Item 1: _____

Item 2: _____

(2)

3.8.2 (a) Having patient information on paper poses a security risk. Give TWO reasons why data on paper is more at risk than digital data.

Reason 1: _____

_____

Reason 2: _____

_____

(2)

(b) Give TWO methods which will help prevent any loss of confidential information in non-digital form.

Method 1: _____

_____

Method 2: _____

_____

(2)

3.9 **MobiHealth** have decided to upgrade all their laptops used in the urban locations.

Explain whether it will be possible to upgrade:

3.9.1 to a bigger laptop screen.

_____

_____

_____

_____

(2)

3.9.2 the RAM.

_____

_____

_____

_____
(2)
[40]

SECTION C   INTERNET AND COMMUNICATION TECHNOLOGIES

QUESTION 4   THEORY

The **MobiHealth** regional office has a network with various devices connected to it.

A network diagram is included as **Appendix A**. You should study this diagram before answering Question 4 and Question 5. Remember to keep the overall scenario in mind at the same time.

Real time footage from the HD CCTV (video) cameras is stored on the CCTV server attached to device C. The same footage is uploaded as it is being viewed to another server at the head offices, maintaining a duplicate copy of the footage. The offices are also used as a training facility for the doctors and nurses, making use of online training courses and video seminars. All employees have access to the facilities on the network for work purposes only.

4.1   A, B and C are all the same type of device. What is the name given to this device?

_____

(1)

4.2   The network diagram shows a firewall and a web cache.

4.2.1   What is the purpose of a firewall?

_____

_____

_____

_____

(2)

4.2.2   What is the purpose of a web cache?

_____

_____

_____

_____

(2)

4.2.3 For each of the threats shown in the table below, you need to indicate whether a firewall would be effective or not in terms of managing the threat and support your answer with a reason.

Threat	Yes / No	Reason
URL blocking		
Hardware theft		
Denial of service attack		

(6)

4.2.4 List ONE similarity and ONE difference between a web cache and a disk cache when considering internet access. Your answers may not be the opposites of each other.

Similarity: _____

_____

Difference: _____

_____

(2)

4.3 The network design makes use of the star topology.

4.3.1 List one advantage and one disadvantage of this topology. Your answers may not be the opposites of each other.

Advantage: _____

_____

Disadvantage: _____

_____

(2)

4.3.2 As with most star topologies, this network uses UTP cabling. List one advantage and one disadvantage of UTP as a connection medium. Your answers may not be the opposites of each other.

Advantage: _____

_____

Disadvantage: _____

_____

(2)

4.4 The network has four different physical servers linked to device C. A modern trend in network design is to make use of virtualised servers based on the local network.

4.4.1 What is meant by "server virtualisation"?

_____

_____

_____

_____

(2)

4.4.2 List and explain ONE advantage and ONE disadvantage of server virtualisation. Your answers may not be the opposites of each other and you should include a brief explanation of why each is an advantage or disadvantage.

Advantage: _____

Explanation: _____

_____

Disadvantage: _____

Explanation: _____

_____

(4)

[23]

QUESTION 5   APPLICATION

5.1   Users of the computers connected to component A on the network diagram are complaining of slow network access to the servers connected to device C.

5.1.1   Explain, with reference to the scenario and network layout by giving TWO possible reasons why the users are experiencing slow access across the network.

Reason 1: _____

_____

Reason 2: _____

_____

(2)

5.1.2   Name and explain TWO changes that could be made to the network design to increase the network speed.

Change 1: _____

Explanation: _____

_____

_____

Change 2: _____

Explanation: _____

_____

_____

(4)

5.2   The internet connection is shown as a 300mbps link over fibre. **MobiHealth** needs a single backup internet connection out from the firewall in case the fibre link fails.

5.2.1   Give ONE reason why a fibre link, which is usually very reliable, might fail causing lost connectivity.

_____

_____

(1)

5.2.2 Recommend to **MobiHealth** TWO other possible internet connection technologies they could use, which will allow them to have a connection of similar speed.

_____

_____

_____

_____

(2)

5.3 One of the technical staff at **Mobihealth** has asked you to help explain the following terms. You need to:

- give a brief definition of each;
- suggest ONE expected user of each.

5.3.1 Intranet

Definition: _____

_____

_____

Expected user: _____

(2)

5.3.2 Internet

Definition: _____

_____

_____

Expected user: _____

(2)

5.3.3 Extranet

Definition: _____

_____

_____

Expected user: _____

(2)

5.4   **MobiHealth** has a website to promote the facilities they make available to the urban communities. The technical manager has heard about Search Engine Optimisation (SEO). One of the keys to successful SEO is to carefully manage the keyword list (a list of frequently searched words) associated with the **MobiHealth** website.

   5.4.1   Suggest TWO possible key words that could be chosen for the **MobiHealth** website in the SEO process.

   Keyword 1: _____

   _____

   Keyword 2: _____

   _____

   (2)

   5.4.2   Why will it be necessary for **MobiHealth** to change the keyword list over time? Justify your answer with TWO different reasons.

   Reason 1: _____

   _____

   Reason 2: _____

   _____

   (2)

   5.4.3   The **MobiHealth** website is viewed by users with desktop and mobile browsers.

      (a)   In the urban areas where **MobiHealth** operate, which version of the website do you think will increasingly have more traffic associated with it? Justify your answer.

      _____

      _____

      _____

      _____

      (2)

(b)   Explain why it is necessary for the two versions of the website (the desktop version and the mobile version) to have different keyword lists.

(2)

5.4.4   Do you believe that newer search technologies, such as voice searching, will have an effect on the way in which keyword lists are derived? Justify your answer.

(2)
[25]

SECTION D   SOCIAL IMPLICATIONS

QUESTION 6

Read the following extract from an article dealing with medical matters. This will be necessary to answer the questions that follow.

In February 1998, a well-respected medical journal published the results of a small study which has become one of the most damaging pieces of research in medicine. The results of this study were reported and discussed on many websites.

The results of the study, involving 12 children, suggested a link between the measles, mumps, and rubella vaccine and autism*. These vaccinations are given to many children in most countries around the world.

The study has since been shown to be false, the doctor who did the research is no longer permitted to practice medicine and the journal retracted the article. It was revealed that the doctor who did the research paid children attending his son's 10th birthday party to donate their blood for the research. Continued research has shown that autism is NOT caused by vaccines.

Even though the research has been disproved, a dangerous movement of vaccine denial has led many parents to refuse to have their children vaccinated. This has caused new outbreaks of measles resulting in many deaths, from a disease which was previously well-controlled.

[Adapted from: <https://www.vox.com/2018/2/27/17057990/andrew-wakefield-vaccines-autism-study>
Accessed 16 January 2019]

*Autism is a medical disorder. People who suffer from autism often have difficulty interacting socially and communicating, as well as having repetitive patterns of thought and behaviour.

6.1   Technology has made it possible for more people to have access to information and be better informed.

Give TWO methods of digital communication that would have helped spread information (either good or bad) about the research mentioned in the article.

Method 1: _____

_____

Method 2: _____

_____

(2)

6.2   With so much information being presented to us daily via the internet, we need to be skilled at evaluating whether or not the information is reliable.

If you were a parent of a young child and you read the results of the original study and the supplied article, what facts might have made you think it was:

6.2.1   genuine?

_____

_____

(1)

6.2.2   unreliable?

_____

_____

(1)

6.3   **MobiHealth** has decided to take part in similar medical research. They have taken the details of all the children they have treated in the past 10 years and given this to the researchers.

6.3.1   Do you believe it is legal for **MobiHealth** to do this?

_____

(1)

6.3.2   Justify your answer to Question 6.3.1.

_____

_____

(1)

6.4   Independent of the data referred to in Question 6.3 above, it has been discovered that a **MobiHealth** employee has been forwarding emails about patients and their vaccination records to the press in response to a query.

What policy document would **MobiHealth** use as a basis for taking disciplinary action against the employee?

_____

_____

(1)

6.5   A number of parents from both the urban and rural communities have come to the **MobiHealth** clinic because there is concern about the health risks of vaccinations. The staff at **MobiHealth** has asked you to help them produce an information campaign to help educate the parents.

Give THREE means of communication which you could use in your campaign which will use technology appropriate to the communities which **MobiHealth** serves, explaining why each would be appropriate and effective in getting factual information about all communities served by **MobiHealth**.

Your answer must indicate which community (urban, rural or both) your method would benefit with information. There is an example shown – you may not use this method in your answers.

	Method	**Community**	**Justification**
E.g.	Email	Urban	Email is a quick way to send information to people and the majority of people treated in the urban areas will have access to email.
1			
2			
3			

(6)

6.6   **MobiHealth** is undertaking more research regarding vaccinations. They have bought a large database of medical data. The servers at the regional offices are not powerful enough to manage all the calculations on the data that need to be done.

6.6.1   Name the processing technique which will need to be employed to allow this processing to take place on multiple machines.

(1)

6.6.2   Give TWO other examples or project names where this processing technique is often used.

Example 1:

Example 2:

(2)
[16]

SECTION E   DATA AND INFORMATION MANAGEMENT AND SOLUTION DEVELOPMENT

QUESTION 7

The **MobiHealth** database which stores details of the patients who are treated at each mobile clinic, stores the following data in one table called **tblMedicalData:**

Field	Description
PatientID	Unique ID for each patient treated by the clinic
Surname	The surname of the patient
FirstName	The first names of the patient
ConsultID	Unique ID for each consultation
Date	The date of the consultation
Duration	The duration of the consultation
FollowUp	The number of days when the patient must return for another consultation

A patient can have many different consultations. Each consultation will only be with one patient. Each consultation needs a follow up a certain number of days later.

Sample data for **tblMedicalData** is shown below:

PatientID	Surname	FirstName	ConsultID	Date	Duration	FollowUp
1	Bhebhe	Mthunzi	234	01/04/18	20	10
2	Hlongwa	Kagiso	244	02/04/18	25	90
3	Luthuli	Bonginkosi	267	15/10/18	10	30
4	Chonco	Uluthando	315	12/07/18	15	0
5	Khoza	Langa	337	12/07/18	40	90
6	Zindela	Inyoni	219	21/02/18	55	0
7	Luthuli	Mthunzi	288	16/04/18	12	90
4	Chonco	Uluthando	266	17/06/18	18	10
1	Bhebhe	Mthunzi	322	21/03/18	20	90

7.1   It is common practice to normalise database tables.

7.1.1   List THREE reasons why database tables should be normalised.

Reason 1: _____

_____

Reason 2: _____

_____

Reason 3: _____

_____

(3)

7.1.2 Database tables can be normalised to a number of normal forms.

List the characteristics of both the second and third normal forms. (2NF and 3NF)

2NF: _____

_____

_____
(2)

3NF: _____

_____

_____
(2)

7.2 **tblMedicalData** is going to be transformed into TWO new tables: **tblPatients** – for patient specific data and **tblConsultations** – for consultation specific data. In the questions which follow, you must restrict your answers to working with just these two tables, i.e. you may not define any additional tables and you are not required to remove any transitive dependencies.

7.2.1 Define the term *primary key*.

_____

_____

_____

_____
(2)

7.2.2 Define the term *composite key*.

_____

_____
(1)

7.2.3 Write down the best primary key for **tblMedicalData**.

_____

_____

_____
(2)

7.2.4 Complete the following two tables, showing the fields that will be present in the two new tables. <u>Your primary keys must be listed as the first field in each table</u>. Indicate your choice of foreign key below the tables.

tblPatients	tblConsultations

Foreign Key: _____

(5)

7.2.5 Define the term *foreign key*.

_____

_____

_____

_____

(2)
[19]

QUESTION 8

A software developer is busy writing an OOP application for **MobiHealth**. One of the classes in the OOP application will be used to define **Patient** objects. There are also classes for **Doctor** objects and **Clinic** objects.

Each **Patient** object will have the following fields:

patientID : integer
surname : string
firstName : string
patientAge : integer
medication : array [20] string
clinicName : string
followUp : integer

A patient is always treated by the same doctor and each doctor only works in one mobile clinic, each of which has a unique name.

All fields of **Patient** objects are private.

8.1   Answer the following question relating to the object fields:

In which class(es) will the fields of each **Patient** object be directly accessible? Tick the box next to the correct option below.

- The Patient, Doctor and Clinic classes

- The Patient and Doctor classes

- Only the Patient class

- The Patient and Clinic classes

(1)

8.2   The **Patient** class will have the following methods:

- A parameterised constructor method which will accept 7 parameters named **p** (integer), **s** (string), **fN** (string), **a** (integer), **m** (string array), **c** (string) and **f** (string);
- Accessor method for the **clinicName** field;
- Mutator method for the **clinicName** field. This method will have a parameter: **cn**, of the correct type to match the type of the corresponding field;
- A *toString* method.

8.2.1   The **Doctor** class has a field which is a Patient object. Both classes have *toString* methods. Is this an example of method overloading, method overriding or neither? Explain your answer.

_____

_____

_____

_____

_____

_____

(3)

8.2.2   You are required to assist the developers by completing a class diagram for the **Patient** class.

<u>Fields</u>

<u>Methods</u>

(9)

8.2.3   Currently the age of a patient is stored as an integer field in the **Patient** object. What would be a better data value and corresponding data type to store in this field which will still allow us to know the patient's age?

_____

(1)

8.3   When the developers are coding the **Patient** class for the application, they will be working with various algorithms. They first represent the algorithms visually by writing them on pieces of paper which they then fit together to make a working algorithm. Some of the pieces of paper have been mixed up and you have been asked to re-assemble one of the algorithms.

The algorithm in question is meant to sort an array of **medication** (a field in the **Patient** class). The developers are using an **improved Bubble Sort** which uses a **flag** to stop the sort if no further swaps are needed.

8.3.1   Included as **Appendix B** is a sheet containing representations of the various pieces of paper that the algorithm was planned on. Each has a letter of the alphabet to identify it. You are required to assemble these into the correct order and write down the correct order, i.e. the letters of the alphabet to get the algorithm to work correctly. NB: Some of the pieces of paper are not relevant to this algorithm. There are exactly the correct number of blocks for a correct answer. You have also been given TWO lines of the sort, G and M. They are in the correct positions.

Sample Answer:

C	G	F	L	D	S	A

Your Answer:

				G				M			

(10)

8.3.2   Does this algorithm sort the array in ascending or descending order?

_____

(1)

8.4   A method to determine the average age of a patient is being coded. The algorithm for the method is included as **Appendix C**.

There are four values in the array: 24 ; 36 ; 18 and 22.

The algorithm will loop through an array of patient ages (named **ageArr**) and calculate the average age. It will also maintain a running average whilst looping through the array. If the running average exceeds 60, an error message will be displayed.

8.4.1   This algorithm has been coded, but is resulting in unexpected output. You are required to complete the following trace table to assist the programmer in finding the error in the algorithm.

line	size	temp	runningAvg	k	count	runningAvg > 60?	DISPLAY
1	4						
2		0					
3			0				
4					0		
4				0			
6		24					
7					1		
8			24				
9						F	
5				1			
6							
7							
8							
9							
5							
6							
7							
8							
9							
10							
5							
6							
7							
8							
9							
10							
11							

(9)

8.4.2   Which line in the algorithm is responsible for the error?

_____

(1)

8.4.3   Is the variable count necessary in this algorithm as it stands? Can it be replaced by k? Justify your answer.

_____

_____

(2)

[37]

Total: 180 marks

ADDITIONAL SPACE (ALL questions)

REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.