NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2013

INFORMATION TECHNOLOGY: PAPER I

Time: 3 hours 180 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 12 pages. 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 ALL questions – there are no options in this paper.
4. Show all working where applicable.
5. Non-programmable calculators may be used.
6. Number your answers exactly as the sub-questions are numbered.
7. Start each answer to each question on a **new page**.
8. Please leave a **line open** between sub-questions.
9. It is in your own interest to write legibly and to present your work neatly.

SCENARIO

'Re-engineering the human ...'

Experts from a biometric engineering team predict that bionic technology will give us longer, healthier lives in the future. 'Re-engineering the human', explores some remarkable breakthroughs in the design of prosthetic limbs, artificial organs, bones and even blood cells. Bionic limbs with machine intelligence can now sense their environment and predict a user's intentions. Smarter, stronger, speedier robotics will someday enhance the power of the able-bodied. A new prosthetic arm actually composed of a swarm of robots, each with a detachable segment housing a processor that works in concert with the others, is bringing new hope to many people.

[Adapted from: Popular Mechanics, June 2012]

QUESTION 1

The biometric engineering team needs help with the following terms:
(State TWO key facts for each term)

1.1 Cloud Computing

1.2 RFID

1.3 System Software

1.4 Virtualisation

1.5 Firmware

1.6 VPN

1.7 Digital signature

1.8 RSI

1.9 UML

1.10 Android

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[1] Biometrics – identification of humans by their characteristics or traits, e.g. fingerprint reader to gain access to a secure room.

QUESTION 2

The biometric engineering team has many considerations preparing disabled people for the world they have to live in. They need advice when reviewing the following devices for assisting the disabled.
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Device A: Samsung Galaxy Note 10.1

Cellular connectivity	GSM/3G/4G Bands 850 / 900 / 1800 / 1900 HSPA 850 / 900 / 1900 / 2100 (3G model)
Display	10.1" LCD at 1 280 × 800 149 ppi pixel density
Processor	Samsung Exynos 4 Quad 1.4 GHz quad-core
Graphics	Mali-400 MP4 GPU
RAM	2 GB
Storage	16/32/64 GB internal user storage microSDXC slot
Connectivity	Wi-Fi 802.11 b/g/n Bluetooth 4.0 Infrared
Camera	5 MP rear camera with LED flash 1.9 MP front camera
Ports	Samsung proprietary connector 3.5 mm audio jack S-Pen slot
Launch OS	Embedded Android 4.0 'Ice Cream Sandwich'

[<http://www.neowin.net/news/review-samsung-galaxy-note-101>]

Device B: The Lenovo IdeaPad Yoga 13 Convertible laptop

[<http://www.cnet.com/laptops/lenovo-ideapad-yoga-13/4505-3121_7-35477652.html>]

Processor	Intel 3rd Gen Core i5, 3 i5-3317U / 1.7 GHz, 3 MB cache, Dual-Core) [2.6 GHz Turbo boost] 64 bit
Graphics Clock Rate	850 MHz [1100 MHz Turbo boost]
Operating system	MS Windows 8
Chipset	Mobile Intel QS77 Express
Bus Speed	1 600 MHz / PC3-12800
Memory	8 GB DDR3L SDRAM
Hard drive description	128 GB SSD / Serial ATA-300
Graphics	Intel HD Graphics 4000
Audio	Stereo speakers, combo headphone / microphone jack
Data	USB 2.0, SD card reader

Networking	Ethernet, 802.11n Wi-Fi, Bluetooth

2.1 Device B has a chipset. Name the TWO components that usually make up a chipset. (2)

2.2 Examine Device A.

2.2.1 What is the frequency of the processor? (1)

2.2.2 By using the connectivity terminology listed in the advertisement for Device A, briefly explain TWO methods that can be used to share data between the tablet and the laptop. (4)

2.2.3 Give TWO input methods that can be used on Device A. (2)

2.2.4 Explain what 'embedded' in terms of the Operating System means in Device A. (2)

2.2.5 Give TWO features one can use on the tablet to improve the usability for the visually impaired. (2)

2.3 Refer to Device B.

2.3.1 Explain what the '64' refers to in the processor and give an advantage of a 64-bit operating system. (2)

2.3.2 The device has turbo boost which overclocks the CPU. Explain the difference between clock multiplication and overclocking. (2)

2.3.3 Distinguish between 'Graphic Clock Rate' and 'Bus Speed'. (2)

2.3.4 Which part of the FSB (Front Side Bus) dictates how much RAM can be accessed? (1)

2.3.5 Define 'access time' in terms of a mechanical hard drive. (2)

2.3.6 Why does a Solid State hard drive use less power than a hard drive? (1)

2.3.7 Give TWO other advantages of a Solid State hard drive. (2)

2.4 Give TWO advantages of choosing Device B over Device A. (2)

2.5 Give TWO disadvantages of choosing Device B over Device A. (2)

Device C: Tongue Drive System prototype built on a commercial wireless headset

[<http://www.research.gov/common/images/PublicAffairs>]

2.6 Examine Device C.

The engineering team has developed a wireless technology that can convert a user's tongue motions to specific commands, which will enable paralysed people to use tablets and laptops to their advantage.

2.6.1 Why can you not connect Device C to Device A? Explain. (2)

2.6.2 When Device C is connected to Device B, name and explain the software process whereby this device is recognised. (3)

2.6.3 The control unit of Device C will have a ROM chip with embedded software, called firmware. What type of memory does more complex firmware use to allow updates? (1)

2.6.4 Give TWO functions of the firmware in the ROM chip in Device C. (2)
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QUESTION 3

The biometric engineering team decides to reach out to the community by creating a 'thin-client' computer lab with 30 computers, a desktop for the lab manager and a desktop for the administrator's use in the administration block. These will have to be able to communicate with each other as a network. The network must also cater for staff to use their smartphones and tablets as network devices.

Some IT consultants advise the team to set up a thin client-server network.

3.1 Explain why peer to peer is not suitable for this network setup with thin clients. Give THREE reasons. (3)

3.2 The server software could be proprietary or open source software.

3.2.1 Give an example of each type of software (proprietary and open source). Provide the name and version. (2)

3.2.2 Give a disadvantage of each – proprietary and open source software. (2)

Figure 3.3: Thin Client

Processor	Intel® Atom Processor N280 1.66 GHz 32 bit
FSB Speed	667 MHz
Instruction Set	32-bit (x86)
Instruction Set Extensions	SSE2, SSE3, SSSE3
Operating system	Windows® Embedded Standard 2009
Memory, standard	1 GB DDR3 SDRAM
SSD ROM	2 GB Flash
Graphics	Intel GL40 graphics chipset (64 MB for graphics)
Network interface	10/100/1000 Gigabit Ethernet (RJ-45), TCP/IP with DNS and DHCP, Point-to-Point Protocol (PPP), Direct Connection through RS-232, Point-to-Point over Ethernet (PPPoE)
Power	Worldwide auto-sensing 100-240 VAC, 50-60 Hz energy-saving automatic power-down, surge-tolerant 65-watt power supply

3.3 Read the network interface specifications for the thin client computer (Figure 3.3) as seen above and answer the questions which follows:

3.3.1 Which network architecture is used with this computer? (1)

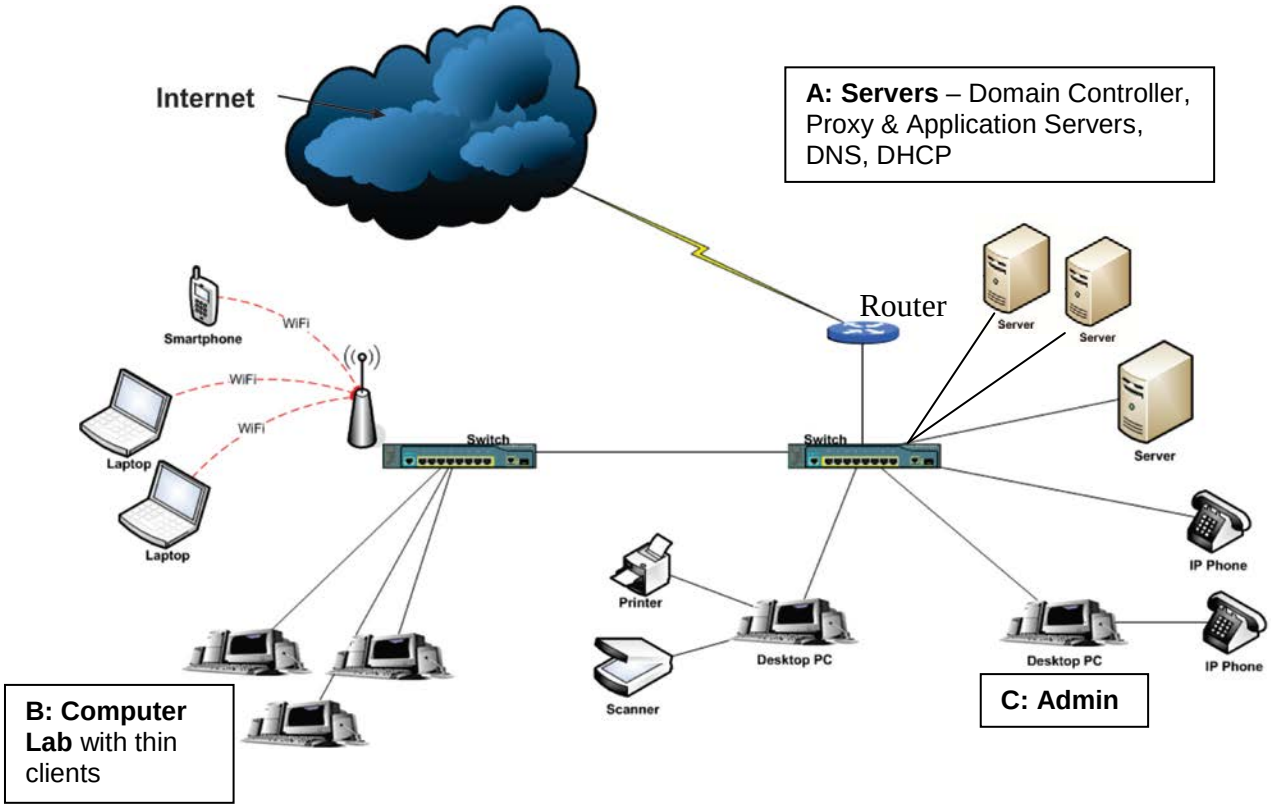
3.3.2 Which cable type should be used for the 'thin client' computers? Why? (2)

3.3.3 What does '10/100/1000 Gigabit' refer to? (2)

3.3.4 Which topology do you suggest for the room? Give TWO reasons. (3)

3.3.5 '**TCP/IP** with **DNS** and **DHCP**' – explain each term. (6)

3.4 Look at the network diagram below – this is an approximation of the projected company network.



In the location of the computer laboratory, there are two options to provide Internet connectivity – '**Wireless**' OR '**3G**'. There is no ADSL service available. The 'Wireless' have a group of line-of-sight towers to provide connectivity in the area.

3.4.1 What type of signal would be used in line of sight towers? Give ONE reason for your answer. (2)

3.4.2 Briefly explain what **3G** is. (2)

3.4.3 Which connection option would you choose – 'Wireless' or '3G'? Give ONE reason for your answer. (2)

3.4.4 Within the same company there are various network devices. Briefly describe the following:

(a) Switch (2)

(b) Proxy server (2)

(c) Router (2)

(d) Scanner (2)

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QUESTION 4

4.1 Distinguish between system software and application software. (2)

4.2 It is important for the biometric engineering team to have a licence agreement when purchasing software.

4.2.1 Does this mean that the team now owns the software? (1)

4.2.2 Motivate your answer to Question 4.2.1. (1)

4.3 Justify how each of the following is beneficial to the team's network:

4.3.1 Firewall (2)

4.3.2 Anti-virus software (2)

4.3.3 RAID (2)

4.4 Biometric devices are installed at the door of the team's computer laboratory for attendance control purposes and security. The manager of the biometric engineering team for instance has a fingerprint reader to unlock the laboratory.

4.4.1 Name TWO other examples of biometric devices and systems, other than a fingerprint reader, that can be used for these purposes. (2)

4.4.2 Do you think it is a violation of privacy to scan people's fingerprints before accessing a venue? Give TWO reasons for your answer. (3)

4.5 Computer software converts real-time muscle activity signals into robotic arm's movements, particularly for the use of prosthesis control. Memory allocation is a real-time task that shares computing resources and is therefore more critical in a Real-Time Operating System than in other operating systems.

4.5.1 What does 'Real-Time' mean? (2)

4.5.2 Virtual memory is one of the methods that have been devised to increase the effectiveness of memory management. Explain how this is possible. (4)

4.6 SYS/BIOS is another example of a Real-Time Operating System. SYS/BIOS provides a wide range of system services to an embedded application such as pre-emptive multitasking.

4.6.1 Define multitasking and multithreading. (4)

4.6.2 If processors nowadays are all dual core, do you think that multithreading is still necessary in an application? Give TWO reasons for your answer. (3)

4.7 How will 'interrupts' work together with 'plug and play', so that a newly inserted device can immediately be available to the user? (2)

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QUESTION 5

5.1 *Twitter can bring about a transformation in society*. Either agree or disagree with this statement by providing TWO arguments. Justify each argument. (4)

5.2 The biometric engineering team is also involved in nature conservation. With the plight of the rhino at present, the staff decided to start a rhino watch as they have a herd of rhino in the conservancy. Employees of the company go on game walks over weekends and tweet the location of the rhinos and of any other interesting sightings.

5.2.1 Suggest a hash tag for the tweets. (1)

5.2.2 Do you think it would be a good idea to tweet the locations of the rhino? Justify your answer. (2)

5.3 The conservation group also needs advice on running an interactive Internet site to discuss conservation issues with the greater community. They are not sure which to choose: a blog, wiki or a forum.

Briefly explain these terms and their differences.

5.3.1 Blog (2)

5.3.2 Wiki (2)

5.3.3 Forum (2)

5.4 In the following scenario, choose the most appropriate (Blog, Wiki, Forum):

Scenario: Collaboratively developing a conservation policy.

Explain the reason for your choice. (2)

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QUESTION 6

The biometric engineering team must deal with aspects of sourcing equipment and obtaining quotations to set up their IT infrastructure. The first task is to create a database to hold the quotations (cost estimate) that will be submitted for supplying equipment. One of the task team members has set up the database shown below. For each item a minimum of three quotes is required. Some companies will provide more than one quotation (cost estimation).

Relationships:

- One-to-one: Each company has its own unique code and its own name, address and email.
- One-to-many: Each company can provide more than one quotation per day.
- Many-to-many: Quotations can have many items on it and items can appear on many different quotations.

Figure 6.1

Quotes		
Field Name	**Data Type**	**Description**
CompanyCode	Text	The first 5 letters of the company name followed by a sequence number
CompanyName	Text	The name of the company
CompanyAddress	Text	The address of the company
CompanyEmail	Text	The email address of the company
ItemCode	Text	Unique code for each item
ItemDescription	Text	Description of the item
ItemQuantity	Text	Number of items required
ItemCost	Text	Cost of one item
QuoteNo	Text	Unique number for each quote

6.1 Explain the purpose of a primary key in a database table. (2)

6.2 There are several problems with the design of this database. The steps below are part of the process of solving the design problems.

6.2.1 All the data types were declared as text. Indicate TWO fields which should not be of a text type and indicate the appropriate data type for EACH of the fields you have identified. (4)

6.2.2 Considering that many companies have multiple quotations (cost estimations), what is the most obvious weakness of the Quotes table design with regard to capturing data on a quotation? You MUST explain your reasoning. (2)

6.2.3 A poorly designed database can lead to errors whilst doing normal, everyday database maintenance tasks. These errors are often referred to as 'anomalies'. Name THREE of the anomalies that can result from a badly designed database. (3)

6.2.4 The given table actually contains information on **at least** TWO separate groups or categories of data. Normalise the database up to 3NF (Third Normal Form). Write the answer as a set of relations. You MUST show the following:

- The fields that each of the new tables will contain. (3)
- The primary key of each table. (3)
- The foreign keys and the tables that will contain the foreign keys needed to establish relationships/links between the tables. (3)

6.3 Part of a good database design is anticipating and preventing errors when entering data. Consider the data that can be captured about the quote. The task team have decided that they will not accept quotes for less than 100 units or more than 5 000 units.

6.3.1 What is the technique that can be used to ensure that data falls within a predetermined range? (1)

6.3.2 Write out the rule you would use to ensure that the number of units entered will not be outside the predetermined range. Use the field names from Figure 6.1. (2)

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QUESTION 7

The biometric engineering team wants to write a little computer game quiz to teach facts about the rhino. In the game 'To Save the Rhino', ten questions must be correctly answered in thirty seconds. If correctly answered you get another rhino, if not, you lose a rhino. The questions will be aimed at recording correct facts about rhinos, (e.g. rhino horn is NOT an effective aphrodisiac or a cure for cancer, etc.) and teaching other facts about rhinos. There are TWO types of questions: TRUE or FALSE and MULTIPLE CHOICE with THREE options.

The questions and correct answers are stored in a text file. Below are the class diagrams for each type of question:

QuesOb
– question:String

QuesTF
– question:String
– TF:boolean

QuesMultChoice
– question:String
– ans:String
– a, b, c:String

7.1 The above classes could be simplified using inheritance. Draw the class diagrams, clearly showing inheritance, and remove any unnecessary fields or methods. (3)

7.2 Give TWO advantages of inheritance. (2)

7.3 What does polymorphism mean? (2)

7.4 Parameters are fundamental to programming. Describe how the following concepts are related:

7.4.1 Formal parameters (2)

7.4.2 Arguments (2)

7.5 Problem: Input and validation of a (20) digit number.

- The number will be valid if, and only if, the twentieth digit (20^{th}) is equal to the remainder of the sum of the first nineteen (19) digits divided by 20.
- The program should print a suitable message informing the user whether the number is valid or invalid.

7.5.1 Declare any variable(s) necessary to store the above 20 digit number. (2)

7.5.2 Hence, using the variables (data structure) declared in Question 7.5.1, write the algorithm that will allow for the input and validation of a (20) digit number. (7)

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Total: 180 marks