The question paper consists of 7 pages

Instructions:
- Answer all questions.
- Please write neatly and legibly.
- Do not write in pencil.
- Ensure that all diagrams are neatly drawn.
- Unless otherwise stated, diagrams do not constitute complete answers.
- Calculators may not be used.
SECTION A – THEORY

QUESTION 1
1.1. What is software engineering? (2)

1.2. Name and briefly discuss one general issue that affects all types of software in today’s world of software engineering. (2)

1.3. The web has changed the way software is designed and implemented. One such change is cloud computing. Briefly discuss what cloud computing is, and how it affects software design. (2)

1.4. An acquaintance of yours has recently been hired to work at a software company developing software for military installations and the company has contacted you for a reference. Your friend has claimed to have a bachelor’s degree in Software Engineering, even though he did not. Speaking to this acquaintance, they claim that their experience means more than any academic qualification.

What are you going to say in your reference of your acquaintance? Do you believe that experience outweighs academic knowledge? (4)

QUESTION 2
Requirements engineering is the process of establishing the services that the customer requires from a system and the constraints under which it operates and is developed.

2.1. There are several ways/notations of writing system requirements specifications. Briefly discuss two (2) ways and mention in which circumstances each might be used. (4)

2.2. Discuss two (2) problems that can occur during the requirements elicitation process. (2)

2.3. After the requirements have been approved, there is a chance that they might be changed. Using a diagram to aid you in your discussion, briefly discuss how requirement changes can be managed. (4)

QUESTION 3
SupereSoftware has hired you as a software engineer. You have been assigned to design a stock management system for Neonute Textiles, a national distributed of newt leather related products.

Pharox Foods would like to be involved throughout the development process and get more feedback from the developers. In the past they found it difficult to judge the project progress from just software design documents. It should be noted that due to the agreement between SupereSoftware and Neonute Textiles the entire system will be developed on-site i.e. at Neonute Textiles’ business premises. It is also a requirement that the entire system be developed entirely from scratch i.e. all parts of the system must be developed by SupereSoftware.

With the aid of diagram(s) to help your written discussion, select and discuss a software process model that should be used to develop the stock management.
QUESTION 4
Extreme Programming (XP) is perhaps the best known and most widely used of the agile methods. As such, SupereSoftware has decided that they will change their development cycle to allow for XP. One drawback, according to SupereSoftware, is that XP is less reliable and buggier software.

4.1. Briefly discuss the key features of the testing process in XP. (4)

4.2. Agile methods were developed for use by small programming teams who could work together in the same room. Briefly discuss how agile methods can be scaled. Be sure to mention the “scaling up” and “scaling out” perspectives in your discussion. (6)

QUESTION 5
The finance department at Jetfire cc requires a system that can be used to process their payroll for all of their employees. They want to be able to process all the employees' pay slips at the same time as well as being able to perform certain transactions on the pay slip data such as adding UIF, PAYE, pension fund contributions, etc. Once all transactions are done the pay slips must be printed.

Keep in mind that the design process for identifying the sub-systems making up a system and the framework for sub-system control and communication is architectural design.

5.1. Which architectural design pattern would you recommend for the above project? With the aid of a diagram, describe the pattern you recommend. (5)

5.2. Briefly compare the advantages and disadvantages of your recommended pattern. (2)

5.3. Briefly discuss three (3) uses of application architectures. (3)

QUESTION 6
Given the socio-technical systems stack below, answer the questions that follow.

1: Society
2: Organization
3: Business Processes
4: Application System
5: Communication and Data Management
6: Operating System
7: Equipment
6.1. What is understood by the term “socio-technical system”? (2)
6.2. Systems engineering is only concerned with some of the layers in the socio-technical stack. Which layers are they? (1)
6.3. Emergent system properties are properties of an integrated system as a whole and not just that of the individual parts. Briefly name and describe two categories of emergent system properties. (4)
6.4. One non-deterministic factor of socio-technical systems is the human element. Why are humans said to be non-deterministic? (3)

**QUESTION 7**

7.1. It may not always be possible to develop a system that is absolutely dependable. Explain how some factor(s) may impact the development of a dependable system. You may use diagrams to aid in your discussion. (4)
7.2. Would you say that the dependability of systems might often be more important than their functionality? Motivate your answer. (2)
7.3. In terms of safety, briefly discuss one possible means for a system to cause damage. HINT: Make use of terms linked to safety. (4)

**QUESTION 8**

Given the risk triangle shown below, answer the questions that follow.

![Risk Triangle Diagram]

8.1. Explain why the boundaries defining the ALARP region in the risk triangle are liable to change over time. (4)
8.2. How, and why, does specifying requirements for security differ from specifying requirements for safety? (6)
QUESTION 9
Software engineering has been more focused on original development but it is now recognised that to achieve better software, more quickly and at lower cost, a design process that is based on systematic software reuse is required.

9.1. List and discuss three (3) problems that could be encountered when switching to reuse-based development. (3)

9.2. Briefly define what an **application framework** is. (3)

9.3. Commercial-Off-The-Shelf (COTS) systems are often large systems. Discuss two (2) problems that could be encountered when integrating COTS systems into existing systems. (4)

QUESTION 10
The components in a distributed system may be implemented in different programming languages and may execute on completely different types of processor. Models of data, information representation and protocols for communication may all be different.

OutThereX Industries specialises in developing image processing applications that are used to detect the possibility of alien activity around certain neighbourhoods. The application requires a lot of intensive computer processing and hence makes use of the GPU of a computer. The company would now like their customers to be able to use their application online by making use of a web-browser in order for the company to keep track of certain statistics regarding the application. Off-the-shelf software will be made available for the customers. Customers must install the software on their personal computers if they wish to make use of the service. The company would like to start off by making the application available to a small number of customers.

10.1. Recommend a client-server architecture that they can use. (1)

10.2. Provide the definition for the architecture you recommended. (2)

10.3. Justify why you recommended the architecture. (2)

10.4. Draw a diagram showing the structure of the chosen architecture. (3)

10.5. What is the main disadvantage of the architecture you recommended? (2)

Section A Total: [100]
SECTION B – PRACTICAL

QUESTION 11
Create a UML Use-Case Diagram to model the following:

The Insta-grammar system allows for digital snapshots to be taken of poor language usage with the system automatically providing corrected text.

- There are two main roles played by users of the system namely: user and administrator. Administrators are capable of doing everything a normal user can do, the reverse is not true.
- Users are capable of taking pictures and viewing grammar suggestions. Every time a picture is taken a grammar suggestion is automatically provided.
- The administrator is capable of monetising user data through targeted advertising and content resale
- The administrator may ban users based on one of two reasonable causes: Posting inappropriate content and misuse of the apostrophe.
- The administrator is capable of backing up the image archive and adding new grammar rules.

[10]

QUESTION 12
Create a UML Activity Diagram to model the following:

Immature T-Lymphocytes (aka T-Cells) are generated in the bone marrow from where they migrate to the thymus gland. Inside the thymus they are exposed to antigens by way of antigen presenting cells. The T-Cells are simultaneously exposed to antigens which are produced by the body (self-samples) and foreign antigens which have been collected from elsewhere (non-self-samples). T-Cells which express affinity for self-samples are removed from the body (negative selection) to prevent the body from attacking itself (auto-immune disorders). T-Cells which survive this process are considered mature T-Cells.

[10]

QUESTION 13
Create a UML Class Diagram to model the following:

Colour may be modelled using several different colour models. RGB represents colour using as its red, green and blue components (as positive integers). HSV represents colour using three real numbers (hue, saturation and value). CMYK represents colour according to the amount of cyan, magenta, yellow and black in a pixel using real numbers. RGB and HSV are additive colour models while CMYK is a subtractive colour model. A graphics display has a colour model (which it keeps hidden and manages the lifecycle of) but does expose an externally visible display method which takes the name of the file to be displayed as a string.

[10]
QUESTION 14
Write a minimal code example in any object oriented programming language which implements the following UML Interaction Sequence Diagram:

```plaintext
sd Process File

AsciiFileHandler

AsciiTextFile

openFile(fName)

fHandle = openFile(fName)

loop [while not eof]

readLine()

line = readLine()

close()

displayResults()
```

QUESTION 15
Create a UML Deployment Diagram to model the following:
The number cruncher system is implemented on an infrastructure-as-a-service (IaaS) cloud computing system such as Amazon’s elastic compute cloud:

- The primary interface to the system is via a node which runs the CommandAndControl.py Python script.
- Computation is carried out via a set of nodes (since UML does not support the multi-object syntax when applied to deployment nodes you may assume that exactly three nodes are booted). Each computation node is running the NumberCruncher.py Python script.
- All inter-node communication occurs via TCP/IP.

Section B Total: [50]

Grand Total: [150]