INTERNATIONAL UNIVERSITY OF EAST AFRICA
'Learning to Succeed'

FACULTY OF SCIENCE AND TECHNOLOGY

END OF SEMESTER EXAMINATIONS - AUGUST 2025

PROGRAMME: BSSE
YEAR/SEM: YEAR 3/SEMESTER 2
COURSE CODE: SWE3200
NAME: SOFTWARE EVOLUTION

DATE:
TIME:

INSTRUCTIONS TO CANDIDATES:

SECTION A

Attempt All Questions

Question 1:

You have been hired by a financial technology (fintech) company that uses old software systems to manage customers, handle transactions, and produce regulatory reports. These systems have been in place for more than 12 years. They are critical to the business but now break down often, cost a lot to maintain, and are hard to update. The company wants to switch to newer technologies like microservices, cloud computing, and faster deployment methods. You are in charge of helping with this modernization process.

a)
i. What is meant by software evolution? (2 marks)
ii. What are Lehman’s Laws of Software Evolution? (2 marks)
iii. Name four of Lehman’s Laws that apply to this case. (4 marks)
iv. For each law you listed, explain how it relates to the fintech company's old systems. (4 marks)

b)
i. What is software maintenance? (2 marks)
ii. List and explain four types of software maintenance. (4 marks)
iii. Give one example task for each type based on the fintech company’s modernization. (4 marks)

c)
i. What is software re-engineering, and how would you use it in this case? (3 marks)
ii. What is code refactoring, and why is it useful here? (2 marks)
iii. What is reverse engineering, and when would you apply it in the modernization process? (2 marks)
iv. Why is version control important when modernizing a system? (2 marks)
v. How can containerization (e.g., Docker) help in this modernization? (3 marks)

d)
i. Mention two technical risks that could happen during modernization. (2 marks)
ii. Mention two organizational challenges that the company may face. (2 marks)
iii. Suggest one way to reduce each of the risks and challenges. (2 marks)

Question 2:

You are a software engineer in a government IT department managing the evolution of a long-standing citizen data management system. Originally built as a standalone database application, it has been upgraded over time into a web-based enterprise system with mobile and cloud features. Despite these improvements, the system now suffers from high maintenance costs, poor performance, and growing user dissatisfaction. Your team must evaluate its evolution and recommend improvements.

Answer the following questions:

(a)
i. What is software evolution? *(2 marks)*
ii. What are the primary goals of software evolution? *(2 marks)*

iii. How does software evolution apply to the system described in the scenario? *(2 marks)*

(b)
i. Identify two reasons why software evolution is essential for long-term projects. *(2 marks)*
ii. Explain how software evolution improves system relevance and usability over time. *(2 marks)*
iii. Why is it important to evolve legacy government systems in particular? *(2 marks)*
iv. In what ways can software evolution support new technologies and user needs? *(2 marks)*

(c)
i. Identify three key challenges faced during software evolution. *(3 marks)*
ii. Explain how each of these challenges might appear in the citizen data system scenario. *(3 marks)*

(d)
i. What are Lehman's Laws of Software Evolution? *(2 marks)*
ii. Describe any four of Lehman's laws. *(4 marks)*
iii. For each law described, provide an example of how it could be applied or observed in the scenario. *(2 marks)*

(e)
i. Select any two real-world software systems (e.g., Linux, web apps, ERP systems). *(2 marks)*
ii. Describe how each system has evolved over time. *(2 marks)*
iii. What lessons can be learned from the evolution of each selected system in terms of scalability, maintainability, or user adoption? *(4 marks)*

(f)
i. Suggest two strategic actions that can support the continuous evolution of the government system. *(2 marks)*
ii. Justify how each recommended action would address the current system's challenges. *(2 marks)*

SECTION B

Choose any Three(3) Questions

Question 1:

Zimsoft Solutions Ltd, a mid-sized software development firm in Uganda, developed a health management system for public hospitals five years ago using the Waterfall model. Recently, the Ministry of Health has requested the company to update the system to comply with new healthcare regulations, improve performance, and introduce new features for telemedicine integration. Zimsoft is now considering migrating to Agile or DevOps to handle ongoing updates more effectively.

Based on the scenario above, answer the following questions:

(a) Identify and briefly explain the **four types of software maintenance**. For each type, provide one relevant example from the scenario.
(8 Marks)

(b) Differentiate between **software maintenance** and **software evolution**, using the case of Zimsoft Solutions to illustrate your points.
(4 Marks)

(c) Discuss how **software evolution** is handled differently in the **Waterfall, Agile, and DevOps models**, and explain which model would be most suitable for Zimsoft's future updates.
(4 Marks)

(d) Identify **two technical** and **two organizational challenges** Zimsoft may face during the transition from Waterfall to Agile or DevOps, and suggest strategies to mitigate each.
(4 Marks)

Question 2:

Uganda Revenue Systems Ltd (URSL), a government-affiliated agency, has been relying on a Java-based legacy system developed in the early 2000s to manage taxpayer registration and record-keeping. Over the years, the system has become increasingly difficult to maintain, lacks integration capabilities with modern applications, and contains complex legacy code that newer developers struggle to understand. As part of its digital transformation agenda, URSL has initiated a project to modernize the system using a phased strategy.

Questions:

(a) Describe four key characteristics of legacy systems that may be applicable to the URSL system.
(4 Marks)

(b) Identify and explain three common issues developers may face when working with the legacy Java codebase.
(6 Marks)

(c) Discuss the following three strategies that can be used to modernize legacy systems like URSL's Java application. Include one advantage and one limitation for each:

Reverse engineering

- Migration
- Encapsulation
  (6 Marks)

(d) Using a case study approach, outline a basic plan URSL could follow to modernize their legacy Java application. Your plan should include stakeholder involvement, technical approach, and risk mitigation.
(4 Marks)

Question 3:

You have been hired by **TechRevamp Ltd**, a Ugandan software company that maintains a legacy inventory management system used across multiple districts. The system was developed over a decade ago and has become increasingly difficult to maintain due to poor documentation, frequent bugs, and growing customer demands for new features. The management has tasked your software engineering team with improving the codebase through re-engineering and refactoring practices without changing its core functionality.

Questions:

a) Describe **four key steps** you would follow during the **software re-engineering process** to improve the system's maintainability. *(4 marks)*
b) Identify **three common code smells** you are likely to encounter in such a legacy system and propose a **suitable refactoring technique** for each. *(6 marks)*
c) Recommend one refactoring tool (e.g., IntelliJ IDEA, PyCharm, or VS Code) and explain **how it can assist in the refactoring process**, especially for identifying and correcting code smells. *(4 marks)*
d) Explain the role of **automated refactoring** and **static analysis tools** in improving code quality, giving one example of each. *(6 marks)*

Question 4:

You are working on a school project with your team to build a simple web application. You decide to use **Git** for version control and **GitHub** to store your project online. Each team member is working on different parts of the project using different branches. Later, you plan to package the app using **Docker** and deploy it using **Kubernetes**.

Answer the following questions:

a) What is Git, and why is it useful in a group project like this? *(3 Marks)*
b) What is a Git branch, and why should team members use different branches for their tasks? *(3 Marks)*
c) What is a merge conflict in Git, and how can it be fixed in a simple way? *(3 Marks)*
d) What is the difference between GitHub, GitLab, and Bitbucket? Give one reason why GitHub is commonly used by students. *(4 Marks)*
e) What is Docker, and how does it help in running the web application the same way on every computer? *(4 Marks)*
f) What is Kubernetes, and why would it be helpful when the project grows and needs to run on many computers? *(3 Marks)*

Question 5:

You have recently been hired as a junior software engineer at**TechNova Solutions Ltd**, a Ugandan-based software development company. Your first assignment is to contribute to the maintenance and ongoing improvement of an enterprise-level inventory management system that has been in use for over 8 years. The project manager has tasked you with analyzing the evolution of this software and preparing a brief report on software evolution principles that will be presented to stakeholders unfamiliar with software engineering concepts.

Tasks:

a. Define *software evolution* and briefly explain why it is essential in modern software development.
(4 marks)

b. Identify and explain **three reasons** why software systems must continue to evolve, using **Lehman's Laws** to support your explanation.
(6 marks)

c. Discuss any **two real-world software systems** (e.g., Linux, Microsoft Office, enterprise web applications) that demonstrate continuous evolution. For each case, explain how software evolution is evident.
(6 marks)

d. Based on the scenario, suggest **two challenges** TechNova Solutions Ltd might face when evolving its inventory management system and propose a brief solution to each.
(4 marks)

Question 6:

You have been hired as a software engineer at **EastTech Solutions Ltd**, a Ugandan-based company developing a health management system for regional hospitals. After deployment, the system must be regularly updated to accommodate changes in health policies, user feedback, and emerging technologies. You are part of the team responsible for maintaining and evolving the system using a mix of Agile and DevOps practices.

Answer the following questions based on the scenario above:

(a) Differentiate between *software maintenance* and *software evolution* in the context of this project. Provide one relevant example for each.
(4 marks)

(b) List and describe the four types of software maintenance. For each type, give a specific example of a task you would perform on the health management system.
(6 marks)

(c) Compare the Waterfall and Agile lifecycle models based on their suitability for managing changes in large-scale systems like the one at EastTech Solutions.
(6 marks)

(d) Explain how DevOps practices such as continuous integration and automated testing would support the ongoing maintenance and evolution of the health system at EastTech.
(4 marks)

Question 7:

Uganda Revenue Technology Authority (URTA) has been using a legacy tax processing system developed in the early 2000s. The system has become increasingly difficult to

maintain due to outdated technology, limited support, and the lack of proper documentation. With the need for digital transformation and improved service delivery, URTA is considering various modernization approaches to upgrade the system without disrupting critical tax services.

Questions:

(a) Define what is meant by a legacy system and describe two *technical* and two *business* challenges URTA is likely facing with their current legacy tax system.
(6 marks)

(b) Explain how the following modernization strategies can be applied to URTA's system:
i. Reverse engineering
ii. Migration
iii. Encapsulation
(6 marks)

(c) Discuss how the lack of documentation and outdated technologies in URTA's system may affect the success of their modernization efforts.
(4 marks)

(d) Suggest two key considerations URTA should keep in mind when planning for the modernization of mission-critical systems like tax processing platforms.
(4 marks)

Question 8:

You are a software engineer at *SoftCare Solutions*, a company that maintains an old hospital management system developed over 15 years ago. The system is becoming increasingly difficult to maintain due to poor documentation, duplicated logic, and outdated design patterns. The company plans to re-engineer the system to improve maintainability and performance while preserving its core functionalities. You are tasked with evaluating the system and proposing improvement strategies using software re-engineering and refactoring techniques.

Answer the following questions

(a) What is software re-engineering, and why is it important in the context of legacy systems like the one at SoftCare Solutions? Briefly describe three major steps typically involved in re-engineering such systems.
(6 marks)

(b) While reviewing the source code, you detect several code smells. Identify and describe two common code smells that may affect maintainability. For each, suggest an appropriate refactoring technique to resolve the issue.
(6 marks)

(c) To streamline the refactoring process, your team decides to use static analysis tools and IDE plugins. Explain how these tools assist in automated refactoring, and name at least two tools that could be used in this scenario.
(4 marks)

(d) Discuss two benefits and two risks associated with re-engineering and refactoring legacy software systems.
(4 marks)

Question 9:

You have been hired as a software engineer by "AgriSoft Solutions Ltd", a company in Uganda that specializes in developing custom farm management systems for large-scale agricultural cooperatives. The company has recently secured a contract to build a "Crop Monitoring and Inventory System" that will help farmers record planting data, monitor crop health, and track inventory levels. Due to the importance of documentation, fixed requirements, and regulatory reporting, the company decides to use the Waterfall Software Development Model.

(a) Draw and clearly label the five major phases of the **Waterfall Model** that would be applied in this project. *(6 Marks)*

(b) For each of the following phases, explain the main activities that will be carried out during the development of the Crop Monitoring and Inventory System:

- Requirements Analysis *(2 Marks)*
- System Design *(2 Marks)*
- Implementation *(2 Marks)*
- Testing *(2 Marks)*
- Deployment & Maintenance *(2 Marks)*

(c) Briefly explain **two key advantages** of using the Waterfall Model in this type of agricultural software project. *(2 Marks)*
(d) Identify and explain **two possible limitations** of using the Waterfall Model in this case. *(2 Marks)*

Question 10:

The Ministry of Health in South Sudan plans to develop a **Mobile Health Reporting System (MHRS)** to enable community health workers in remote areas to submit real-time reports on malaria outbreaks, drug stock levels, and patient information using their mobile phones. Due to the dynamic and evolving nature of user requirements and the need to involve health workers in the design process, the ministry has chosen to apply the **Prototype Model** during the system development process.

Question:
As a software engineering consultant assigned to this project:

(a) Draw and clearly label the **Prototype Model** showing all major steps involved in the development process. *(6 marks)*
(b) Describe each of the steps you have drawn, and explain how each step would be practically applied in the development of the MHRS. *(10 marks)*
(c) Identify **two key benefits** and **two limitations** of using the Prototype Model in this scenario. *(4 marks)*

Question 11:

Uganda Revenue Authority (URA) is planning to implement a new tax management information system to streamline tax registration, filing, and payment processes across the country. The project team decides to use the **Joint Application Development (JAD)** approach to gather requirements and ensure user involvement from various departments

including compliance, IT, customer service, and finance.

As a software engineering consultant, you have been asked to facilitate the process using the JAD model.

Required:

a) Briefly explain the main purpose of using the JAD model in this system development context. (3 Marks)

b) Identify and describe the roles of any **four key participants** involved in a JAD session for this project. (4 Marks)

c) Draw a labeled diagram showing the **step-by-step process** of the JAD model, from project initiation to final approval. (6 Marks)

d) Explain what happens in each step of the JAD process you have illustrated in part (c), linking each step to how it would be applied to the URA tax system project. (7 Marks)

Question 12:

Kigali HealthTech Solutions, a software development firm based in East Africa, has been contracted by a public hospital in Rwanda to develop an **electronic health records (EHR)** system within a short timeframe. The hospital management insists on **user involvement at every stage**, quick delivery, and flexibility to change requirements during the development process.

As a software engineering student, you are required to guide the development team by applying the **Rapid Application Development (RAD)** model.

Tasks:

(a) Based on the scenario above, briefly justify **why the RAD model is the most suitable development approach** for this project.
(3 marks)

(b) Draw and clearly label the **four major phases** of the RAD model. Use arrows to show the flow between stages.
(7 marks)

(c) Describe each phase of the RAD model in relation to the development of the EHR system mentioned above.
(8 marks)

(d) State **two advantages and two limitations** of using the RAD model for this project.
(2 marks)