JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF INFORMATICS AND INNOVATIVE SYSTEMS

DEPARTMENT OF COMPUTER SCIENCE & SOFTWARE ENGINEERING

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR SCIENCE IN SECURITY AND FORENICS

4TH YEAR, 2ND SEMESTER 2024/2025 ACADEMIC YEAR

MAIN CAMPUS

COURSE CODE: ICB1422

COURSE TITLE: BIOMETRIC AUTHENTICATION TECHNOLOGIES

EXAM VENUE: **STREAM:**

DATE: 16/4/2025 **EXAM SESSION: 9.00-11.00**

TIME: 2.00 HOURS

INSTRUCTIONS

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1. **Answer QUESTION ONE (Compulsory) and ANY other TWO questions**
2. **Candidates are advised not to write on the question paper**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room**
4. **No mobile devices (e.g. laptops, phones. e.t.c.) are allowed into the Examination Room**

QUESTION ONE **(30 MARKS)**

With the growing adoption of biometric authentication technologies, it is essential to analyze their fundamental characteristics. Please discuss the following aspects of biometric systems:

a) Biometrics aims at identifying or verifying the claimed identity of an individual based on their physical, chemical, or behavioral traits. Classify biometric identifiers based on their source (physiological or behavioral). Provide examples of each type. (6 Marks)

b) Suppose a bank company hired you to coordinate deploying an access management system to control the entrance of authorized people into the many vaults spread among their different branches. The bank directors have heard about Biometrics but are not sure about the benefits of using it. They think using simple access cards and long passwords is as effective as and much cheaper than using a biometric system. What would you say to convince them if it is your duty to change their mind? (6 Marks)

c) Good job, you convinced the directors to use a biometric system. Among many off-the-shelf available solutions, four well-documented systems caught your attention. The table below summarizes these solutions after a careful reading of their specs. (4 Marks)

	System 1	System 2	System 3	System 4
Trait	Voice	Face	Fingerprint	Iris
AUC	0.96	0.98	0.97	0.92
d-prime	2.94	4.09	2.80	2.35
FMR @ EER	0.0675	0.0027	0.0554	0.0912
FNMR @ EER	0.0675	0.0027	0.0554	0.0912
Price	$25,000.00	$10,000.00	$2,500.00	$5,000.00
Runtime (comparisons per sec.)	2,500	1,000	1	100
Database storage (MB per 100k individuals)	160	200	2	780

If you were to choose one system based solely on accuracy and ignoring the other aspects (such as trait, price, runtime, memory footprint, number of employees, and system lifetime), what solution would you select? Please justify your answer.

d) One director was intrigued that the two cheapest systems altogether cost less than the other solutions. She was wondering if there is any advantage to acquiring these two systems instead of a single and more expensive one. Does she have a good point? What would be the possibilities if the company acquires the two cheapest solutions? Would you be able to leverage them both? If you would, please explain how you could do it. (8 Marks)

e) Your company just brought some more information to the table. Only around 50 employees will need access to the vaults. In addition, the directors want to make an investment that should last at least ten years (i.e., the to-be-acquired system is expected to operate for one decade before replacement). Based on these requirements, what candidate systems would probably need database template updates during their lifetime? Please justify your answer. (6 Marks)

QUESTION TWO **(20 MARKS)**

The Independent Electoral and Boundaries Commission (IEBC) in Kenya utilizes Kenya Integrated Election Management System (KIEMS) kits for voter verification during elections. These kits capture voters' facial images, fingerprints, and civil data. The IEBC has announced the need to replace 45,352 KIEMS kits due to obsolescence after 10 years, at a cost of Ksh.65,000.00 per kit. https://www.citizen.digital/news/iebc-needs-ksh617b-allocation-for-2027-polls-n358202

a) Discuss the advantages and disadvantages of using biometric authentication (specifically facial and fingerprint recognition) in electoral processes, considering the KIEMS kits scenario. (6 marks)

b) Explain the key security and privacy considerations that the IEBC must address when implementing and maintaining the KIEMS kits and the associated voter biometric data. (5 marks)

c) Analyze the factors that contribute to the obsolescence of biometric technologies like the KIEMS kits, and suggest strategies for the IEBC to mitigate these factors in future implementations. (5 marks)

d) Evaluate the cost-effectiveness of replacing the KIEMS kits versus exploring alternative biometric authentication technologies or approaches for voter verification in Kenya. (4 marks)

QUESTION THREE **(20 MARKS)**

Biometric authentication systems, while offering numerous benefits, also raise significant ethical and security concerns. Discuss the following aspects of biometric systems, highlighting the potential issues and challenges associated with each:

a) Ethical Aspects: Misuse, abuse, bias, function creep, and covert deployment. (8 marks).

b) Errors and Attacks: Denial of access, intrusion, repudiation, impersonation, obfuscation, spoofing, hill climbing, master keys, and closed-set versus open-set scenarios.

(12 marks)"

QUESTION FOUR **(20 MARKS)**

a) When designing a biometric authentication system for a particular application, the choice of biometric trait is critical. Enumerate and describe the seven factors that guide the selection of a suitable physical or behavioral trait. (7 Marks)

b) In the design of a practical biometric system, what factors, besides of the chosen biometric trait, must be taken into account? (5 Marks)

c) Draw a well-labelled diagram of a typical biometric system. Then, explain the function of each of its four main modules. (8 Marks)

QUESTION FIVE **(20 MARKS)**

a) For effective deployment of multibiometric systems, several integration strategies are available. Discuss the different types of multibiometric systems and their respective advantages. (4 Marks)

b) Explain in detail the operational principles of both Parallel and Cascade multibiometric architectures. Using diagrams where appropriate, illustrate how each architecture integrates multiple biometric modalities. (10 Marks).

c) Discuss the three levels of fusion that can be employed to integrate multiple biometric systems, and explain the characteristics of each level. (6 Marks).

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