



## FACULTY OF SCIENCE

### ACADEMY OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

<b>MODULE</b>	IT28X07 BIOMETRICS
<b>CAMPUS</b>	AUCKLAND PARK CAMPUS (APK)
<b>ASSESSMENT</b>	JULY 2020

**DATE:** 2020-07

**SESSION:** 08:00 - 10:00

**ASSESOR(S):**

PROF D.T. VAN DER HAAR

**EXTERNAL MODERATOR:**

PROF S. VIRIRI (UKZN)

**DURATION:** 120 MINUTES

**MARKS:** 100

Please read the following instructions carefully:

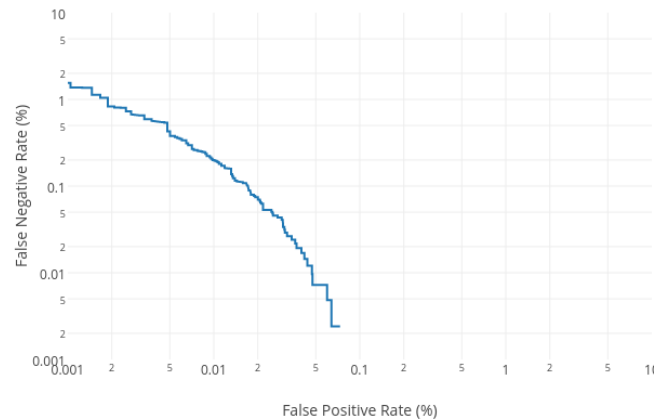
1. This is a time restricted open book assessment. Answer **all** the questions in a text processor or on paper, which is scanned and submitted.
2. Write *cleanly* and *legibly* on any handwritten parts (if applicable).
3. This paper consists of 4 pages.
4. Ensure that your submission to **Eve** is *complete* and done *before* the cut-off time.

## SECTION A - SHORT QUESTIONS

### QUESTION 1

#### *General Biometric Systems*

- (a) Describe two (2) **benefits** of passwords, which biometric-based authenticators do **NOT** share. (4)
- (b) Analyse the following image and answer the questions that follow: (6)



1. What does the image depict? (2)
2. What is the formula for calculating precision? (2)
3. What is the formula for calculating recall? (2)

Total: 10

### QUESTION 2

#### *Fingerprint Recognition*

- (a) Provide the coordinates for **four** examples of bifurcations in the fingerprint binary image below: (4)

	0	1	2	3	4	5	6	7	8	9
0	1	0	1	0	0	0	1	1	1	0
1	1	0	1	0	1	0	1	1	0	0
2	1	1	0	1	1	1	1	0	1	1
3	0	1	1	1	1	1	1	0	0	0
4	1	1	1	0	0	1	1	0	1	0
5	1	1	0	0	1	1	1	1	0	1
6	1	0	0	1	1	0	1	0	0	1
7	1	1	0	1	1	0	1	0	0	0
8	1	1	0	1	1	1	1	1	1	0
9	0	0	1	1	1	0	1	0	0	1

- (b) Briefly describe the capture **process**, along with which **sensors** are used for hand geometry recognition. (4)

Total: 8

### QUESTION 3

#### *Face Recognition*

- (a) List four (4) **face detection class types** that each face detection algorithm can be classified into. (4)
- (b) Analyse the equation below, describe which **method** the following equation relates to, along with the **role** it plays in face recognition: (4)

$$G_c[i, j] = B e^{-\frac{(i^2 + j^2)}{2\sigma^2}} \cos(2\pi f(i \cos\theta + j \sin\theta))$$

Total: 8

### QUESTION 4

- (a) Briefly describe three (3) **limitations** of speaker recognition. (3)
- (b) If audio signal A is  $0.1 \text{ watt/m}^2$  and audio signal B is  $1.2 \text{ watt/m}^2$ , what is its **power difference** (in watts dB)? Secondly, will a human experience **pain** listening to audio signal B? (4)

Total: 7

### QUESTION 5

**Retina** recognition-based biometric systems are known to be accurate and can be used in highly secure environments. Discuss the **process** required to capture a retina sample, along with the **steps** required to process and match a sample. For each step in your discussion be sure to elaborate on the following aspects:

- The sensor that can be used to capture a sample.
- A brief description of the steps followed to process and match a sample.
- The algorithms used at each step.

Total: 8

**QUESTION 6**

For the greyscale pixels below derive the **local binary pattern** (*hint* use the centroid as a threshold) matrix/image (with radius=1, clockwise and zero padding parameters):

$$\begin{bmatrix} 229 & 85 \\ 165 & 64 \\ 216 & 44 \\ 70 & 132 \\ 116 & 50 \end{bmatrix}$$

Total: 10

**QUESTION 7**

*Multi-modal and Pervasive Systems*

- (a) Discuss **decision-level biometric fusion**, along with which methods can be used to achieve it. (4)
- (b) Discuss what **smart textiles** are, along with their potential applications. (4)

Total: 8

**QUESTION 8**

*Biometric Trends and Esoteric Biometrics*

- (a) Discuss **brain wave recognition**, along a brief description on **how** you would implement such a system. (4)
- (b) Provide a reason why **DNA** recognition has not become ubiquitous. (2)

Total: 6

**QUESTION 9**

*Vulnerabilities and Countermeasures*

**Draw** an **attack tree** that highlights the **weaknesses** that will typically be found for a **fingerprint-smart card multimodal access control** system such as the one found at the University of Johannesburg **AND** provide a discussion on two **reasons** why you would want to subvert a biometric system, **ALONG** with two ways to **safeguard** against them.

Total: 10

## SECTION B - LONG QUESTIONS

### QUESTION 10

Following a recent surge of working from home transitions for many companies a company (Company Y) has just released an employment monitoring tool that works using employee smart phones. The application can determine whether you are busy with work sitting on your desk or whether you are busy with non-work activities such as being on social media or playing games. However, an employee who works at a South African company (company W) that uses this monitoring tool has lashed out at this tool and is taking both companies to “the highest court in the land”. Write a report on the following:

- The common criticisms of biometrics.
- The ethical considerations related to biometrics.
- The legal aspects related to biometrics
- Your opinion on whether the companies should be able to use this tool.

Total: 10
-----------

### QUESTION 11

The South African government is doing a review of the passport and they are considering the extension of the current passport to support multiple biometric attributes at the border. However, it is difficult to understand the standards for international station and vendor compliance. Comprehensively discuss **standards** in biometric systems, and your selected **biometric attributes** suitable for passports by paying special attention to the following:

- Examples of standards organisations for biometric systems and the challenges they currently face.
- Your selected biometric attributes for passports, along with a justification
- Advantages and disadvantages of your selected biometrics.
- Your opinion on whether including additional biometrics in passports is warranted.

Total: 15
-----------

— End of paper —