

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination

Course No.: EEE 4871

Course Title: Biomedical Signal Processing

Summer Semester, A. Y. 2022-2023

Time: 3 Hours

Full Marks: 150

There are 3 (three) questions. Answer all 3 (three) questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

- | | | |
|----|---|--------------------------------|
| 1. | a) Explain in detail how ECG captures the electrical activity of the heart. | 10
(CO1, PO1) |
| | b) Explain how through examining ECG important insights (e.g. identifying different abnormalities) can be gained. | 10
(CO1, PO1) |
| 2. | A group of researchers want to identify and locate brain tumors in patients. For this purpose, they took scans through CT and MRI. However, the quality of the images was not very good. So, they needed to take certain image preprocessing steps for better visualization. | |
| | a) At first, they decided to enhance the quality of the images. For this, they selected three different techniques: Contrast adjustment, histogram equalization, and gamma correction.

Discuss the above-mentioned techniques and explain their differences. | 10
(CO2, PO2) |
| | b) Secondly, they wanted to locate the boundary of the tumor. For this, they selected three different techniques: Dynamic thresholding, region growing, and clustering.

Discuss the above-mentioned techniques and explain which one you think would be better suited for this task. | 15
(CO2, PO2) |
| | c) One of the researchers suggested using Neural Network based approaches for segmentation. U-Net is the most popular CNN architecture for image segmentation.

Discuss how it works with proper illustrations. | 10
(CO2, PO2) |
| | d) One of the researchers suggested that edge-detection filters can also be used for this purpose. Discuss the operation of different edge-detection filters and explain how these techniques would fare compared to other segmentation techniques. | 10
(CO2, PO2) |
| | e) After segmenting the ROI, the researchers need to decide the presence of a tumor as well as the severity of the situation. For this purpose, they choose the following quantification techniques: Compactness, Chain codes, and statistical moments.

Explain how these techniques can be utilized for quantification. | 15
(CO2, PO2) |
| | f) Another researcher suggested using other imaging modalities: OCT and PET. Discuss how these two biomedical imaging techniques work and whether they can be used for tumor detection in the brain. | 10
(CO1, PO1) |

- g) MRI is usually regarded as the best biomechanical imaging modality. Explain how it is achieved using MRI.

10
(CO1,
PO1)

3. a) Identify the type of abnormalities present in the following ECGs in Fig. 1. Justify your answer.

15
(CO1,
PO1)



Fig. 1

- b) Explain how different brain-related abnormalities (e.g. sleep apnea, epilepsy) can be identified from EEG.
- c) In order to accurately extract information from ECG or EEG, the signals need to be preprocessed to remove different artifacts and noises. Discuss such signal processing techniques in detail.
- d) For the given matrix below, first apply a median filter (kernel size = 3) followed by a high-pass filter (kernel size = 4). Show the output with relevant calculations.

10
(CO1,
PO1)

15
(CO2,
PO2)

10
(CO2,
PO2)

Input =

32	45	124	22	29	100	100	0
27	26	29	122	24	32	100	0
45	126	18	19	126	100	100	0
100	3	23	44	55	100	100	0
33	126	2	89	56	100	100	0
45	5	124	67	67	100	100	0
32	45	56	122	67	100	100	0
3	4	0	9	120	100	100	0