

**BIOSIGNAL AND BIOMEDICAL IMAGE PROCESSING
(AEIE 6121)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

**Group - A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Electrodes convert the _____ in the tissue to the electronic conduction.
(a) electronic conduction (b) ionic conduction
(c) electric conduction (d) impulsive conduction
 - (ii) The order of the EEG waves related to the amplitudes is _____.
(a) Microvolts (b) Millivolts (c) Pico (d) None of above
 - (iii) EEG is related to the activities of _____.
(a) Nerve fibers (b) Muscles (c) Brain (d) None of above
 - (iv) The Channel that opens up after a stimulus is applied.
(a) Na⁺ (b) K⁺ (c) Both (a) and (b) (d) Ca²⁺
 - (v) The most common form of medical imaging, using high-energy radiation to penetrate skin and tissues but not bone is _____.
(a) X-rays (b) MRI (c) PET (d) Ultrasound
 - (vi) Naïve Bayes' Classifier refers to
(a) Supervised Learning (b) Unsupervised Learning
(c) Reinforced Learning (d) All of the mentioned
 - (vii) Structuring elements run over image's
(a) rows (b) columns
(c) edges (d) every element
 - (viii) Dilation followed by erosion is called
(a) Opening (b) translation
(c) blurring (d) closing
 - (ix) The number of nearby neighbours to be used to classify the new record is _____.
(a) KNN (b) Euclidean Distance
(c) Validation (d) All the above

- (x) Which of the following is required by K-means clustering?
(a) Number of clusters (b) Initial guess as to cluster centroids
(c) Distance metric (d) All of the above.

Group- B

2. (a) What are the stages of a data acquisition system? Show different stages of pre-hospital brain stroke diagnosis from “sensing of a Biosignal to Classification”.
[[CO1] (Remember/LOCQ)]
(b) Explain the operation of the computer tomography (CT).
[[CO2] (Remember/LOCQ)]
(c) What is the basic difference between Goldberger Common Terminal and Wilson’s Central Terminal related to ECG? [[CO1](Remember/LOCQ)]
(2 + 5) + 4 + 1 = 12
3. (a) What is the fundamental difference between MRI and PET?
[[CO2] (Remember/LOCQ)]
(b) An ECG data sequence is given by $x(n) = \{2, 1, -1, 0, 5, -1\}$. Calculate (i) Mean Absolute Value, (ii) Square Integral, (iii) RMS and (iv) Variance (v) Integrated ECG. [[CO1] (Apply /IOCQ)]
2 + 10 = 12

Group - C

4. (a) Apply the 4-point radix-2 DIT-FFT algorithm to find the DFT of the sequence $x(n) = \{1, 1, 1, 1\}$. [[CO3] (Apply/ IOCQ)]
(b) Using Matrix method find the DFT of the sequence $x(n) = \{1, 0, -1, 0\}$.
[[CO3] (Analyze/ IOCQ)]
6 + 6 = 12
5. (a) The transfer function of an analog low pass filter is given by $H_a(s) = \frac{1}{(s^2 + 5s + 6)}$. Convert this analog filter into an IIR digital filter. Take the sample time as 1 second. [[CO3] (Analyze/IOCQ)]
(b) The impulse response of a FIR filter is given by $h(n) = \{1, 2, 4, 3, 1\}$. Develop the structure of this FIR filter using direct-II. Can it be a linear phase filter?
[[CO3] (Create/HOCQ)]
6 + (5 + 1) = 12

Group - D

6. (a) The CT- image data of a patient is obtained as shown below. Apply the Region Splitting algorithm to obtain the segmented image. Assume the threshold value $T \leq 4$, where, $T = (P_{\max} - P_{\min})$, P is the pixel strength.

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

[(CO4) (Apply/IOCQ)]

- (b) What are the ways of Image Morphing? Define dilation and erosion. List the events that may occur when the structuring element is overlapped with the image. [(CO5) (Understand/LOCQ)]

7 + 5 = 12

7. (a) Apply the Split and Merge algorithm to segment the following CT- image data of the chest of a person. Assume the threshold value $T \leq 4$.

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

[(CO4) (Apply/IOCQ)]

- (b) Let X be a MRI image data and Y is a structuring element given in the following diagrams

X	0	0	0	0	0	0
	0	0	1	1	0	0
	0	1	1	1	1	0
	0	0	1	1	0	0
	0	0	0	0	0	0

Y	1
	1
	0

- i) Compute $X \oplus Y$ ii) Compute $X \ominus Y$. [(CO5) (Apply/IOCQ)]

4 + (4 + 4) = 12

Group - E

8. (a) Show the flow chart of K-Means algorithm. [(CO6) (Remember/LOCQ)]
 (b) What is the significance of K in K-Means algorithm? [(CO6) (Remember/LOCQ)]
 (c) Using K-means algorithm and Euclidean distance formula, build two clusters from the following data set.

Patients	Height (m)	Weight (Kg.)
P1	185	72
P2	165	56

P3	195	60
P4	155	68

[(CO6) (Create/HOCQ)]

$4 + 2 + 6 = 12$

9. (a) For the following data set, predict the class for a test data X (Cholesterol=175 units, Blood Sugar level (BSL) = 110 units) using KNN algorithm. Take K=3 and apply Euclidean distance formula.

No. of samples	Cholesterol (units)	BSL (units)	Prediction
1	295	175	positive
2	245	175	positive
3	185	105	negative
4	200	132	positive
5	175	103	negative

[(CO6) (Evaluate/HOCQ)]

- (b) A data set of certain diseased subjects is given below. Decide the class of a test patient X (P = 3 and Q = 7) using the KNN algorithm. Take K= 3 and apply Euclidean distance formula.

No.	P	Q	Class
1	7	7	False
2	7	4	False
3	3	4	True
4	1	4	True

[(CO6) (Evaluate /HOCQ)]

$6 + 6 = 12$

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	26.04%	48.96%	25.0 %

Course Outcome (CO):

After the completion of the course students will be able to

1. Understand acquisition, general properties and clinical applications of biomedical signals such as ECG, EEG, EMG, EP and speech signal.
2. Learn the fundamentals of different modes of 2D and 3D medical imaging, including fluoroscopic, ultrasound imaging, computed tomography and magnetic resonance imaging.
3. Demonstrate advanced knowledge of filtering, transforms and spectral analysis of biomedical signal and images.
4. Apply image processing techniques for enhancement, filtering, segmentation and registration biomedical images.
5. Gain skill set to compress biomedical signals and images using loss less and lossy compression techniques as well as modern compressed sensing technique.

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6. Perform signal analysis and classification using PCA, ICA, LDA, Bay's classifier, KNN and k-means clustering algorithm

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
AEIE	https://classroom.google.com/c/NDA1NjAyNzU0NTE3/a/NDU4Nzk4MDM2MDk5/details