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Question Paper Code : 90387

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

Fifth/Sixth/Eighth Semester

Biomedical Engineering

CBM 342 — BRAIN COMPUTER INTERFACE AND APPLICATIONS

(Common to : Computer Science and Engineering/Electronics and Communication Engineering/Electronics and Telecommunication Engineering/Medical Electronics)

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between invasive, non-invasive, and partially invasive BCIs.
2. Name two common methods used to remove artifacts from EEG data.
3. How sensorimotor related to brain function and movement?
4. Define Visual Evoked Potential (VEP).
5. What is Principal Component Analysis (PCA), and how is it used in feature reduction?
6. What advantages do wavelets offer over traditional Fourier Transform methods for analyzing non-stationary signals?
7. Define vector quantization.
8. What is Gaussian Mixture Modeling (GMM)?
9. How does visual feedback contribute to the control of neuroprosthetic devices?
10. Define Functional Electrical Stimulation (FES).

PART B — (5 × 13 = 65 marks)

11. (a) Explain the techniques used to capture brain signals, including electrode placement and the use of different types of electrodes and the challenges associated with EEG signal acquisition, such as noise and signal variability, and propose solutions to improve the reliability of acquired signals.

Or

- (b) Discuss the importance of signal preprocessing in the context of Brain-Computer Interfaces. Explain the typical preprocessing steps involved, such as filtering, normalization, and feature extraction.
12. (a) Describe the Mu rhythm, including its characteristics, frequency range, and significance in sensorimotor activity and outline the implications of Mu rhythm in BCI applications, particularly in understanding brain states during active and passive movements.

Or

- (b) Illustrate the P300 wave, including its characteristics, eliciting conditions, and significance in cognitive neuroscience and explain the applications of P300 in BCI systems and how it can be used for communication in non-verbal individuals.
13. (a) Explain the Auto-Regressive (AR) model in detail, including its mathematical formulation and how it utilizes past values to predict future values. Discuss its applications in various fields.

Or

- (b) Elucidate on Principal Component Analysis (PCA) and its significance in feature reduction and data analysis. Discuss the mathematical principles behind PCA, including eigenvalues and eigenvectors.
14. (a) Enumerate how LDA is used for classification and its advantages over other classification methods. Also give examples of its application in real-world scenarios such as facial recognition or medical diagnosis.

Or

- (b) Explain how neural networks learn from data using back propagation and gradient descent algorithms.
15. (a) Describe the concept of functional restoration using neuroprosthesis and the technological advancements that have contributed to the development of neuroprosthetic devices and their application in restoring motor functions.

Or

- (b) Define brain-actuated control systems and discuss their significance in neuroprosthetic applications. Explain the methodologies used to interpret brain signals for controlling devices.

PART C — (1 × 15 = 15 marks)

16. (a) (i) Analyze the use of parametric methods in time series analysis. Discuss the various types of parametric models, such as Auto-Regressive (AR), Moving Average (MA), and ARMA models. (10)
- (ii) Evaluate the strengths and weaknesses of using parametric methods compared to non-parametric methods in modeling and forecasting time series data. (5)

Or

- (b) (i) Explain Hidden Markov Modeling (HMM) and its components, including states, observations, and transition probabilities. How HMMs are used to model time series data and sequential patterns, such as in speech recognition or natural language processing? (10)
- (ii) Write the algorithms used for training HMMs, such as the Baum-Welch algorithm, and their effectiveness in various applications. (5)
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