INDIANINSTITUTE OF INFORMATION TECHNOLOGY
DESIGN AND MANUFACTURING (IIITDM) KANCHEEPURAM

COURSE FORMAT

<table>
<tr><td>Course Code</td><td>(to be filled by Office of Acad.)</td><td>Course Title</td><td colspan="4">Brain-Computer Interfaces</td></tr>
<tr><td rowspan="2">Dept./Faculty proposing the course</td><td rowspan="2">Dr Kannadasan K, CSE</td><td rowspan="2">Structure (LTPC)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td rowspan="2">To be offered for</td><td rowspan="2">UG, PG</td><td>Type</td><td colspan="2">Core ☐</td><td colspan="2">Elective ■</td></tr>
<tr><td>Status</td><td colspan="2">New ■</td><td colspan="2">Modification ☐</td></tr>
<tr><td>Pre-requisite</td><td>COT</td><td colspan="3">Submitted for approval</td><td colspan="2">Senate 61</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">• To understand neural signals and their role in Brain-Computer Interfaces (BCI).
• To learn about signal processing and machine learning techniques in BCI system design.
• To learn to develop and explore BCI applications with ethics.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">Upon completion of the course, the students will be able to:
• Summarize the principles and applications of Brain-Computer Interfaces (BCIs).
• Understand and choose appropriate techniques for designing effective BCIs.
• Identify and integrate multidisciplinary technologies for BCI applications.</td></tr>
<tr><td>Contents of the course
(With approximate break-up of hours for L/T/P)</td><td colspan="6">Fundamentals of Brain Activation and Signals: Brain activation patterns: Spikes, Oscillatory potentials, Event-Related Potentials (ERPs), Mu rhythms, Stimulus-related potentials: Visual, Auditory, Cognitive tasks, Overview of brain signals used in BCIs: EEG, MEG, fNIRS, fMRI. (6L)
Types of Brain-Computer Interfaces: Classification of BCI systems: Invasive, Non-invasive, and Hybrid, Characteristics of brain signals for BCI applications, Advantages and limitations of each BCI type, Case studies of successful BCI implementations. (9L)
Signal Processing for BCI Systems: Basics of BCI signal processing, Filtering techniques: Spatial, Temporal, and Spatio-temporal filters, Time and frequency domain analysis, Advanced techniques: Wavelet analysis, Empirical Mode Decomposition, Artifact reduction and signal enhancement, Feature extraction methods. (9L)
Interfacing the Brain and Machine: BCI system hardware: Sensors, Amplifiers, and Signal acquisition systems, Advances in Machine Learning and Deep Learning for BCI classification: ConvNet, BCINet, EEGNet. Brain-to-machine interfacing: Neuro-prosthetics, Cursor control, and Robotic control (9L)
Applications and Emerging Trends in BCIs: Applications of BCIs: Assistive technologies, Neuro-rehabilitation, and Gaming, Advanced applications: Visual cognitive BCIs, Emotion detection systems. Ethical considerations and challenges in BCI development, Future trends: Hybrid BCIs, AI-driven BCIs, and wearable devices (9L)
Practice Component: Preparation of stimuli for event-related potentials and stimulus related potentials. (8P). Signal processing techniques for BCI applications (8P). Classification of signals with deep learning techniques (8P). BCI data collection with case-study (4P)</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Ella Hassianien, A & Azar.A.T, Brain-Computer Interfaces Current Trends and Applications, Springer, 2015, ISBN 978-3319109787
2. Rajesh.P, N.Rao, Brain-Computer Interfacing: An Introduction, Cambridge University Press, First edition, 2013, 978-0521769419</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. Jonathan Wolpaw, Elizabeth Winter Wolpaw, Brain Computer Interfaces Principles and practice, Oxford University Press, USA, Edition 1, January 2012, 978-0199921485
2. Bernhard Graimann, Brendan Allison, GertPfurtscheller, Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction, Springer, 2010, 978-3642020902
3. Pachori, Ram Bilas. Time-frequency analysis techniques and their applications. CRC Press, 2023, 9781032392974.</td></tr>
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