Birla Institute of Technology & Science, Pilani
K K Birla Goa Campus

COURSE HANDOUT (PART II)

Course no. : **BITS F315**

Course title : **Introduction to Cognitive Neuroscience**

Instructor-in-charge : **VEEKY BATHS**

Overview: The subject of cognitive neuroscience is, in a broad sense, the human mind. Cognitive neuroscience helps to understand how the human brain supports thought, perception, affection, action, social process and other aspects of cognition and behavior. Questions about the mind are studied from different scientific perspectives in philosophy, linguistics, psychology, neuroscience, and computer science. Cognitive Neuroscience is an interdisciplinary approach to understand the neural substrates of mental processes. It is a broad area where insights from psychology, neurobiology, bioengineering, physics, computer science, linguistics, mathematics and philosophy find relevance. This course will introduce the students to the methods of Cognitive Neuroscience and will prepare students to address exciting problems in the field.

Outline & Learning Objective: This course aims to cover the methods and approaches used to investigate the workings of the mind. The objective is to introduce basic cognitive processes including perception, attention, learning, memory and language. Experimental findings and theories regarding cognitive processes will be discussed in the course. Students will also learn how to record and analyze EEG/ERP using the 32 channel EEG/ERP system. Each student will be required to record and analyze one subject's data on any one of the available experiments.

Textbook:

1. *Gazzaniga, M.S., R.B. Ivry & G.R. Mangun. Cognitive neuroscience: the biology of the mind (4^{th} ed., New York: Norton, 2008). ISBN: 978-0-393-11136-1.*

References:

1. Ward, J. The student's guide to cognitive neuroscience (Hove: Psychology Press, 2006). ISBN: 1-84169-535-1.

2. BERNARD J.BAARS & NICOLE M.GAGE: COGNITION, BRAIN, AND CONSCIOUSNESS, Introduction to Cognitive Neuroscience Second Edition

3. MICHAEL W. EYSENCK and MARK T. KEANE: COGNITIVE PSYCHOLOGY A Student's Handbook, Sixth Edition

Lecture Plan & List of key topics to be covered:

No.	Topic	No. of Lectures
1	• **Introduction:**Introduction to Cognitive Neuroscience,The Brain Story, The Psychological Story, Philosophy of Mind and cognition	2L
2	• **Methods of Cognitive Neuroscience:** Cognitive Psychology and Behavioral Methods, The Marriage of Function and Structure: Neuroimaging, Brain Graphs,Computer Modeling, EEG,fMRI	4L
	• **Neuroscience-Inspired Artificial Intelligence:** How AI and Neuroscience drive each other.	2L
3	• **The Neuroscience of Happiness and Wellbeing:** Subjective well being, Satisfaction with Life Scale, Hedonic hotspots, Hug- There's Neuroscience to prove it's good for you, Enhancing your Happiness level and leading a life of happiness and fulfillment. **Case Study: Mental Health Awareness and Psychodrama**	3L

4	• **Artificial Intelligence and Neuroimaging:** Introduction: Basics of AI and Neuroscience, Neuroscience inspired artificial working memory in humans, Understanding the working of brain's systems through neuroimaging (MRI, EEG, PET, fMRI, etc.), Decoding AI models to understand brain atrophy: current trends and techniques of Machine learning, Deep Learning models and Graph neural networks, Analyzing and extracting features of the neuroimaging data using Explainable AI (XAI) techniques, Recent developments and future works in the field. **EEG Lab I**	4L
5	• **Brain Computer Interface and Pervasive Healthcare:** Eyetracking, Virtual reality, Augmented reality Brain Computer Interface, BCI as IoT and its application in remote health monitoring, Brain fringerprinting,Signal Processing algorithm, Data Processing, Feature Extraction, Feature Classification **EEG Lab II**	4 L
6	• **Meomory** : The Anatomy of Memory, Memory Deficits: Amnesia Mechanisms of Memory, Imaging Human Memory, Memory Consolidation, Cellular Basis of Learning and Memory, Working memory: classical research on short-term memory.	3L
7	• **Emotions:** What Is an Emotion? Neural Systems Involved in Emotion Processing, Categorizing Emotions, Theories of Emotion Generation, The Amygdala Interactions Between Emotion and Other Cognitive Processes, Get a Grip! Cognitive Control of Emotion, Emotional disorders	3L
8	• **Psycholinguistics:** History, Language structure, Psycholinguistics and cognitive science, The Fundamentals of Language in the Human Brain, Language Comprehension ,Neural Models of Language Comprehension ,Neural Models of Speech Production, eye tracking , EEG and fMRI evidences in language production, Connectionist models of speech perception, eye movements in visual word recognition ➢ **Research paper discussion**	3L +1P

9	• **Network Neuroscience:** Introduction to Network Neuroscience, Simple measures to characterize network structure, From EEG to graphs, Networks of the Brain: Quantitative Analysis and Modeling, Centrality measures and hubs, relation between Network structure and function and its application to Mental health and Neuroscientific data. • **Research paper discussion**	5L
10	• **Consumer Neuroscience:** Secrets for selling to the subconscious mind, The neuromarketing toolbox, emotions and feelings, Wanting, Liking and Deciding, Neuroeconomics of individual and collective decision making from cellular to behavioural levels. Sentiment analysis **Research Paper discussion**	4L +1P
11	• **AR/VR/AI Solutions for dementia care:** Detection of irregularities in brain functioning by VR games based on movement, reaction, short-term memory, etc Games to hone your Spatial Memory, Facial Recognition, etc. Dozens of AR and VR games focused on increasing brain's activity and improve a particular ability.	3L +1P
12	• **Social Cognition:** Anatomical Substrates of Social Cognition, Know Thyself Theory of Mind: Understanding the Mental States of Others, Social Knowledge • **Research Paper discussion**	2L
13.	• **Introductory Psychology:** Course introduction, syllabus review, Psychology as a profession and a science, States of Consciousness, Biological Basis of Behaviour, Intelligence : Views of its nature, measuring intelligence; Emotional Intelligence, The Psychoanalytic Approach; Humanistic theories; Trait theories; Learning Approaches to Personality	5L

Evaluation Scheme:

Components	Duration	Weight (%)	Date	Remarks
Mid Sem Examination	1.5 hour	30	13/10/2023	Closed book
Assignment/Yoga Project/paper discussion	Variable	30	To be announced (TBA) in the class	TBA in the class
Comprehensive Examination	3 hours	40	11/12/2023	Closed and/or open book

Chamber consultation hours:

To be announced in the class.

Grading policy:

Grades would be awarded as per the institute guidelines. Decision for borderline cases would be based also on the student's sincerity and his/her participation in classroom activities.

Make-up policy:

You may apply for make-up only if you miss any of the evaluation components due to serious medical emergency for which a valid proof would have to be produced. However, the final decision would rest with the instructor team. Make-up for quizzes, assignments and seminars will not be given.

Notices:

Will be announced in classroom.