PhD Entrance Syllabus in Cognitive Science

Unit 1. Foundations of Cognitive Science

- Definition & Scope: Interdisciplinary nature (psychology, neuroscience, linguistics, AI, philosophy)

- Historical Overview: Behaviorism to cognitive revolution; key figures (Miller, Chomsky, Neisser)

- Major Paradigms: Symbolic, connectionist, embodied, enactive, extended mind

- Applications: Education, HCI, clinical neuropsychology

Unit 2. Research Methods & Experimental Design

- Philosophy & Ethics: Falsifiability (Popper), paradigms (Kuhn); ethics, consent

- Designs: True/quasi-experiments; within/between-subjects; factorial/mixed designs

- Data Collection: Behavioral (reaction time, eye/mouse-tracking), EEG/ERP, fMRI, PET, MEG

- Analysis: Descriptive/inferential stats (t-tests, ANOVA, regression), qualitative methods

- Tools: PsychoPy, E-Prime, OpenSesame; Python/R; Git/GitHub

Unit 3. Perception and Attention

- Visual: Feature detection, Gestalt principles, object recognition (Biederman's RBC)

- Auditory: Spectral vs. temporal processing; speech perception models (TRACE vs. cohort)

- Multisensory: McGurk effect, temporal binding

- Attention Theories: Broadbent, Treisman, Load theory

- Phenomena: Attentional blink, change blindness, dual-task performance

- Neural Networks: Dorsal vs. ventral attention systems

Unit 4. Memory and Learning

- Working Memory: Baddeley & Hitch model; Cowan's embedded processes

- Long-Term Memory: Episodic, semantic, procedural; consolidation

- Forgetting: Decay, interference, false memories (Loftus)

- Learning: Classical & operant conditioning; observational learning

Unit 5. Language and Cognition

- Psycholinguistics: Lexical access, parsing, speech production

- Acquisition: Critical period; first vs. second language; statistical learning

- Neurolinguistics: Broca's/Wernicke's aphasias; split-brain studies

- Pragmatics: Speech acts, Gricean maxims, implicature

Unit 6. Decision-Making and Executive Function

- Judgment & Choice: Expected Utility, Prospect Theory; framing effects

- Heuristics & Biases: Availability, representativeness, confirmation bias

- Problem Solving: Means-ends analysis; insight vs. analytic; creativity

- Cognitive Control: Inhibition, task-switching, working-memory updating

Unit 7. Computational Modeling & AI

- Symbolic vs. Connectionist: Production systems; neural networks/backpropagation

- Bayesian Models: Probabilistic inference; predictive coding

- Reinforcement Learning: Model-free vs. model-based; reward prediction error

- Cognitive Architectures: ACT-R, SOAR, CLARION

Unit 8. Cognitive Neuroscience

- Neural Fundamentals: Neuron structure; action potentials; neurotransmitters

- Brain Systems: Lobes & networks (default-mode, executive, salience)

- Techniques: EEG/ERP (P300, N400); fMRI BOLD; TMS/tDCS

- Development & Plasticity: Critical periods; synaptic pruning; LTP

Unit 9. Social and Developmental Cognition

- Theory of Mind: False-belief tasks; neural correlates

- Social Influence: Conformity, obedience, group dynamics

- Development: Piagetian & neo-Piagetian; Vygotsky's sociocultural theory

- Comparative Cognition: Animal studies of learning, memory, problem-solving

Unit 10. Human–Computer Interaction & Applied Cognitive Science

- UX Principles: Cognitive load, mental models, affordances

- Usability Testing: Heuristics, think-aloud, eye-tracking

- Assistive Tech: Brain–computer interfaces; cognitive prosthetics

- Education: Cognitive tutors; serious games; adaptive learning systems

Unit 11. Philosophy of Mind & Ethics

- Positions: Dualism, functionalism, identity theory, emergentism

- Consciousness: Qualia, global workspace theory; neural correlates

- Extended Mind: Clark & Chalmers thesis; sensorimotor contingencies

- Ethics: Neuroethics; cognitive enhancement; AI and privacy

Unit 12. Emerging Topics in Cognitive Science

- Embodied & Enactive Cognition

- Neuroeconomics & Decision Neuroscience

- Cultural & Cross-linguistic Cognition

- Big Data & Cognitive Informatics