

COGNITIVE SCIENCE

Cognitive science has emerged in the last few decades as a major discipline that promises to be increasingly important in the 21st century. It focuses on the study of intelligent systems, both real and artificial. Cognitive science is the empirical study of intelligent systems, including the human mind. It is an interdisciplinary science, which combines results from neuroscience, computer science, linguistics, mathematics, philosophy and psychology to the study of language processing, perception, action, learning, concept formation, inference and other activities of the mind with applications for information technology and the study of artificial intelligence. A Cognitive Science graduate, skilled in the analysis of cognitive and decision-making processes, is well-prepared for a rewarding professional future.

Semester 1

Semester 2

Studies in Cognitive Sciences

Semester 3

1. Foundations of Cognitive Science

This course provides an introduction to the study of intelligence, mind and brain from an interdisciplinary perspective. It encompasses the contemporary views of how the mind works, the nature of reason, and how thought processes are reflected in the language we use. Central to the course is the modern computational theory of mind and it specifies the underlying mechanisms through which the brain processes language, thinks thoughts, and develops consciousness.

2. Biological Basis of Behavior

Biopsychology is focused on the structure and function of the nervous system. This course will provide the foundation for understanding the biological basis of behavior. It will cover the perspectives, questions, and techniques of neuroscience, brain cell structure and function, neural communication, neurotransmitters, neurological disorders and treatment, brain development, and neural systems responsible for motivation, learning, emotion, stress, sleep, sensation, perception, and consciousness.

3. Research Methods and Statistics in Psychology

The objective of the course is to equip students with advanced training in research methods and professional skills. Students can apply theoretical knowledge to analyze

practical problems and develop hypotheses, understanding dynamics of sampling and data analyses for conducting research and writing the report.

4. **Maths 1 (calculus, linear algebra)**

This course will focus on providing an introduction to calculus and linear algebra. The focus will be on introduction to concepts which are useful for understanding and developing algorithms for Natural Language Processing, Machine Learning, etc.

Semester 4

1. **Philosophy of Mind and Psychology**

This course covers topics such as the mind-body problem, consciousness, the recognition that others have minds, reasons as causes, individuality, rationality, emotions, freedom of will and a host of related issues.

2. **Foundations of Cognitive Neuroscience** (*one unit of the course will be on Artificial Neural networks*)

This course represents an exciting synthesis of behavioral neurology and cognitive neuroscience. It is a subfield of neuroscience that studies the biological processes that underlie human cognition, especially in regards to the relation between brain structures, activity and cognitive functions.

3. **Fundamentals of Cognitive Psychology**

Cognitive psychology is the study of how we sense and interpret information from the world around us, incorporate this new information with our prior experiences, and determine how to respond to an ever-changing environment. While the main purpose of this course is to introduce you to the scientific study of the mind, you will also begin to understand the central role cognition plays in our everyday lives.

4. **Introduction to Programming and Algorithms**

This course will provide an understanding of the fundamentals of programming. The focus will be on object-oriented programming, like Python or Java. The course will also focus on introducing students to open source programming tools including cloud-based tools. Second part of the course will focus on algorithms and their implementation. The algorithms will aim at providing an insight into various algorithms.

Semester 5

1. **Introduction to Linguistics**

This course will give students an overview of the field of modern linguistics and basic skills in linguistic analysis. It also investigates how languages are learned and how they change over time. As language is involved in a large number of human activities, linguistics contributes to many other fields of inquiry, including anthropology, psychology, philosophy, law and the natural sciences.

2. Visual Cognition

This course treats basic image capturing methods, perceptual organization, depth and categorization. This course will be built around contemporary research on vision to give an overview of cognitive processes in general. Furthermore, the course deals with visual perceptual learning, attention and gaze control.

Elective (I): Two to be chosen

- **Mathematical Methods for Cognitive Science**

The course will start with an introduction to linear algebra (already completed under **Maths 1** course), and further introduce to the students various tools and mathematical models for regression analysis, Principal Component Analysis, basics of probability and statistics, hypothesis testing, bootstrapping, estimation and decision theory, classification, clustering, time series analysis, information theory.

- **Culture and Cognition**

This course is about the study of the relationship between human culture and human cognitive capabilities. Cultural learning allows humans to build on existing knowledge and make collective advancements.

- **Learning and Memory**

The goal of this course is to understand theories about how human beings learn (encode), store, and retrieve (remember) all of the amazing things we are able to remember. To do this (and to gain historical perspective), we will discuss the research experiments which led to these theories, including extensive research with animals.

- **Image Processing and Computer Vision**

This course will help students understand how a computer ‘sees’ and ‘understands’ an image. The processing of images; eg, generating various effects in images and preparing them for further processing. The course will also help students to use tools to apply machine learning algorithms to identify and classify objects in images.

Semester 6

1. Introduction to Natural Language Processing

This course will introduce the concepts of natural language processing through computers. The course will help students to understand how a computer acquires and comprehends the language. The fundamental mathematical models for modeling of languages, how computers translate between languages. The course will have a corresponding laboratory component where students will be asked to develop task specific programs.

2. Computational Cognition

This course will introduce the computational principles underlying cognition. The course will explore as to how human beings perform their activities based on psychological mechanisms, processes, and knowledge structures. It will cover various computational models for representations, mechanisms, and processes and focus on cognition in terms of computer algorithms and programs. The course will introduce the neural network based cognitive models.

Elective (II): One to be chosen

- **Introduction to Formal Logic**

This course introduces students to the fundamentals of formal logic. Formal logic aims to represent certain aspect of human thinking in abstract terms, allowing us to manipulate abstract, symbolic structures and to construct proof of validity. Students will learn the fundamentals of categorical, propositional, and predicate logic. Categorical (*or* Syllogistic) logic is the study of arguments whose constituent sentences express certain relations between classes. Propositional (*or Boolean*) logic, lies at the foundation of modern computer systems, and it is the study of sentence-connecting expressions that in ordinary language like and, or, and not. Finally, predicate (*or first-order*) logic is the study of arguments that depend on predication and quantification. Students will develop the ability to (a) represent thinking formally through rigorously defined symbolic language standing variety of class of natural language sentences (b) evaluate each language via mathematical models.

- **Judgement and Decision Making**

This course examines the psychology of human decision making and judgment. How do we make judgments? What influences our choices? It will cover basic models and strategies of decision making and look at applications of these models in a variety of fields, including consumer choice, medicine, law and many others. It also covers the systematic flaws observed in people's actual decisions, the uniquely psychological factors that influence decision-making (e.g., emotion), and the neural systems that underlie the decisions of both humans and non-human animals.

- **Cognitive Disorders**

This course will help students to understand different categories of mental health disorders that primarily affect learning, memory, perception, and problem solving, and include amnesia, dementia, and delirium.

Layout plan for Cognitive Science Major

Semester	Course	Credits	Remarks
3	Foundations of Cognitive Science	4	Core Courses
	Biological Basis of Behavior	4	
	Research Methods and Statistics in Psychology	4	
	Maths 1	4	
4	Philosophy of Mind and Psychology	4	Core Courses
	Foundations of Cognitive Neuroscience	4	
	Fundamentals of Cognitive Psychology	4	
	Introduction to Programming and Algorithms	4	
5	Introduction to Linguistics	4	Core Courses
	Visual Cognition	4	
	Mathematical Methods for Cognitive Science	4	Elective Courses. Students must choose any <u>two</u> .
	Culture and Cognition	4	
	Learning and Memory	4	
	Image Processing and Computer Vision	4	

6	Introduction to Natural Language Processing	4	Core Courses
	Computational Cognition	4	
	Introduction to Formal Logic	4	Elective Courses. Students must choose any <u>one</u> .
	Judgement and Decision Making	4	
	Cognitive Disorders	4	

* The structure can be decided by the central course committee. The structure marked in this table is only for those courses where Tutorial (**T**) and Practicals (**P**) must be necessarily part of the course.

Course Coordinator: Dr. Santha Kumari (SHSS)

Cognitive Science Minor

	Psychology Major & Cognitive Science Minor	Other Majors
Semester 3	Foundation of cognitive Science	Biological Basis of Behaviour
	Maths1	Research Methods & Statistics
Semester 4	Philosophy of Mind and Psychology	Fundamentals of Cognitive Psychology
	Introduction to Programming and Algorithms	Introduction to Programming and Algorithms
Semester 5	Introduction to Linguistics	Introduction to Linguistics
	Visual Cognition	Visual Cognition