NS6002: ADVANCED COMPUTATIONAL NEUROSCIENCE

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Advanced Computational Neuroscience

Subject Code
NS - Neuroscience
Course Number
6002

Academic Unit
Neuroscience (NS)

College/School
College of Biomedicine (BD)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

Brain computing is vital to understanding various brain functions and phenomena. Thanks to the development of different numerical techniques, computational models, and experimental discoveries, the investigation of computational aspects in Neuroscience has become possible. This course aims to promote the awareness of computational aspects in Neuroscience. Prior experience in computer languages is not necessary in this course. Topics covered in this course include computational models for ion channels, models for synapses, models for neurons, descriptive models, neural coding, information theory, and analysis of neural data. In addition, implementations of computational models and analytic techniques will be exercised.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Promote awareness of the computational aspects of Neuroscience	25	x		
2	Gain fundamental knowledge of computational models for neural systems	50	x	x	x
3	Able to apply modern machine learning techniques to analyze neural data	25	x	x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	The primary form of teaching; Systematic presentation of class content	1, 2, 3	
2	Projects	Learning and practicing computing tools for computational models and data analysis; Initiating discussion among students and encouraging explorations in computational studies; Report the results in a journal-article format	1, 2, 3	
3	Presentation	Give presentations of the project results; The presentation session will be conference-like	1, 2, 3	

4	Hand-in Assignment	Helping the students to check their understanding of class content continuously	2, 3	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Lab Assignments	2, 3	15	
2	Presentation	1, 2, 3	10	
3	Midterm Examination	1, 2, 3	35	
4	Final Project	1, 2, 3	40	

Continuous Assessment (%)

100

Assessment Rubrics (AR)

Assessment Task

Lab Assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Based on the submitted assignment, evaluate whether the students can understand the concepts of the models and skills they learned in lessons.

Excellent

(A+, A, A-) The student submits the clearly written lab assignment without errors.

Good

(B+, B, B-) The student submits the clearly written lab assignment with minor errors.

Fair

(C+, C, C-) The student submits the written lab assignment with some errors.

Marginal

(D) The student submits the written lab assignment with significant errors.

Failure

(F) The student fails to submit the lab assignment. Or the student submits a partially finished assignment with significant errors.

Assessment Task

Presentation (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Able to show the origination of the knowledge and concept involved in the computational project.

Excellent

(A+, A, A-) The student gives a systematic presentation of the results and responds appropriately to queries from audience classmates.

Good

(B+, B, B-) The student gives a moderate presentation of the results and responds acceptably to queries from audience classmates.

Fair

(C+, C, C-) The student gives a basic presentation of the results and responds partly to queries from audience classmates.

Marginal

(D) The student gives a basic presentation of the results and fails to respond to queries from audience classmates.

Failure

(F) The student fails to give a presentation of the results and fails to respond to queries from audience classmates.

Assessment Task

Midterm Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Able to show an understanding of concepts and applications of numerical methods and models.

Excellent

(A+, A, A-) Students achieve a 86% or greater on the examination.

Good

(B+, B, B-) Students achieve a 65% or greater on the examination.

Fair

(C+, C, C-) Students achieve a 50% or greater on the examination.

Marginal

(D) Students achieve a 40% or greater on the examination.

Failure

(F) Students achieve less than 40% on the examination.

Assessment Task

Final Project (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Able to show an understanding of concepts and applications of numerical methods and models to solve given problems

Excellent

(A+, A, A-) The students solved the problems properly and submitted a well-written report without errors.

Good

(B+, B, B-) The students solved the problems properly and submitted a well-written report with minor errors.

Fair

(C+, C, C-) The students solved the problems in the correct direction and submitted a well-written report with some errors.

Marginal

(D) The students partially solved the problems and submitted a basic report with some errors.

Failure

(F) The students failed to solve the problems or submit a report.

Assessment Task

Lab Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Based on the submitted assignment, evaluate whether the students can understand the concepts of the models and skills they learned in lessons.

Excellent

(A+, A, A-) The student submits the clearly written lab assignment without errors.

Good

(B+, B) The student submits the clearly written lab assignment with minor errors.

Marginal

(B-, C+, C) The student submits the written lab assignment with some errors.

Failure

(F) The student fails to submit the lab assignment. Or the student submits a partially finished assignment with significant errors.

Assessment Task

Presentation (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Able to show the origination of the knowledge and concept involved in the computational project.

Excellent

(A+, A, A-) The student gives a systematic presentation of the results and responds appropriately to queries from audience classmates.

Good

(B+, B) The student gives a moderate presentation of the results and responds acceptably to queries from audience classmates.

Marginal

(B-, C+, C) The student gives a basic presentation of the results and responds partly to queries from audience classmates.

Failure

(F) The student fails to give a presentation of the results and fails to respond to queries from audience classmates.

Assessment Task

Midterm Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Able to show an understanding of concepts and applications of numerical methods and models.

Excellent

(A+, A, A-) Students achieve a 86% or greater on the examination.

Good
(B+, B) Students achieve a 65% or greater on the examination.

Marginal
(B-, C+, C) Students achieve a 50% or greater on the examination.

Failure
(F) Students achieve less than 40% on the examination.

Assessment Task
Final Project (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Able to show an understanding of concepts and applications of numerical methods and models to solve given problems

Excellent
(A+, A, A-) The students solved the problems properly and submitted a well-written report without errors.

Good
(B+, B) The students solved the problems properly and submitted a well-written report with minor errors.

Marginal
(B-, C+, C) The students solved the problems in the correct direction and submitted a well-written report with some errors.

Failure
(F) The students failed to solve the problems or submit a report.

Part III Other Information

Keyword Syllabus
Neuronal Models, Synaptic Models, Neuronal Network, Neural Coding, Information Theory, Analysis of Neural Data.

Reading List

Compulsory Readings

	Title
1	Nil. All necessary materials will be provided.

Additional Readings

	Title
1	Dayan, P., & Abbott, L. (2014). Theoretical neuroscience: Computational and mathematical modeling of neural systems. MIT Press.
2	James V Stone. (2018). Principles of Neural Information Theory. Sebtel Press.