Subject Description Form

Subject Code	DSAI5203
Subject Title	Brain-inspired Computing
Credit Value	3
Level	5
Pre-requisite/ Co- requisite/ Exclusion	Knowledge in linear algebra, calculus, and python programming is required.
Objectives	The subject is aims to provide a multidisciplinary study on neuroscience and computing, enabling students to understand the fundamentals of brain function and apply them to design innovative computing systems. It will primarily focus on exploring the computational principles, models, hardware systems, and applications derived from the human and animal brains.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Understand the operating principles and models of biological neurons b. Understand the learning algorithms underpinning neural computation c. Understand the principles and models for visual systems, auditory system, motor system, and memory system, etc. d. Familiar with the neuromorphic computing hardware and systems e. Familiar with the techniques for brain-signal analysis and able to apply them to analyze and interpret brain signals f. Able to design brain-inspired model and systems to solve real-world pattern recognition problems
Subject Synopsis/ Indicative Syllabus	**1. Fundamentals of Neural Computation** - Spiking Neuron Models and Neuronal Dynamics - Artificial Neural Networks - Learning Algorithms for Biological and Artifical Neural Networks **2. Brain-Signal Analysis and Neural Decoding** **3. Cognitive Computing** - Sensory and Motor System (visual system, auditory system, brain control of movement, etc.) - Memory and Learning System **4. Neuromorphic Computing Hardware and Systems** - Neuromorphic sensors: silicon retina, silicon cochlea, silicon nose, etc. - Neuromorphic chips: TrueNorth, Spinnaker, Loihi, Tianjic, etc.

<table>
<tr>
<td>Teaching/Learning Methodology</td>
<td>
1. Lectures and Seminars

The concepts and introductions on brain-inspired computing will be given via lectures. There will be in-class activities (e.g., discussions and exercises) to better engage students in active learning.

2. Labs and Tutorials

Hands-on experience will be given via labs and tutorials to reinforce the concepts learned and gain practical skills in brain-signal analysis and brain-inspired computing.

39 hours of class activities including - lectures, tutorials, lab, and seminars where applicable.
</td>
</tr>
<tr>
<td>Assessment Methods in Alignment with Intended Learning Outcomes</td>
<td>
The relative weighting of the different assessment components are as follows:
<table>
<tr><td rowspan="2">Specific assessment methods/ tasks</td><td rowspan="2">% weighting</td><td colspan="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td></tr>
<tr><td>1. Quiz</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Assignment</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Exam</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Continuous assessments consist of a project, assignments, and quizzes, which are designed to facilitate students to achieve intended learning outcomes. The project is designed to enhance students’ ability to acquire the understanding and using different knowledge, principles, techniques, tools to solve a real problem through team. Assignments and quizzes are to ensure the students understand the concepts.

Examination will evaluate student’s understanding and usage of brain-inspired computing.
</td>
</tr>
<tr>
<td rowspan="5">Student study effort expected</td>
<td>Class Contact:</td>
<td></td>
</tr>
<tr>
<td>Class Activities (lectures, seminars, labs, tutorials)</td>
<td>39 Hrs.</td>
</tr>
<tr>
<td>Other student study effort:</td>
<td></td>
</tr>
<tr>
<td>Self-study, Exercises, Assignments, Quizzes, Exams</td>
<td>66 Hrs.</td>
</tr>
<tr>
<td>Total student study effort</td>
<td>105 Hrs.</td>
</tr>
</table>

Reading list and References	1. Gerstner, Wulfram, et al. Neuronal dynamics: From single neurons to networks and models of cognition. Cambridge University Press, 2014. 2. Bear, Mark, Barry Connors, and Michael A. Paradiso. Neuroscience: exploring the brain, enhanced edition: exploring the brain. Jones & Bartlett Learning, 2020. 3. Research papers and articles selected from: - Nature - Science - IEEE Transactions on Pattern Analysis and Machine - IEEE Transactions on Neural Networks and Learning Systems - AI Conference (NeurIPS, ICML, ICLR, AAAI, IJCAI, etc.)