Subject Description Form

Subject Code	AMA564
Subject Title	Deep Learning
Credit Value	3
Level	5
Pre-requisite / Co-requisite/ Exclusion	N.A.
Objectives	The objective of this course is to equip students with the mathematical foundations and practical skills of deep learning, a core subfield of artificial intelligence. The curriculum will cover mathematical foundations of deep neural networks, key deep neural network architectures and training algorithms, computational tools, and real-world applications, emphasizing both the theoretical foundations and problem-solving skills in dynamic environments.
Intended Learning Outcomes *(Note 1)*	Upon completion of the subject, students will be able to: a) Understand the mathematical foundations of deep learning. b) Demonstrate mastery of the principles of machine learning and deep learning with mathematical theories. c) Develop quantitative skills of deep learning and interpret the outcomes of deep learning algorithms. d) Identify, define, and formulate problems of deep learning in real applications and generate workable solutions to problems.
Subject Synopsis/ Indicative Syllabus *(Note 2)*	Key topics to be delivered: a) The development history of deep learning. b) Mathematical foundations of deep neural networks: linear algebra, universality of neural networks, various loss functions. c) Fully connected neural networks. d) Optimization algorithms: backpropagation, stochastic gradient descent and its variants. e) Convolutional neural networks: architecture, mathematical understandings, and applications. f) Recurrent neural networks: architecture, autodifferentiation, and applications. g) Generative models: understanding VAE, GAN, Diffusion models from the statistical point of views and their applications. h) Preliminary Statistical Learning Theory: bias-variance trade-off; VC

<table>
<tr><td></td><td>dimension; AUC scores.
i) A brief introduction of large language model.</td></tr>
<tr><td>Teaching/Learning Methodology

(Note 3)</td><td><u>Lectures:</u>
Introduce deep learning theory, algorithm derivations, and industry applications, with a focus on mathematical foundations and technical frameworks.

<u>Tutorials:</u>
Hands-on coding sessions and group discussions on case studies, using real-world datasets and simulation environments (e.g., Pytorch).</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes

(Note 4)</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="4">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td></tr>
<tr><td>1. Project</td><td>30</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Assignments</td><td>20</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></tr>
<tr><td>Total</td><td>100 %</td><td colspan="4"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

<u>Project:</u>

Training students’ ability to organize learned algorithms for real problems, and skills of presentation

<u>Assignments</u>

Assignments covering foundational concepts, algorithms, and applications, enhancing students’ understanding of core concepts and algorithms and application of deep learning.

<u>Exam</u>

Written assessment for students’ understanding of mathematical foundations, algorithms, and applications covered over the whole semester.</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>26 Hrs.</td></tr>
<tr><td>▪ Tutorial</td><td>13 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Self-learning from reference materials</td><td>40 Hrs.</td></tr>
<tr><td>▪ Reading and research for the case study</td><td>40 Hrs.</td></tr>
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	Total student study effort	119 Hrs.
Reading List and References	Textbooks: Goodfellow I., Bengio Y., Courville A. Deep Learning, The MIT Press, 2016 References: 1. Francois Chollet with J. J. Allaire, Deep Learning with Python Manning Publications Co.2018. 2. Hastie, T., Tibshirani, R, and Friedman, J. The Elements of Statistical Learning, Springer 2009. 3. Mohri, M., Rostamizadeh, A., & Talwalkar, A Foundations of Machine Learning The MIT Press, 2018. 4. Bubeck, S., Convex optimization: Algorithms and complexity, Now Publishers Inc. 2015.	