Subject Description Form

Subject Code	AAE4011
Subject Title	Artificial Intelligence in Unmanned Autonomous Systems
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	**Pre-requisite:** AAE4301 Avionics Systems
Objectives	This subject will provide students with 1. The main concepts, ideas, and techniques of advanced artificial intelligence (AI) in unmanned autonomous systems, e.g. unmanned aerial vehicles (UAV), unmanned ground vehicles (UGV); 2. The major components of typical unmanned autonomous systems fulfilling a certain function, such as environment inspection using UAVs; and 3. Expansive view into the technological trend of AI and its application in unmanned autonomous systems.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Apply AI algorithms or adopt AI tools in solving engineering problems in unmanned autonomous systems; b. Understand the relationship between multiple functions of unmanned autonomous systems, including perception, path planning, decision making, and control; c. Design partial of the functions of typical unmanned autonomous systems, such as positioning, and path planning; and d. Improve the existing AI algorithms to specific unmanned autonomous systems applications.
Subject Synopsis/ Indicative Syllabus	**Introduction to Artificial Intelligence**: The topic mainly includes the basic knowledge of machine learning such as conventional classification and regression together with high-level AI, such as convolutional neural network (CNN) for image segmentation. **Introduction to Unmanned Autonomous Systems**: The topic mainly includes the major existing applications of unmanned autonomous systems, such as UAV and UGV. Meanwhile, the topic will include the basic knowledge of typical unmanned autonomous systems. **Optimization Algorithm to Unmanned Autonomous Systems**: The topic mainly includes the optimization algorithms such as Gauss-Newton used to solve the engineering problems related to unmanned autonomous systems. **Sensors for Unmanned Autonomous Systems**: The topic mainly introduces the typical sensors applicable to unmanned autonomous systems. The sensors include the light detection and ranging (LiDAR), inertial measurement unit (IMU), and camera. Basic algorithms for sensors-based positioning will be introduced.

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<u>Navigation for Unmanned Autonomous Systems</u>: The topic mainly include positioning and navigation for the unmanned autonomous system using simultaneous localization and mapping (SLAM) using LiDAR sensors together with point cloud processing, registration,

<u>AI-aided Navigation for Unmanned Autonomous Systems</u>: The topic mainly includes the application of AI in LiDAR SLAM using object detection in unmanned autonomous systems.

<u>Case Study (mini-group projects)</u>: A design project will be carried out for students to learn the deployment of AI in unmanned autonomous systems through practice.

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<tr><td>Teaching/Learning Methodology</td><td>

Teaching is conducted through lectures and case studies (mini-group projects). Lectures are used to deliver advanced knowledge concerning various aspects of AI, data analysis, and its applications in unmanned autonomous systems The basic knowledge, research methodology, and theoretical models will be introduced. Case study will provide the understanding of how to address and formulate problems by using mathematical programming, artificial intelligence algorithms, and optimization techniques in unmanned autonomous systems.

Research methodology, data analytics skills, and algorithm design skills are taught in class as well as the related real-life scenarios using data to enhance their research abilities.

<table>
<tr><td rowspan="2">Teaching/Learning Methodology</td><td colspan="4">Intended subject learning outcomes to be covered</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td></tr>
<tr><td>1. Lecture</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Case Study</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
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<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</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</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td></tr>
<tr><td>1. Homework assignment</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Mini-group project</td><td>15%</td><td></td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>3. Test</td><td>15%</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>4. Examination</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:

Overall Assessment:

0.50 × End of Subject Examination + 0.50 × Continuous Assessment

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	The examination is adopted to assess students on the overall understanding and the ability to apply the concepts. It is supplemented by continuous assessment including assignments, closed-book tests, and mini-group projects. The continuous assessment is aimed at enhancing the students' comprehension and assimilation of various topics of the syllabus. In particular, a group mini-project is used to assess the students' capacities of self-learning and problem-solving, and effective communication skills in English to fulfill the requirements of being aircraft design engineers.	
Student Study Effort Expected	Class contact:	
	▪ Lecture	33 Hrs.
	▪ Case Study	6 Hrs.
	Other student study effort:	
	▪ Literature review / case study / reading	36 Hrs.
	▪ Self-study / preparation	36 Hrs.
	The total student study effort	111 Hrs.
Reading List and References	1. Guido, S., & Müller, A. (2016). Introduction to machine learning with python (Vol. 282). O'Reilly Media. 2. Marsland, S. (2015). Machine learning: an algorithmic perspective. CRC press. 3. Zhang, Tao, Qing Li, Chang-shui Zhang, Hua-wei Liang, Ping Li, Tian-miao Wang, Shuo Li, Yun-long Zhu, and Cheng Wu. "Current trends in the development of intelligent unmanned autonomous systems." Frontiers of information technology & electronic engineering 18, no. 1 (2017): 68-85. 4. Barfoot, Timothy D. State estimation for robotics. Cambridge University Press, 2017. 5. Thrun, S. (2002). Probabilistic robotics. Communications of the ACM, 45(3), 52-57.	

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