The Hong Kong Polytechnic University

Subject Description Form

Subject Code	AAE5302
Subject Title	U-space Design, Air Traffic Service and Urban Aircraft System Traffic Management
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	1. To provide students with the key knowledge relevant to U-space, airspace structure, UAS traffic management (UATM), low-altitude airspace capacity, airspace demand, service network design, resource allocation. 2. To provide students with comprehensive understanding of the U-space ecosystem, U-space service manager module, and design mechanisms. Extend the knowledge gained to analyse and develop new airspace designs for desired needs, such as for terrain concerns, weather hazard concerns, wind disturbance, etc. 3. To provide students with the practical knowledge of mathematical methods commonly used in the included topics. It includes data analytics, optimization model formulation, traffic models.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Have the basic knowledge of how low-altitude airspace is structured; b. Apply techniques to properly evaluate the low-altitude airspace demand and capacity; c. Understand different types of U-space structure and their advantages. Be able to develop new airspace design for desired use; d. Understand fundamental concepts of UAS traffic management (UATM); and e. Be able to apply the learned knowledge and skills practically in specific problem setting.
Subject Synopsis/ Indicative Syllabus	**Introduction:** Overview and basic concepts in U-space, including components in U-space, U-space infrastructure, factors influence the capacity or demand of the U-space, prospects and drawbacks for introducing emerging UAM, and potential solutions. **Low-altitude airspace structure and design:** The definition, design, and categorization of low-altitude airspace for UAM. Different types of proposed low-altitude airspace structure (e.g. layered, corridor, freemix). The operating environments include airspaces, types of operations, regulations, and procedures necessary to support an operation.

<table>
<tr><td></td><td>Low-altitude airspace capacity analysis based on different airspace design: The definition of UAV traffic demand and capacity in low-altitude airspace. Introduce the models used to estimate airspace capacity. Airspace capacity analysis of different airspace structure type. Introduce demand-capacity balancing technique when the requested resources cannot support the collective UAM Operational Intent demand.

UAS traffic management: Air traffic management, air traffic control strategies for UAM. Introduce new ATC tactical deconfliction techniques, including the formulation of new separation standards that would rely on enhanced aircraft performance and air traffic management system fidelity may be utilized.

U-Space Utilisation: U-space ecosystems, services, frameworks; e-VTOL flight and automation technologies; overall U-space system safety, route duration, and route distance decisions; key areas to be addressed by the U-space program (CONOPs, datalinks, UAV information management, ground technology).

Congestion management and resource allocation: Introduce air traffic service in the low-altitude airspace. The design and component of the service network. Based on air traffic management strategies, introduce resource allocation models for efficient use of airspace.

Existing challenges and opportunities: Terrain concerns, weather hazard concerns, airspace design in urban complex structures, wind field constraints, and noise control. Characterize different problems such as air corridor constraints and natural environment to address the complex and variable airspace, complicated obstacles, low altitude flights, noise and meteorology faced by their path planning to make finer planning and management.</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>Teaching is conducted through class lectures and case study. The basic concepts, research methodology and theoretical models will be introduced. The understanding of problems and challenges in U-space design and solution strategies development will be emphasized. Research methodology, case study and analytics skills are taught in class as well as the related real-life scenarios to enhance the teaching and learning abilities.
<table>
<tr><td rowspan="2">Teaching/Learning Methodology</td><td colspan="5">Outcomes</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td></tr>
<tr><td>Lecture</td><td>√</td><td>√</td><td>√</td><td>√</td><td></td></tr>
<tr><td>Case Study</td><td></td><td></td><td></td><td>√</td><td>√</td></tr>
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Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c	d	e
1. Assignments	40%	√	√	√	√	
2. In-class Test	30%	√	√	√		√
3. Group project	30%	√	√	√	√	√
Total	100 %					

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

Overall Assessment:

1 × Continuous Assessment

100% Continuous assessment consists of assignments, in-class test, and group project report. Group project reports are required to be submitted to show the findings. This continuous assessment aimed at enhancing the students' comprehension and assimilation of various topics of the syllabus via assignments. Group project is used to assess the students' capability of self-study and problem-solving and effective communication with team members so as to fulfil the requirements of working in the aviation industry. The quiz can help students involved more in understanding the application of principles from lectures in real problems.

Student Study Effort Expected

Class contact:	
▪ Lecture	39 Hrs.
Other student study effort:	
▪ Self-learning/preparation	36 Hrs.
▪ Literature study/case study/reading	36 Hrs.
Total student study effort	111 Hrs.

Reading List and References

1. Eurocontrol (2024) ERNIP Part 1 European Airspace Design Methodology Guidelines - General Principles and Technical Specifications for Airspace Design
2. FAA. (2023) Concepts of Operations: Unmanned Aircraft Systems Traffic Management.
3. Boyles, S. D., N. E. Lownes, and A. Unnikrishnan. (2023) Transportation Network Analysis, Volume I, Version 0.91.
4. Balakrishnan, R., Ranganathan K., A Textbook of Graph Theory. 2nd ed. 2012 Edition
5. Arblaster, M. Air Traffic Management: Economics, Regulation and Governance. 2018 Edition.