Subject Description Form

Subject Code	AAE4009
Subject Title	Data Science and Data-driven Optimisation in Airline and Airport Operations
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	This subject will provide students with 1. A conceptual and practical foundation in airport and airline operations for knowledge representation and reasoning of artificial intelligence, data mining, soft computing and optimisation methods as problem solving tools; and 2. Research methodology, data interpretation and analytical skills in regard to real-life data and case scenarios of airport and airline operations; and 3. Experience of conducting proper research experiments and engineering reports for results dissemination.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Identify and formulate the data-driven engineering problems in airport and airline operations; and b. Transfer the expert knowledge into knowledge-based system and algorithms via machine learning approaches; and c. Plan, design and develop appropriate algorithms via soft computing methods and analysis the data and the solution quality with alternatives; and d. Review the performance and make judgements based on numerical results and provide off-the-shelf suggestions, profitable solutions and actionable managerial insights.
Subject Synopsis/ Indicative Syllabus	Lectures are used to deliver the fundamental knowledge in relation to various aspects of machine learning, data mining, data analytics, data-driven optimisation and artificial intelligence in airline and airport operations (outcomes a to d). Several laboratories will be made available to equip students with the basic knowledge of data mining, soft computing, optimisation and artificial intelligence in solving aviation engineering problems (outcomes a to c). Given the basic knowledge of data science, a group mini project will be used to help students deepen their knowledge of a specific topic through literature study, methodology study, analysis of data, dissemination of research findings and report writing (outcomes a to d). The subject covers the following topics.

Machine learning, data mining and artificial intelligence - The topics include the following elements:

- Supervise and unsupervised learning approach.
- Descriptive methods, including clustering, association.
- Predictive methods, including classification and regression.
- Supervised learning algorithms: Nearest neighbour algorithm, fuzzy logic, gaussian mixture, neural network, linear regression, logistic regression, decision trees, Naïve Bayes, genetic algorithms
- Unsupervised learning algorithms: associate rules, principal component analysis, gaussian mixture

Data-driven optimisation - The topics include the following elements:

- Basic mathematical formulation and modelling, convex optimisation, data-driven modelling, airline scheduling planning, crew rostering, runway scheduling, gate assignment problem, air logistics transportation problem

Optimisation methods and soft computing - The topics include the following elements:

- Branch and Bound algorithm, heuristics, meta-heuristics, swarm intelligence

Teaching/Learning Methodology

Teaching is conducted through class lectures, case studies, and laboratory exercises. The basic knowledge, research methodology and theoretical models will be introduced. The understanding of how to address and formulate problems by using mathematical programming, artificial intelligence algorithms, and soft computing techniques with modern programming language is emphasised. Research methodology, data analytics skills, algorithm design skills and programme methods are taught in class as well as the related real-life scenarios using data to enhance their research abilities. Laboratory exercises, mini reports, oral disseminations and test are used to make up the course work marks.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed			
		a	b	c	d
1. Laboratory	40%	✓	✓	✓	✓
2. Mini report	20%			✓	✓
3. Oral presentation	10%			✓	✓
4. Test	30%	✓	✓	✓	✓
Total	100 %				

	Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes: Overall assessment: 1.0 x continuous assessment The continuous assessment (100%) is aimed at enhancing the students' comprehension and assimilation of various topics of the syllabus via several laboratory teaching and laboratory report, numerical analysis, reading assignment. In particular, mini projects are used to assess the students' capacities of self-study and problem-solving and effective communication skills in English so as to fulfil the requirements of working in the aviation industry. Test will be conducted to evaluate the students performance in mathematical problem formulation and algorithm design for a given airport and airline engineering problem with a limited examination time.	
Student Study Effort Expected	Class contact:	
	▪ Lecture/seminar	24 Hrs.
	▪ Laboratory	15 Hrs.
	Other student study effort:	
	▪ Literature review / Scientific finding and analysis / final report writing preparation / presentation material preparation	36 Hrs.
	▪ Self-study / preparation	36 Hrs.
	Total student study effort	**111 Hrs.**
Reading List and References	1. Barber, D. (2012). Bayesian reasoning and machine learning. Cambridge University Press. 2. Boyd, S., Boyd, S. P., & Vandenberghe, L. (2004). Convex optimization: Cambridge university press. 3. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to algorithms: MIT press. 4. De Neufville, R., & Odoni, A. (2003). Airport systems. planning, design and management. New York: McGraw-Hill. 5. Guido, S., & Müller, A. (2016). Introduction to machine learning with python (Vol. 282). O'Reilly Media. 6. Marsland, S. (2015). Machine learning: an algorithmic perspective. CRC press. 7. Richert, W. (2013). Building machine learning systems with Python. Packt Publishing Ltd. 8. Wallwork, A. (2016). English for writing research papers: Springer.	

	9. Wells, A. T. (2007). Air transportation: A management perspective: Ashgate Publishing, Ltd. 10. Wu, C.-L. (2016). Airline operations and delay management: insights from airline economics, networks and strategic schedule planning: Routledge.

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