Subject Description Form

Subject Code	AAE6202
Subject Title	Mathematics and Computational Methods for Aviation Engineering Applications
Credit Value	3
Level	6
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	1. To provide students with understanding and knowledge about the advanced mathematics in aviation engineering. 2. To develop students' capability to conduct numerical analysis and design optimisation methods in solving mathematical modelling in the context of aviation and air transportation. 3. To provide students with in-depth and the state-of-the-art modelling methods in aviation domain.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. obtain in-depth knowledge and the state-of-the-art numerical methods and modelling approaches; b. competently apply the fundamental mathematic concepts in formulating the aviation or air transport research problems and able to conduct analysis and solve the problems with relevant research methodologies; c. critically evaluate the characteristics and properties of the models with the given engineering problems; and d. identify the key challenges in the research domains and able to conduct critical review of the research methodologies.
Subject Synopsis/ Indicative Syllabus	**Differential equations -** ordinary differential equations; partial differential equations; numerical methods **Dynamical systems –** fixed point; stability; discrete-event systems; finite-dimensional dynamical systems; infinite-dimensional dynamical system **Convexity and convex functions** – affine and convex sets; hyperplanes; convex functions and its properties; conjugate function, quasiconvex functions, log-concave and log-convex functions; convexity with respect to generalised inequalities **Convex optimisation problem** – convex optimisation; linear optimisation; quadratic optimisation problems; geometric programming; vector optimisation **Duality** – The Lagrange dual function; the Lagrange dual problem; geometric interpretation; saddle-point interpretation; optimality condition; perturbation and sensitivity analysis.

Statistical estimation – Parametric distribution estimation; non-parametric distribution estimation

Uncertainty modelling - Stochastic Linear Programming, stochastic integer programmes, and approximation and sampling methods (e.g., Monte Carlo methods and sample average approximation; Robust optimisation, min-max/max-min optimisation, decomposition methods for two-stage robust optimisation problems.

Algorithms for unconstrained minimisation – unconstrained minimisation problems; descent methods; gradient descent method; steepest descent method.

Interior-point methods – Inequality constrained minimisation problems; logarithmic barrier function and central path; Primal-dual interior-point methods.

Teaching/Learning Methodology

1. The teaching and learning methods include lectures/tutorials, projects and homework assignments.

2. The lectures/tutorials aim at providing students with integrated knowledge of mathematics in air transportation, air mobility, safety and reliability modelling in aviation.

3. Homework assignments and quiz are used to allow students to reflect on and deepen their knowledge of a selected topic.

Teaching/Learning Methodology	Intended subject learning outcomes			
	a	b	c	d
1. Lectures/tutorials	√	√	√	√
2. Homework assignments	√	√	√	√

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
1. Projects (case study)	30%	√	√	√	√
2. Tests/assignments	20%	√	√	√	√
3. Examination	50%	√	√	√	√
Total	100%				

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

1. The assessment is comprised of 50% continuous assessment (projects and tests) and 50% examination.

2. The continuous assessment consists of projects and tests. They are used to

	evaluate the progress of students' study, assist them in self-monitoring of fulfilling the respective subject learning outcomes, and enhance the integration of the knowledge learned. 3. The examination is used to assess the knowledge acquired by the students for understanding and analysing the problems critically and independently; as well as to determine the degree of achieving the subject learning outcomes.	
Student Study Effort Expected	Class contact:	
	▪ Lectures	39 Hrs.
	Other student study effort:	
	▪ Self-study	33 Hrs.
	▪ Projects/homework assignments	50 Hrs.
	Total student study effort	122 Hrs.
Reading List and References	1. Ashford, N. J., Stanton, H. M., Moore, C. A., Pierre Coutu, A. A. E., & Beasley, J. R. (2013). *Airport operations*. McGraw-Hill Education. 2. Birge, J. R., & Louveaux, F. (2011). *Introduction to stochastic programming*. Springer Science & Business Media. 3. Boyd, S., Boyd, S. P., & Vandenberghe, L. (2004). *Convex optimisation.* Cambridge university press. 4. Griffiths, D. V., & Smith, I. M. (2020). *Numerical methods for engineers*. CRC press. 5. Kong, Q., Siauw, T., & Bayen, A. (2020). *Python Programming and Numerical Methods: A Guide for Engineers and Scientists*. Academic Press. 6. Michael, L. P. (2018). *Scheduling: theory, algorithms, and systems*. Springer.	

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