Subject Description Form

Subject Code	AAE6203
Subject Title	Mathematics for Aircraft Structure, Guidance, Navigation, and Control
Credit Value	3
Level	6
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	1. To provide students with understanding and knowledge about the key mathematics in aircraft structure, guidance, and control. 2. To develop students' capability to numerically analyze research problems from a mathematical view, for example using the matrix to represent the problem. 3. To provide students with in-depth mathematical examples of aircraft structure, guidance, and control.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. obtain in-depth knowledge of basic matrix concepts, notations, vectors, matrix space, and key properties of the matrix, solving the optimization problem using the matrices. b. competently apply fundamental mathematic concepts to aircraft structure, guidance, and control problems. c. critically evaluate the characteristics of the given engineering problem using the properties of the matrix. d. identify the key challenges of the research in aircraft structure, guidance, and control from the mathematical view.
Subject Synopsis/ Indicative Syllabus	1. **Normed Vector Spaces**: Concepts, notations, and methods in vector space theory; Vector spaces and properties; Normed Spaces and basic theorems; Banach spaces and fundamental theory; Linear mappings and properties; Contraction mappings and the Banach fixed point theorem. 2. **The Lebesgue Integral**: Step functions; Lebesgue integrable functions; The space L 1 (R); The space Lp (R). 3. **Hilbert Spaces and Orthonormal Systems**: Inner product spaces; Hilbert spaces; Orthogonal and orthonormal systems; Projection theorem 4. **Linear Operators on Hilbert Spaces**: Bilinear functional and quadratic forms; Adjoint and self-adjoint operators; Invertible, normal, isometric, and unitary operators; Positive, projection, and compact operators; Eigenvalues and eigenvectors

5. **Application Issues (selective)**: Method of successive approximations; Ordinary differential equations and differential operators; or the Fourier transform

6. **Linear Algebra for the Unmanned Autonomous Systems**: a) Vectors, matrices, symmetric groups, lie groups, matrices operators, observability/degeneration analysis of state estimation, and matrix factorization b) State estimation with least squares, best linear unbiased estimator, and minimum variance estimator.

7. **Dynamic System and Stability**: Dynamic system and stability notions and Lyapunov theory overview. Controllability and observability. A normal form of a controllable linear autonomous system.

8. **Probability and Statistics**: Random variable, probability, Bayesian analysis, covariance and correlation, hypothesis testing, maximum likelihood, etc.

9. **Case Studies**: Application of the mathematic concepts to the research of aircraft structure, guidance, and control.

Teaching/Learning Methodology

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

2. The lectures/tutorials aim at providing students with integrated knowledge of mathematics in aircraft structure, guidance, and control.

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

4. Case studies will be raised to develop student's skills in applying mathematical concepts to real engineering problems.

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

Assessment Methods in Alignment with Intended Learning Outcomes	(see table and explanation below)

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 analyzing 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	33 Hrs.
▪ Tutorials	6 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. Bertsekas, D. (2015). *Convex optimization algorithms*. Athena Scientific.
2. Nagrath, I. J. (2006). *Control systems engineering.* New Age International.
3. Sadraey, M.H. (2012). *Aircraft design: A systems engineering approach.* John Wiley & Sons.