Subject Description Form

Subject Code	AAE4201
Subject Title	Flight Control Systems
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	**Pre-requisite:** AAE3004 Dynamical Systems and Control
Objectives	To provide students with in depth knowledge of manual and powered flight control systems.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Acquire good understanding of the capabilities of the flight control systems; and b. Acquire good understanding of the limitations of the flight control systems; and c. Acquire good understanding of manual control of the flight control systems; and d. Acquire good understanding of powered control of the flight control systems including Fly-By -Wire.
Subject Synopsis/ Indicative Syllabus	**Tail surfaces and control surfaces - Design and construction -** Describe the following types of construction: • Cantilever, • Non-cantilever (braced). **Structural components -** Describe the function of the following structural components: • Spar and its components (web and girder or cap), • Rib, • Stringer, • Skin, • Torsion box. **Loads, stresses and aeroelastic vibrations ('flutter') -** Describe the vertical and horizontal loads on the ground. Describe the loads in flight for symmetrical and asymmetrical conditions, considering both vertical and horizontal loads and loads due to engine failure. Describe the principle of flutter, flutter damping and resonance for the wing and control surfaces. Explain the significance on stress relief and flutter of the following:

	• Chord-wise and span-wise position of masses (e.g. engines, fuel and balance masses, control balance masses); • Torsional stiffness; • Bending flexibility. Describe the following design configurations: • Conventional (low or mid set) tailplane; • T-tail. **Primary fight controls -** Define a 'primary flight control'. List the following primary flight control surfaces: • Elevator; • Aileron, • Roll spoilers; • Rudder. List the various means of control surface actuation including: • Manual; • Fully powered (irreversible); • Partially powered (reversible). **Manual controls -** Explain the basic principle of a fully manual control system. **Fully powered controls (irreversible) -** Explain the concept of irreversibility in a flight control system. Explain the need for a 'feel system' in a fully powered control system. Explain the operating principle of a stabiliser trim system in a fully powered control system. Explain the operating principle of rudder and aileron trim in a fully powered control system. **Partially powered controls (reversible) -** Explain the basic principle of a partially powered control system. Explain why a 'feel system' is not necessary in a partially powered control system. **System components, design, operation, indications and warnings, degraded modes of operation, jamming -** List and describe the function of the following components of a flight control system: • Actuators; • Control valves; • Cables or electrical wiring; • Control surface position sensors. Explain how redundancy is obtained in primary flight control systems of large transport aeroplanes. Explain the danger of control jamming and the means of

	retaining sufficient control capability. Explain the methods of locking the controls on the ground and describe 'gust or control lock' warnings. Explain the concept of a rudder-deflection limitation (rudder limiter) system and the various means of implementation (rudder ratio changer, variable stops, blow-back). **Secondary fight control - System components, design, operation, degraded modes of operation, indications and warnings -** Define a 'secondary flight control'. List the following secondary flight control surfaces: • Lift-augmentation devices (flaps and slats); • Speed brakes; • Flight and ground spoilers; • Trimming devices such as trim tabs; • Trimmable horizontal stabiliser. Describe secondary flight control actuation methods and sources of actuating power. Explain the function of a mechanical lock when using hydraulic motors driving a screw jack. Describe the requirement for limiting speeds for the various secondary flight control surfaces. For lift-augmentation devices, explain the load-limiting (relief) protection devices and the functioning of an autoretraction system. Explain how a flap/slat asymmetry protection device functions. Describe the function of an autoslat system. Explain the concept of control surface blowback (aerodynamic forces overruling hydraulic forces). **Fly-by-wire control -** Explain that a FBW flight control system is composed of the following: Pilot's input command (control stick/column); • Electrical signalling, including pilot input to computer, computer to flight control surfaces, feedback from aircraft response to computer; • Flight control computers; • Actuators; • Control surfaces. State the advantages and disadvantages of a FBW system in comparison with a conventional flight control system including weight, pilot workload, flight-envelope protection. Explain why a FBW system is always irreversible. State the existence of degraded modes of operation.

Teaching/Learning Methodology

1. The teaching and learning methods include lectures/tutorials sessions, homework assignments, tests, case study reports/presentations, and examination.

2. The continuous assessments and examination are aimed at providing students with integrated knowledge required to understanding the impact on environment from the aviation industry and the related mitigation measures.

3. Technical/practical examples and problems are raised and discussed in classes and tutorial sessions.

Teaching/Learning Methodology	Intended subject learning outcomes to be covered			
	a	b	c	d
1. Lecture	✓	✓	✓	✓
2. Tutorial	✓	✓	✓	
3. Home assignments		✓	✓	✓
4. Case study report and presentation		✓	✓	✓

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. Homework assignments	10%		✓	✓	✓
2. Test	20%	✓	✓	✓	✓
3. Case study	10%		✓	✓	✓
4. Examination	60%	✓	✓	✓	✓
Total	100 %				

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

Overall Assessment:

0.6 × End of Subject Examination + 0.4 × Continuous Assessment

The continuous assessment consists of three components: homework assignments, test and case study report & presentation. They are aimed at evaluating the progress of study, assisting them in self-monitoring of fulfilling the respective indented subject learning outcomes.

The examination is used to assess the knowledge acquired by the students for understanding and analysis the problem critically and independently; as well as to determine the degree of achieving the indented subject learning outcomes.

Student Study Effort Expected	Class contact:	
	▪ Lectures	26 Hrs.
	▪ Tutorials	13 Hrs.
	Other student study effort:	
	▪ Self-Study	36 Hrs.
	▪ Homework Assignments	15 Hrs.
	▪ Case Study Report Preparation	15 Hrs.
	Total student study effort	**105 Hrs.**
Reading List and References	1. Brian L. Stevens, Frank L. Lewis,, Eric N. Johnson , Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, Wiley-Blackwell Nov 2015.. 2. Clarence W. de Silva, Sensors and Actuators: Engineering System Instrumentation, CRC Press, July 2015. 3. Austin Hughes and Bill Drury, Electric Motors and Drives: Fundamentals, Types and Applications, Newnes, May 2013	

June 2020