Stability and Control

Code	Credit Hours
AE-336	3-0

COURSE DESCRIPTION:

This is a major course which gives a systematic account of aircraft stability and control. It builds up on the concepts already developed in the subjects of rigid body dynamics and incompressible aerodynamics. The first part of the course deals with the aircraft static longitudinal, directional & lateral stability and control. The second part dealswith the development of aircraft equations of motion, encompassing small disturbance theory, aerodynamic forces and moment derivatives. The third part deals with aircraft longitudinal motion, covering pure pitching, stick fixed, phugoid and short period motions.The last part gives an overview of lateral motion, aircraft control response and calculation of stability parameters using software.

TEXT AND MATERIAL:

Textbooks

1. "Performance, Stability, Dynamics & Control of Airplanes" by Bandu N. Pamadi, AIAA Education Series, Latest Available Edition
2. "Flight Stability and Automatic Control" by Robert C. Nelson, McGraw-Hill, NY, Latest Available Edition
3. Basic Aerodynamics by Aviation Maintenance Technician Certification Series, Latest Available Edition

Reference Material:

1. "Feedback Control Systems" by Charles L Phillip, Prentice Hall, 4th Edition, 2000.
2. "Aircraft Control and Simulation" by Brain L. Stevens and Frank L. Lewis, 2ndEdition, 2003.
3. "Aircraft Performance, Stability and Control" by James D. Lang, Dept. of Aeronautics, USAF, 1974.

PREREQUISITE:

Engineering Dynamics
Fundamentals of Incompressible Aerodynamics

ASSESSMENT SYSTEM:

Quizzes	10-15%
Assignments	5 -10%
Mid Terms	30-40%

ESE	40-50%

TOPICS COVERED WITH THEIR CONTRIBUTION TO PLOs:

WeekNo	Description	Ref
1	Review of Basic Definitions from Aerodynamics & Performance Introduction to Stability	Text 1, Chapter 1,2 Text 2, 2.1, 2.2
2	Static Longitudinal Stability with respect to vehicle axis system Longitudinal Control (Effects of various major aircraft components)	Text 2, 2.3 Text 2, 2.4
3	Stick Forces Static Directional Stability with respect to vehicle axis system Directional Control (Effects of various major aircraft components) Static Lateral Stability with respect to vehicle axis system	Text 2, 2.5 Text 2, 2.6 Text 2, 2.7 Text 2, 2.8
4	Roll Control (Effects of various major aircraft components) Introduction to dynamic stability Rigid Body Equations of Motion	 Text 2, 2.9 Text 2, 3.1, 3.2
5	Orientation & Position of Airplane(Inertial and rotating axes system and their transformations)	Text 2, 3.3
6	Gravitational & Thrust Forces Small Disturbance Theory (Linearization of vehicle equations of motion)	Text 2, 3.4 Text 2, 3.5
7	Aerodynamic Force & Moment Stabilityand Control Derivatives Second Order Differential Equations Pure pitching motion	Text 2, 3.6 Text 2, 4.1,4.2 Text 2, 4.3
8	Introduction to aircraft DATCOMMsoftware Aircraft longitudinal stability analysis using second order differential equations solution and solution of pure pitching motion	DATCOMM Manual Text 2, Chapter 4 (Example4.1 & 4.2)

9	MID TERM EXAM	
10	Aircraft longitudinal stability analysis using second order differential equations solution and solution of pure pitching Stick Fixed Longitudinal Motion	Text 2, 4.4
11	Longitudinal Approximations Short period mode Phugoid mode Introduction to Lateral Motion Aircraft lateral stability analysis using second order differential equations solution and solution of Pure rolling motion	Text 2, 4.5 (Example 4.3) Text 2, Chapter 5 Text 2, Chapter 5 (Example 5.2)
12	Introduction to Lateral Motion Lateral Motion & Approximations Spiral model Roll subsidence Dutch roll mode Longitudinal and Lateral Flying qualities related to aircraft stability and control	Text 2, Chapter 5.4 Text 2, 4.7 Text 2, 5.5
13-14	**Aircraft response to externaldisturbances and Control** State space formulation of ExternalDisturbances Atmospheric Turbulence and Wind Shear Models	Text 2, 6.2 – 6.6
15	Introduction to Automatic (Classical)Control Aircraft Transfer Functions (LaplaceTransform)	Text 2, 7.1 Text 2, 8.2
16	Introduction to MATLAB / Simulink	Text 2, Chapter 3
17	Revision	
18	**END SEMESTER EXAMINATION**	

COMPLEX ENGINEERING PROBLEM :

Students are required to select an actual aircraft whose data is easily available in publications. They will model the specified aircraft in DATCOM / XFLR / Flight Gear software and find the relevant aerodynamics stability and control derivatives. They will berequired to carry out parametric study of variations in one of the geometric parameters of the aircraft and study the effects on aircraft stability / control response. A presentation and a research paper on the study performed will be submitted in IEEE format. The grading rubrics will encompass quality of presentation, analysis of results and quality of research paper.