

AE 4531 - Aircraft Flight Dynamics

HOURS: 3-0-3

CATALOG DESCRIPTION: Three-dimensional rigid body dynamics, aircraft equations of motion, static and dynamic stability, flight control design, introduction to aeroelastic phenomena.

PREREQUISITES:

AE 3030 Aerodynamics

With concurrency

AE 3531 Control System Analysis and Design

COURSE OBJECTIVES:

1. Modeling and analysis of aircraft flight dynamics
2. Introduction to aeroelastic phenomena

LEARNING OUTCOMES:

- 1) Kinematics and Dynamics of a 3D Rigid Body
- 2) Formulation and Numerical Solution of Flight Dynamics Equations of Motion
- 3) Concepts of Static and Dynamic Stability of Aerospace Systems
- 4) Location of the Elastic axis vs Aerodynamic Center
- 5) Concepts of Divergence and Stability with a Single DOF Model
- 6) Sweep Effects
- 7) Concept of Flutter with a Pitch/Plunge model
- 8) Relevant Applications to Aerospace Systems

TOPICAL OUTLINE

	<i>Topic</i>	<i>Hours</i>
I	Introduction Review Aerodynamic Nomenclature	3
II.	Aircraft Static Stability and Control Definitions Longitudinal Static Stability Longitudinal Control Directional Stability and Control Roll Stability and Roll Control	6
III.	Introduction to Static Aeroelastic Phenomena Divergence analysis using a Spring restrained Airfoil Model Location of Elastic Axis versus Aerodynamic Center Torsional Divergence Sweep Effects Aileron Reversal	4
IV.	Aircraft Equations of Motion Review Coordinate Systems and transformations Derivatives in Rotating Frames Translational Equations Rotational Equations Effect of spinning rotors	7
V.	Linearization Small Disturbance Theory Aerodynamic Force and Moment Derivatives Lateral-Directional Equations of Motion Equations of Motion in a Non-uniform Atmosphere	5

VI.	Aircraft Longitudinal Dynamics	4
	Review of modal analysis	
	Longitudinal Motion	
	Approximations	
	Influence of Stability Derivatives	
	Transfer Functions	
	Flying Qualities	
VII.	Aircraft Lateral Dynamics	4
	Lateral-Directional Equations	
	Dutch Roll, Roll and Spiral Modes	
	Modal Analysis	
	Approximate Models	
	Transfer Functions	
	Flying Qualities	
VIII.	Introduction to Dynamic Aeroelastic Phenomena	3
	Lift Deficiency Function	
	Flutter Analysis using a 2DOF Pitch-Plunge Model	
	Wing Flutter	
IX.	Aircraft Flight Control System Design	6
	Longitudinal SAS and SCAS Designs	
	Lateral SAS and SCAS Designs	
X.	Midterm Exam and Quizzes	3
		<i>Total</i> 45