**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

AE 3531 (concurrent)

**TEXTBOOKS:**

1. Etkin and Reid: Dynamics of Flight, Stability and Control, John Wiley & Sons, 1996.
2. Nelson, R.C*., Flight Stability and Automatic Control*, 2nd Edition, McGraw-Hill, 1998.
3. Hodges and Pierce: Introduction to Structural Dynamics and Aeroelasticity, Cambridge University.

**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 Hrs**

I Introduction 3

Review

Aerodynamic Nomenclature

II. Aircraft Static Stability and Control 6

Definitions

Longitudinal Static Stability

Longitudinal Control

Directional Stability and Control

Roll Stability and Roll Control

III. Introduction to Static Aeroelastic Phenomena 4

Divergence analysis using a Spring restrained Airfoil Model

Location of Elastic Axis versus Aerodynamic Center

Torsional Divergence

Sweep Effects

Aileron Reversal

IV. Aircraft Equations of Motion 7

Review

Coordinate Systems and transformations

Derivatives in Rotating Frames

Translational Equations

Rotational Equations

Effect of spinning rotors

V. Linearization 5

Small Disturbance Theory

Aerodynamic Force and Moment Derivatives

Lateral-Directional Equations of Motion

Equations of Motion in a Non-uniform Atmosphere

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

Midterm Exam and Quizzes 3

Total 45