

**Airplane Design Part VII:
Determination of Stability, Control and Performance
Table of Contents**

TABLE OF SYMBOLS

ACKNOWLEDGEMENT

1. INTRODUCTION

2. CONTROLLABILITY, MANEUVERABILITY AND TRIM

2.1 LONGITUDINAL CONTROLLABILITY AND TRIM

2.1.1 Applicable Regulations

2.1.2 Relationship to preliminary Design

2.1.3 Mathematical Model for Analyzing Longitudinal Controllability and Trim

2.1.4 Step-by-step procedure for Analyzing Longitudinal Controllability and Trim

2.2 DIRECTIONAL AND LATERAL CONTROLLABILITY AND TRIM

2.2.1 Applicable Regulations

2.2.2 Relationship to preliminary Design

2.2.3 Mathematical Model for Analyzing Directional and Lateral controllability and Trim

2.2.4 Step-by-step procedure for Analyzing Directional and Lateral Controllability and Trim

2.3 MINIMUM CONTROL SPEED

2.3.1 Applicable Regulations

2.3.2 Relationship to preliminary Design

2.3.3 Mathematical Model for Analyzing Minimum Control Speed

2.3.4 Step-by-step procedure for Determining the Minimum Control Speed

2.4 MANEUVERING FLIGHT

2.4.1 Applicable Regulations

2.4.2 Relationship to preliminary Design

2.4.3 Mathematical Model for Analyzing Maneuvering Flight

2.4.4 Step-by-step procedure for Determining Maneuvering Flight Ability

2.5 CONTROL DURING THE TAKEOFF GROUND RUN

2.5.1 Applicable Regulations

2.5.2 Relationship to preliminary Design

2.5.3 Mathematical Model for Analyzing Control During the Takeoff Groundrun

2.5.3.1 Mathematical model for analyzing longitudinal control during the takeoff groundrun

2.5.3.2 Mathematical model for analyzing lateral-directional control during the takeoff groundrun

2.5.4 Step-by-step Procedure for Analyzing Control During the Takeoff Groundrun

2.5.4.1 Step-by-step procedure for analyzing longitudinal control during the takeoff groundrun

2.5.4.2 Step-by-step procedure for analyzing lateral-directional control during the takeoff groundrun

2.6 CONTROL DURING THE LANDING GROUND RUN

2.6.1 Applicable Regulations

2.6.2 Relationship to Preliminary Design

2.6.3 Mathematical Model for Analyzing Control During the Landing Groundrun

2.6.4 Step-by-step Procedure for Analyzing Control During the Landing Groundrun

2.7 ROLL PERFORMANCE

2.7.1 Applicable Regulations

2.7.2 Relationship to Preliminary Design

2.7.3 Mathematical Model for Analyzing Roll Performance

2.7.4 Step-by-step Procedure for Analyzing Roll Performance

2.8 HIGH SPEED CHARACTERISTICS

2.8.1 Applicable Regulations

2.8.2 Relationship to Preliminary Design

2.8.3 Mathematical Model for Analyzing High Speed Characteristics

2.8.4 Step-by-step Procedure for Analyzing High Speed Characteristics

2.9 AEROELASTIC CONSIDERATIONS

3. STABILITY: STATIC AND DYNAMIC

3.1 STATIC LONGITUDINAL STABILITY

3.1.1 Applicable Regulations

3.1.2 Relationship to Preliminary Design

3.1.3 Mathematical Model for Analyzing Static Longitudinal Stability

**Airplane Design Part VII:
Determination of Stability, Control and Performance
Table of Contents**

- 3.1.4 Step-by-step Procedure for Analyzing Static Longitudinal Stability
- 3.2 STATIC LATERAL AND DIRECTIONAL STABILITY
 - 3.2.1 Applicable Regulations
 - 3.2.2 Relationship to Preliminary Design
 - 3.2.3 Mathematical Model for Analyzing Static Lateral and Directional Stability
 - 3.2.4 Step-by-step Procedure for Analyzing Static Lateral and Directional Stability
- 3.3 DYNAMIC LONGITUDINAL STABILITY
 - 3.3.1 Applicable Regulations
 - 3.3.2 Relationship to Preliminary Design
 - 3.3.3 Mathematical Model for Analyzing Dynamic Longitudinal Stability
 - 3.3.3.1 Class II method for analysis of phugoid characteristics
 - 3.3.3.2 Class II method for analysis of short period characteristics
 - 3.3.4 Step-by-step Procedure for Analyzing Dynamic Longitudinal Stability
- 3.4 DYNAMIC LATERAL-DIRECTIONAL STABILITY
 - 3.4.1 Applicable Regulations
 - 3.4.2 Relationship to Preliminary Design
 - 3.4.3 Mathematical Model for Analyzing Lateral-Directional Dynamic Stability
 - 3.4.3.1 Class II method for analysis of the spiral characteristics
 - 3.4.3.2 Class II method for analysis of the dutch roll characteristics
 - 3.4.4 Step-by-step Procedure for Analyzing Dynamic Lateral-Directional Stability
- 3.5 DYNAMIC COUPLING
 - 3.5.1 Applicable Regulations
 - 3.5.2 Relationship to Preliminary Design
 - 3.5.3 Mathematical Model for Analyzing Dynamic Coupling
 - 3.5.3.1 Roll-rate coupling
 - 3.5.3.2 Pitch-rate coupling
 - 3.5.4 Step-by-step Procedure for Analyzing Roll-rate Coupling
- 3.6 STALL CHARACTERISTICS
 - 3.6.1 Applicable Regulations
 - 3.6.2 Relationship to Preliminary Design
 - 3.6.3 Mathematical Model for Analyzing Stall Characteristics
 - 3.6.4 Step-by-step Procedure for Analyzing Stall Characteristics
- 3.7 SPIN CHARACTERISTICS
 - 3.7.1 Applicable Regulations
 - 3.7.2 Relationship to Preliminary Design
 - 3.7.3 Mathematical Model for Analyzing Spin Characteristics
 - 3.7.4 Step-by-step Procedure for Analyzing Spin Characteristics
- 3.8 AEROELASTIC CONSIDERATIONS
- 4. RIDE AND COMFORT CHARACTERISTICS
 - 4.1 RELATIONSHIP TO PRELIMINARY DESIGN
 - 4.2 MATHEMATICAL MODEL FOR ANALYZING RIDE AND COMFORT CHARACTERISTICS
 - 4.2.1 A Model for the Prediction of Ride Comfort From a Passenger Viewpoint (Civil or Military)
 - 4.2.2 A Model for the Prediction of Ride Comfort from a Crew Station Viewpoint (Civil or Military)
 - 4.3 STEP-BY-STEP PROCEDURE FOR ANALYZING RIDE AND COMFORT CHARACTERISTICS
- 5. PERFORMANCE
 - 5.1 STALL
 - 5.1.1 Applicable Regulations
 - 5.1.2 Relationship to preliminary design
 - 5.1.3 Mathematical Model for Analyzing Stall
 - 5.1.4 Step-by-Step Procedure for Analyzing Stall
 - 5.2 TAKE-OFF
 - 5.2.1 Applicable Regulations
 - 5.2.2 Relationship to Preliminary Design
 - 5.2.3 Mathematical Model for Analyzing Takeoff Performance

**Airplane Design Part VII:
Determination of Stability, Control and Performance
Table of Contents**

- 5.2.4 Step-by-Step Procedure for Analyzing Takeoff Performance
- 5.3 CLIMB
 - 5.3.1 Applicable Regulations
 - 5.3.2 Relationship to Preliminary Design
 - 5.3.3 Mathematical Model for Analyzing Climb Performance
 - 5.3.4 Step-by-Step Procedure for Analyzing Climb Performance
- 5.4 CRUISE, RANGE AND PAYLOAD-RANGE
 - 5.4.1 Applicable Regulations
 - 5.4.2 Relationship to Preliminary Design
 - 5.4.3 Mathematical Model for Analyzing Cruise and Range Performance
 - 5.4.4 Step-by-Step Procedure for Analyzing Cruise and Range Performance
- 5.5 ENDURANCE AND LOITER
 - 5.5.1 Applicable Regulations
 - 5.5.2 Relationship to Preliminary Design
 - 5.5.3 Mathematical Model for Analyzing Endurance and Loiter
 - 5.5.4 Step-by-Step Procedure for Analyzing Endurance and Loiter
- 5.6 DIVE
 - 5.6.1 Applicable Regulations
 - 5.6.2 Relationship to Preliminary Design
 - 5.6.3 Mathematical Model for Analyzing Dives
 - 5.6.4 Step-by-Step Procedure for Analyzing Dives
- 5.7 MANEUVERING
 - 5.7.1 Applicable Regulations
 - 5.7.2 Relationship to Preliminary Design
 - 5.7.3 Mathematical Model for Analyzing Maneuvering Flight
 - 5.7.4 Step-by-Step Procedure for Analyzing Maneuvering Flight
- 5.8 DESCENT AND GLIDE
 - 5.8.1 Applicable Regulations
 - 5.8.2 Relationship to Preliminary Design
 - 5.8.3 Mathematical Model for Analyzing Descent and Glide
 - 5.8.4 Step-by-Step Procedure for Analyzing Descent and Glide
- 5.9 LANDING
 - 5.9.1 Applicable Regulations
 - 5.9.2 Relationship to Preliminary Design
 - 5.9.3 Mathematical Model for Analyzing Landing Performance
 - 5.9.4 Step-by-Step Procedure for Analyzing Landing Performance
- 5.10 MISSION PROFILE ANALYSIS
- 5.11 PRODUCTIVITY
- 5.12 PRESENTATION OF AIRPLANE PERFORMANCE DATA
- 6. REFERENCES
- 7. INDEX
- APPENDIX A: CIVIL AIRWORTHINESS REGULATIONS FOR AIRPLANE PERFORMANCE, STABILITY AND CONTROL
 - A1. Definitions and Abbreviations
 - A2. Federal Aviation Regulation: FAR 23, with 1987 Amendments
 - A3. Federal Aviation Regulation: FAR 25
- APPENDIX B: MILITARY AIRWORTHINESS REGULATIONS FOR AIRPLANE PERFORMANCE, STABILITY AND CONTROL
 - B1. Airplane Performance
 - B1.1 MIL-C-005011B(USAF): Military Specification, Charts: Standard Aircraft Characteristics and Performance,
Piloted Aircraft (Fixed Wing)
 - B1.2 AS-5263(USNAVY): Naval Air Systems Command Specification, Guidelines for the Preparation of Standard

**Airplane Design Part VII:
Determination of Stability, Control and Performance
Table of Contents**

Aircraft Characteristics Charts and Performance Data, Piloted Aircraft (Fixed Wing)

B2. Airplane Stability, Control and Flying Qualities

B2.1 MIL-F-8785C: Military Specification, Flying Qualities of Piloted Airplanes

APPENDIX C: THE AIRWORTHINESS CODE AND THE RELATIONSHIP BETWEEN FAILURE STATES,
LEVELS OF PERFORMANCE AND LEVELS OF FLYING QUALITIES

APPENDIX D: INERTIA TRANSFORMATIONS