

**CHAPTER 1****Laws and Definitions**

Introduction .....	1-1
SI Units .....	1-1
Derived Units .....	1-1
Airspeeds.....	1-5
Newton's Laws of Motion .....	1-5

**CHAPTER 2****The Flight Environment**

Introduction .....	2-1
The Atmosphere .....	2-1
The Universal Gas Law.....	2-1
The Effect of Pressure on Density .....	2-1
The Effect of Temperature on Density .....	2-2
The Effect of Altitude on Density.....	2-2
The Effect of Humidity on Density.....	2-2
The International Standard Atmosphere .....	2-2

**CHAPTER 3****Aircraft Components and Terminology**

Wing Position Terminology .....	3-1
Wing Planform Terminology .....	3-2
Wing Section Terminology .....	3-6
Aerofoil Cross-sectional Shapes .....	3-7

**CHAPTER 4****Lift**

Introduction .....	4-1
Airflow .....	4-1
Equation of Continuity .....	4-3
Bernoulli's Theorem .....	4-4
Angle of Attack.....	4-6
Two-Dimensional Airflow about an Aerofoil.....	4-8
Effect of Angle of Attack on the Airflow about an Aerofoil Section .....	4-9
Chordwise Pressure Distributions about an Aerofoil Section .....	4-11
The Centre of Pressure.....	4-14
Aerodynamic Centre .....	4-16
Lift Formula .....	4-17
Variation of Coefficient of Lift with Angle of Attack .....	4-17
Three-Dimensional Airflow About an Aerofoil.....	4-18
Wing Shape and its Effect on Lift .....	4-21

**CHAPTER 5****Drag**

Introduction .....	5-1
Form Drag .....	5-2
Boundary Layer .....	5-4
Skin Friction Drag .....	5-7
Factors Affecting Skin Friction Drag .....	5-7
Interference Drag .....	5-8
Induced Drag .....	5-9
Factors Affecting Induced Drag .....	5-10
Methods to Reduce Induced Drag .....	5-14
Drag Formula .....	5-15
Drag Curves .....	5-16
Lift/Drag Ratio .....	5-18

**CHAPTER 6****Flying Controls**

Introduction .....	6-1
Elevators .....	6-2
The Stabilator .....	6-2
The Rudder .....	6-3
Ailerons .....	6-4
Adverse Aileron Yaw .....	6-5
Combined Primary Control Surfaces .....	6-6
Aerodynamic Balance .....	6-9
Tabs .....	6-12
Mass Balance .....	6-14
Powered Flying Controls .....	6-14
Powered Flying Control System .....	6-16
Layout and Requirements .....	6-16
Control Input Systems .....	6-16
The Power Control Unit (PCU) .....	6-17
Artificial Feel Systems .....	6-19
Trimming Control Systems .....	6-22
Principle of a Trim Tab .....	6-22
Trimming of Powered Flying Controls .....	6-25
Spoilers .....	6-30

**CHAPTER 7****Lift Augmentation**

Basic Lift Augmentation System .....	7-1
Trailing Edge Flaps .....	7-2
Types of Trailing Edge Flaps .....	7-3
Comparison of Different Types of Trailing Edge Flap .....	7-5
The Effect of Trailing Edge Flaps on the Stalling Angle .....	7-6
The Effect of Trailing Edge Flaps on the Stall Speed .....	7-6
Operation of Trailing Edge Flaps .....	7-7
Use of Trailing Edge Flaps for Take-off .....	7-8
The Effects of Raising the Flaps in Flight .....	7-9
The Use of Trailing Edge Flaps During the Approach and Landing .....	7-9
High Lift Devices on Transport Category Aircraft .....	7-10
Leading Edge High Lift Devices .....	7-11
The Effect of Leading Edge Flaps on the Stalling Angle .....	7-16
The Operation of High Lift Devices on Transport Category Aircraft .....	7-17
Protection of High Lift Devices on Transport Category Aircraft .....	7-19

**CHAPTER 8****Stalling**

Introduction .....	8-1
Separated Airflow.....	8-1
The Stalling Angle of Attack.....	8-4
Definition of the JAR/FAR Stalling Speed (VS).....	8-5
The Relationship between Stalling Speed and Lift.....	8-5
Recognition of the Stall at Low Airspeeds.....	8-8
Stall Warning in Light Aircraft.....	8-8
Recovery from a Normal Stall .....	8-9
The Effect of Wing Section on the Stall.....	8-9
The Effect of Wing Planform on the Stall .....	8-10
The Cause of Pitch-up on Sweptback Wings at the Stall .....	8-13
Devices to Alleviate Wing Tip Stalling.....	8-14
Stall Sensing in Transport Category Aircraft .....	8-16
The Stall Warning System on Transport Category Aircraft.....	8-17
The Stall Prevention System on Transport Category Aircraft.....	8-17
Super Stall (Deep Stall) .....	8-18
Accelerated or 'G'-Stall .....	8-19
Spinning .....	8-19
Recovery from a Spin .....	8-24

**CHAPTER 9****Forces Acting On An Aeroplane**

Forces in Steady Level Flight.....	9-1
Lift/Weight and Thrust/Drag Couples .....	9-2
The Contribution of the Tailplane .....	9-5
Straight Steady Climb .....	9-6
Forces in a Straight Steady Climb.....	9-7
Straight Steady Descent (Dive).....	9-8
Steady Straight Glide .....	9-9
Forces in a Steady Straight Glide .....	9-10
The Effect of the Lift/Drag Ratio on Glide Performance .....	9-11
The Effect of a Steady Wind on Glide Performance.....	9-12
The Effect of Weight on Glide Performance.....	9-13
Steady Co-ordinated Turn.....	9-13
Forces Acting on an Aircraft During a Steady Co-ordinated Turn .....	9-14
Calculation of the Centripetal Force.....	9-14
Turning an Aircraft .....	9-14
Factors Affecting an Aircraft's Radius of Turn .....	9-16
Balancing the Turn.....	9-19
Rate of Turn .....	9-21
Load Factor.....	9-21
The Effect of Turning on Stalling Speed .....	9-22
Aircraft Response During a Level Banked Turn .....	9-24
Aircraft Response During Climbing and Descending Turns .....	9-25

**CHAPTER 10****Stability**

Introduction to Stability .....	10-1
Controllability .....	10-1
Static Stability .....	10-2
The Degree of Stability .....	10-2
Dynamic Stability .....	10-3
Static Longitudinal Stability .....	10-3
Mathematical Representation of Static Longitudinal Stability .....	10-4
Factors Affecting Static Longitudinal Stability .....	10-6
Graphical Representation of Static Longitudinal Stability .....	10-9
The Effect of Elevator Deflection on Pitching Moments .....	10-11
Control Force Stability .....	10-12
Manoeuvring Stability .....	10-14
Tailoring The Control Forces .....	10-15
Dynamic Longitudinal Stability .....	10-16
Pilot Induced Oscillations .....	10-17
Directional Static Stability .....	10-17
Graphical Representation of Static Directional Stability .....	10-18
The Factors Affecting Static Directional Stability .....	10-18
Lateral Static Stability .....	10-21
Graphical Representation of Static Lateral Stability .....	10-25
Factors Affecting Static Lateral Stability .....	10-26
Interaction Between Lateral and Directional Static Stability .....	10-26
Dutch Roll .....	10-27
Yaw Damper Systems .....	10-28
Speed Stability .....	10-30

**CHAPTER 11****Ground Effect**

Introduction .....	11-1
The Characteristics of Ground Effect .....	11-1
The Influence of Ground Effect on Landing .....	11-4
The Influence of Ground Effect on Take-Off .....	11-4
The Influence of Ground Effect on Trailing Edge Flaps .....	11-4

**CHAPTER 12****Propellers**

Introduction .....	12-1
Propeller Terminology .....	12-1
Factors Affecting the Blade Angle of Attack .....	12-3
Factors Affecting the Blade Thrust Distribution .....	12-6
Forces Acting on a Blade Section .....	12-6
Centrifugal Turning Moment (CTM) .....	12-7
Aerodynamic Turning Moment (ATM) .....	12-8
Centrifugal Forces .....	12-8
Thrust Bending Forces .....	12-9
Torque Bending Forces .....	12-9
Propeller Efficiency .....	12-9
Forces Acting on a Windmilling Blade Section .....	12-11
Propeller Pitch .....	12-12
Disadvantages of Fixed Pitch Propellers .....	12-14
The Variable and Constant Speed Propeller .....	12-15
Power Absorption .....	12-16
Propeller Solidity .....	12-16
Propeller Effects on Take-off .....	12-16
Propeller Icing .....	12-20

**CHAPTER 13****Asymmetric Flight**

Introduction .....	13-1
Single Engine Performance .....	13-1
Yawing Moments .....	13-3
Asymmetric Blade Effect.....	13-6
The Effect of Bank .....	13-9
The Effect of Weight .....	13-10
Rolling Moments .....	13-10
Minimum Airspeeds During Asymmetric Flight.....	13-11
Turning Flight.....	13-12
Recognition of a Failed Engine .....	13-12

**CHAPTER 14****High Speed Flight**

Introduction .....	14-1
The Speed of Sound .....	14-1
Pressure Waves from a Moving Source.....	14-2
Nature of Compressibility .....	14-4
Mach Number .....	14-4
Flight Speed Classifications .....	14-5
Comparison of Subsonic and Supersonic Flow Patterns .....	14-6
The Development of Shock Waves.....	14-7
Shock Stall .....	14-10
The Effect of Altitude on the Shock Stall .....	14-13
Buffet Onset Boundary Chart .....	14-14
Methods of Reducing or Delaying the Transonic Drag Rise.....	14-16
Transonic Area Rule .....	14-17
Supercritical Wings .....	14-18
Control Problems in Transonic Flight .....	14-18
Vortex Generators.....	14-20
The Effect of Transonic Flight on Aircraft Trim and Stability .....	14-21
Mach Trim .....	14-22
Supersonic Flight .....	14-22
Oblique Shock Wave .....	14-23
Mach Cone.....	14-23
Expansion Wave .....	14-24
Summary of Supersonic Wave Characteristics .....	14-24

**CHAPTER 15****Flight in Adverse Weather Conditions**

Introduction .....	15-1
Ice and Frost .....	15-1
The Effect of Ice, Frost, and Snow on the Aircraft's Performance .....	15-1
The Effects of Contamination on Maximum Wing Lift Capability .....	15-2
The Effects of Contamination on Flaps and Slats .....	15-4
The Effect of Contamination on Take-off Performance .....	15-6
The Effect of Contamination on Aircraft Landing Performance .....	15-8
Tail Icing.....	15-10
Windshear .....	15-11
Vertical Gusts.....	15-11
Horizontal Gusts.....	15-12
Downdraughts and Updraughts.....	15-13
Indications of a Windshear Encounter.....	15-13
General Recovery from a Windshear Encounter.....	15-14
Recovery from a Windshear Encounter During the Take-off, Approach, and Landing .....	15-14
Microbursts .....	15-15
The Effect of a Microburst Encounter During the Approach .....	15-15
The Effect of a Microburst on Take-off .....	15-16
Airborne Windshear Detection Systems.....	15-17
The Effect of Heavy Rain on Aircraft Performance.....	15-17

**CHAPTER 16****Operating Limitations**

Introduction .....	16-1
The Flight Operating Envelope.....	16-2
Manoeuvre and Gust Loads.....	16-4
Aeroelastic Distortion (Aileron Reversal).....	16-5
Emergency Descents .....	16-7