

HELICOPTER AERODYNAMICS STRUCTURES AND SYSTEMS

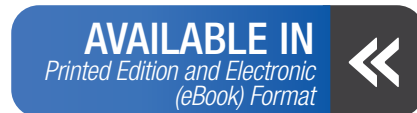
Aviation Maintenance Technician Certification Series



72413 U.S. Hwy 40
Tabernash, CO 80478-0270 USA

www.actechbooks.com

+1 970 726-5111



AVIATION MAINTENANCE TECHNICIAN CERTIFICATION SERIES

Author/Contributor	Dominique Couture
Author/Contributor	Laurence Peyrebrune
Author/Contributor	Peter Vosbury
Contributor	Jim Morris
Layout/Design	Michael Amrine

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WELCOME

The publishers of this Aviation Maintenance Technician Certification Series welcome you to the world of aviation maintenance. As you move towards EASA certification, you are required to gain suitable knowledge and experience in your chosen area. Qualification on basic subjects for each aircraft maintenance license category or subcategory is accomplished in accordance with the following matrix. Where applicable, subjects are indicated by an "X" in the column below the license heading.

For other educational tools created to prepare candidates for licensure, contact Aircraft Technical Book Company.

We wish you good luck and success in your studies and in your aviation career!

REVISION LOG

VERSION	EFFECTIVE DATE	DESCRIPTION OF CHANGE
001	2022 03	Module Creation and Release
001.1	2022 03	Label Correction for Figure 2-1; Page 2.2

MODULE EDITIONS AND UPDATES

ATB EASA Modules are in a constant state of review for quality, regulatory updates, and new technologies. This book's edition is given in the revision log above. Update notices will be available Online at www.actechbooks.com/revisions.html

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FORWARD

PART-66 and the Acceptable Means of Compliance (AMC) and Guidance Material (GM) of the European Aviation Safety Agency (EASA), Appendix 1 establishes the Basic Knowledge Requirements for those seeking an aircraft maintenance license. The information in this Module of the Aviation Maintenance Technical Certification Series published by Aircraft Technical Book Company meets or exceeds the breadth and depth of knowledge subject matter referenced in Appendix 1 of the Implementing Rules. However, the order of the material presented is at the discretion of the editor in an effort to convey the required knowledge in the most sequential and comprehensible manner. Knowledge levels required for Category A1, B1, B2, and B3 aircraft maintenance licenses remain unchanged from those listed in Appendix 1 Basic Knowledge Requirements. Tables from Appendix 1 Basic Knowledge Requirements are reproduced at the beginning of each module in the series and again at the beginning of each Sub-Module.

How numbers are written in this book:

This book uses the International Civil Aviation Organization (ICAO) standard of writing numbers. This method displays large numbers by adding a space between each group of 3 digits. This is opposed to the American method which uses commas and the European method which uses periods. For example, the number one million is expressed as so:

ICAO Standard	1 000 000
European Standard	1.000.000
American Standard	1,000,000

SI Units:

The International System of Units (SI) developed and maintained by the General Conference of Weights and Measures (CGPM) shall be used as the standard system of units of measurement for all aspects of international civil aviation air and ground operations.

Prefixes:

The prefixes and symbols listed in the table below shall be used to form names and symbols of the decimal multiples and submultiples of International System of Units (SI) units.

MULTIPLICATION FACTOR	PREFIX	SYMBOL
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^9	giga	G
1 000 000 = 10^6	mega	M
1 000 = 10^3	kilo	k
100 = 10^2	hecto	h
10 = 10^1	deca	da
0.1 = 10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

International System of Units (SI) Prefixes

EASA LICENSE CATEGORY CHART

Module Number and Title		A1 Airplane Turbine	B1.1 Airplane Turbine	B1.2 Airplane Piston	B1.3 Helicopter Turbine	B1.4 Helicopter Piston	B2 Avionics
1	Mathematics	X	X	X	X	X	X
2	Physics	X	X	X	X	X	X
3	Electrical Fundamentals	X	X	X	X	X	X
4	Electronic Fundamentals		X	X	X	X	X
5	Digital Techniques / Electronic Instrument Systems	X	X	X	X	X	X
6	Materials and Hardware	X	X	X	X	X	X
7A	Maintenance Practices	X	X	X	X	X	X
8	Basic Aerodynamics	X	X	X	X	X	X
9A	Human Factors	X	X	X	X	X	X
10	Aviation Legislation	X	X	X	X	X	X
11A	Turbine Aeroplane Aerodynamics, Structures and Systems	X	X				
11B	Piston Aeroplane Aerodynamics, Structures and Systems			X			
12	Helicopter Aerodynamics, Structures and Systems				X	X	
13	Aircraft Aerodynamics, Structures and Systems						X
14	Propulsion						X
15	Gas Turbine Engine	X	X		X		
16	Piston Engine			X		X	
17A	Propeller	X	X	X			

GENERAL KNOWLEDGE REQUIREMENTS

MODULE 12 SYLLABUS AS OUTLINED IN PART-66, APPENDIX 1

Level 1

A familiarization with the principal elements of the subject.

Objectives:

- The applicant should be familiar with the basic elements of the subject.
- The applicant should be able to give a simple description of the whole subject, using common words and examples.
- The applicant should be able to use typical terms.

Level 2

A general knowledge of the theoretical and practical aspects of the subject and an ability to apply that knowledge.

Objectives:

- The applicant should be able to understand the theoretical fundamentals of the subject.
- The applicant should be able to give a general description of the subject using, as appropriate, typical examples.
- The applicant should be able to use mathematical formula in conjunction with physical laws describing the subject.
- The applicant should be able to read and understand sketches, drawings and schematics describing the subject.
- The applicant should be able to apply his knowledge in a practical manner using detailed procedures.

Level 3

A detailed knowledge of the theoretical and practical aspects of the subject and a capacity to combine and apply the separate elements of knowledge in a logical and comprehensive manner.

Objectives:

- The applicant should know the theory of the subject and interrelationships with other subjects.
- The applicant should be able to give a detailed description of the subject using theoretical fundamentals and specific examples.
- The applicant should understand and be able to use mathematical formula related to the subject.
- The applicant should be able to read, understand and prepare sketches, simple drawings and schematics describing the subject.
- The applicant should be able to apply his knowledge in a practical manner using manufacturer's instructions.
- The applicant should be able to interpret results from various sources and measurements and apply corrective action where appropriate.

PART-66 - APPENDIX I

BASIC KNOWLEDGE REQUIREMENTS

LEVELS

B1.3
B1.4

12.1 - *Theory of Flight – Rotary Wing Aerodynamics*

2

Terminology;
Effects of gyroscopic precession;
Torque reaction and directional control;
Dissymmetry of lift, Blade tip stall;
Translating tendency and its correction;
Coriolis effect and compensation;
Vortex ring state, power settling, overpitching;
Auto-rotation;
Ground effect.

12.2 - *Flight Control Systems*

3

Cyclic control;
Collective control;
Swashplate;
Yaw control: Anti Torque Control, Tail rotor, bleed air;
Main Rotor Head: Design and Operation features;
Blade Dampers: Function and construction;
Rotor Blades: Main and tail rotor blade construction and attachment;
Trim control, fixed and adjustable stabilizers;
System operation: manual, hydraulic, electrical and fly-by-wire;
Artificial feel;
Balancing and rigging.

12.3 - *Blade Tracking and Vibration Analysis*

3

Rotor alignment;
Main and tail rotor tracking;
Static and dynamic balancing;
Vibration types, vibration reduction methods;
Ground resonance.

12.4 - *Transmission*

3

Gear boxes, main and tail rotors;
Clutches, free wheel units and rotor brake;
Tail rotor drive shafts, flexible couplings, bearings, vibration dampers and bearing hangers.

12.5 - *Airframe Structures*

2

- (a) Airworthiness requirements for structural strength;
Structural classification, primary, secondary and tertiary;
Fail safe, safe life, damage tolerance concepts;
Zonal and station identification systems;
Stress, strain, bending, compression, shear, torsion, tension, hoop stress, fatigue;
Drains and ventilation provisions;
System installation provisions;
Lightning strike protection provision;

PART-66 - APPENDIX I

BASIC KNOWLEDGE REQUIREMENTS

- (b) Construction methods of: stressed skin fuselage, formers, stringers, longerons, bulkheads, frames, doublers, struts, ties, beams, floor structures, reinforcement, methods of skinning and anti corrosive protection.
 Pylon, stabilizer and undercarriage attachments;
 Seat installation;
 Doors: construction, mechanisms, operation and safety devices;
 Windows and windscreen construction;
 Fuel storage;
 Firewalls;
 Engine mounts;
 Structure assembly techniques: riveting, bolting, bonding;
 Methods of surface protection, such as chromating, anodizing, painting;
 Surface cleaning.
 Airframe symmetry: methods of alignment and symmetry checks.

2

12.6 - Air Conditioning (ATA 21)

12.6.1 - Air supply

Sources of air supply including engine bleed and ground cart.

2

12.6.2 - Air conditioning

Air conditioning systems;
 Distribution systems;
 Flow and temperature control systems;
 Protection and warning devices.

3

12.7 - Instruments / Avionic Systems

12.7.1 - Instrument Systems (ATA 31)

Pitot static: altimeter, air speed indicator, vertical speed indicator;
 Gyroscopic: artificial horizon, attitude director, direction indicator, horizontal situation indicator, turn and slip indicator, turn coordinator;
 Compasses: direct reading, remote reading;
 Vibration indicating systems - HUMS;
 Glass cockpit;
 Other aircraft system indication.

2

12.7.2 - Avionic Systems

Fundamentals of system layouts and operation of:
 Auto Flight (ATA 22);
 Communications (ATA 23);
 Navigation Systems (ATA 34).

1

PART-66 - APPENDIX I

BASIC KNOWLEDGE REQUIREMENTS

LEVELS

B1.3
B1.4

12.8 - Electrical Power (ATA 24)

Batteries Installation and Operation;
DC power generation, AC power generation;
Emergency power generation;
Voltage regulation, Circuit protection.
Power distribution;
Inverters, transformers, rectifiers;
External/Ground power.

3

12.9 - Equipment and Furnishings (ATA 25)

(a) Emergency equipment requirements;
Seats, harnesses and belts;
Lifting systems;

2

(b) Emergency flotation systems;
Cabin layout, cargo retention;
Equipment layout;
Cabin Furnishing Installation.

1

12.10 - Fire Protection (ATA 26)

Fire and smoke detection and warning systems;
Fire extinguishing systems;
System tests.

3

12.11 - Fuel Systems (ATA 28)

System layout;
Fuel tanks;
Supply systems;
Dumping, venting and draining;
Cross-feed and transfer;
Indications and warnings;
Refueling and defuelling.

3

12.12 - Hydraulic Power (ATA 29)

System layout;
Hydraulic fluids;
Hydraulic reservoirs and accumulators;
Pressure generation: electric, mechanical, pneumatic;
Emergency pressure generation;
Filters;
Pressure Control;
Power distribution;
Indication and warning systems;
Interface with other systems.

3

PART-66 - APPENDIX I

BASIC KNOWLEDGE REQUIREMENTS

12.13 - Ice And Rain Protection (ATA 30)

Ice formation, classification and detection;
Anti-icing and De-icing systems: electrical, hot air and chemical;
Rain repellent and removal;
Probe and drain heating;
Wiper system.

3

12.14 - Landing Gear (ATA 32)

Construction, shock absorbing;
Extension and retraction systems: normal and emergency;
Indications and warning;
Wheels, Tires, brakes;
Steering;
Air-ground sensing;
Skids, floats.

3

12.15 - Lights (ATA 33)

Light sources;
External: navigation, landing, taxiing, ice;
Internal: cabin, cockpit, cargo;
Emergency.

3

12.16 - Pneumatic/Vacuum (ATA 36)

High pressure systems;
Medium pressure systems;
System layout;
Sources: engine/APU, compressors, reservoirs, ground supply;
Pressure control;
Distribution;
Indications and warnings;
Interfaces with other systems.

3

12.17 - Integrated Modular Avionics (ATA 42)

Functions that may be typically integrated in the Integrated Modular Avionic (IMA) modules are, among others:
Bleed Management, Air Pressure Control, Air Ventilation and Control, Avionics and Cockpit Ventilation Control, Temperature Control, Air Traffic Communication, Avionics Communication Router, Electrical Load Management, Circuit Breaker Monitoring, Electrical System BITE, Fuel Management, Braking Control, Steering Control, Landing Gear Extension and Retraction, Tire Pressure Indication, Oleo Pressure Indication, Brake Temperature Monitoring, etc.
Core System;
Network Components.

2

PART-66 - APPENDIX I BASIC KNOWLEDGE REQUIREMENTS

LEVELS

B1.3
B1.4

12.18 - On Board Maintenance Systems (ATA 45)

Central maintenance computers;
Data loading system;
Electronic library system;
Printing;
Structure monitoring (damage tolerance monitoring).

2

12.19 - Information Systems (ATA 46)

Information Systems consist of the units and components which furnish a means of storing, updating and retrieving digital information traditionally provided on paper, microfilm or microfiche. They include units that are dedicated to the information storage and retrieval function such as the electronic library mass storage and controller. They do not include units or components installed for other uses and shared with other systems, such as the flight deck printer or general use display.

2

Typical examples include:

Air Traffic and Information Management
Systems and Network Server Systems.
Aircraft General Information System;
Flight Deck Information System;
Maintenance Information System;
Passenger Cabin Information System;
Miscellaneous Information System.

HELICOPTER AERODYNAMICS STRUCTURES AND SYSTEMS

Welcome	iii
Revision Log.....	iii
Forward.....	iv
EASA License Category Chart	v
General Knowledge Requirements	v
Contents	xi

SUB-MODULE 01

THEORY OF FLIGHT – ROTARY WING AERODYNAMICS

Knowledge Requirements	1.1
12.1 - Theory Of Flight, Rotary Wing Aerodynamics	1.2
Historical Perspective	1.2
Introduction To Theory of Flight	1.4
Terminology.....	1.5
Effects of Gyroscopic Precession.....	1.8
Torque Reaction and Directional Control	1.9
Torque Reaction	1.9
Directional Control	1.10
Dissymmetry Of Lift, Blade Tip Stall	1.10
Vertical Flight	1.10
Forward Flight	1.11
Translational Lift	1.11
Effective Translational Lift (ETL)	1.11
Airflow In Forward Flight.....	1.12
Dissymmetry Of Lift.....	1.12
Blade Tip Stall	1.13
Translating Tendency and Correction.....	1.14
Coriolis Effect And Compensation.....	1.14
Coning.....	1.14
Coriolis Effect	1.15
Vortex Ring State, Power Settling, Overpitching ..	1.16
Vortex Ring State/Power Settling	1.16
Overpitching	1.16
Autorotation	1.17
Hovering Autorotation	1.17
Ground Effect	1.19
In Ground Effect (IGE)	1.19
Out of Ground Effect (OGE).....	1.19
Questions	1.21
Answers	1.22

SUB-MODULE 02

FLIGHT CONTROL SYSTEMS

Knowledge Requirements	2.1
12.2 - Flight Control Systems	2.2
Introduction	2.2
Cyclic Control.....	2.2
Collective Control.....	2.3
Throttle Control	2.3
Correlator	2.4
Governor	2.4
Swashplate.....	2.4
The Cyclic Movement And The Swashplate ..	2.5
Longitudinal And Lateral Movement.....	2.5
The Collective Movement And The Swashplate	2.6
Yaw Control: Anti-Torque Control, Tail Rotor,	
Bleed Air	2.7
Anti-Torque Control, Tail Rotor	2.7
The Tail Collective Hinge	2.8
The Tail Flapping Hinge	2.8
The Tail and Pedal Connection	2.9
Different Solutions	2.9
The Fenestron Solution	2.10
The Bleed Air NOTAR System.....	2.11
Main Rotor Head: Design And Operation	
Features	2.12
Fully Articulated Rotor Systems	2.12
Semi-Rigid Rotor Systems.....	2.14
Rigid Rotor Systems	2.15
Bearingless Rotor Systems	2.15
Blade Dampers: Function And Construction	2.16
Hydraulic Damper	2.16
Multiple Disk Damper.....	2.16
Elastomeric Damper	2.16
Rotor Blades: Main And Tail Rotor Blade	
Construction And Attachment	2.17
Main And Tail Rotor Blade Construction	
And Attachment	2.17
Wooden Rotor Blades	2.18
Metal Rotor Blades	2.18
Composite Rotor Blades	2.18
Blade Attachment	2.19
Tail Rotor Blade Construction	
And Attachment	2.20
Fenestron Tail Rotors.....	2.22
NOTAR Type Anti-Torque Rotor	2.23
Trim Control, Fixed And Adjustable Stabilizers	2.24
Vertical And Horizontal Stabilizers	2.24

CONTENTS

System Operation: Manual, Hydraulic, Electrical And Fly-By-Wire	2.26
Manual Operation	2.26
Hydraulic Operation	2.26
Electrical Fly-By-Wire Operation	2.26
Stability Augmentation System (SAS)	2.26
Artificial Feel	2.28
Friction	2.28
Elastic Rod	2.29
Hydraulic Damper	2.29
Balancing And Rigging	2.29
Rods	2.29
Transmission Unit	2.30
Relay	2.30
Balancing	2.30
Bellcrank	2.31
Rigging	2.32
Questions	2.37
Answers	2.38

SUB-MODULE 03

BLADE TRACKING AND VIBRATION ANALYSIS

Knowledge Requirements	3.1
12.3 - Blade Tracking And Vibration Analysis	3.2
Introduction	3.2
Vibration Types	3.2
Vibration Example	3.2
Imbalance	3.3
Track	3.4
Ground Resonance	3.4
Vibration Reduction Methods	3.5
Amplitude Reduction	3.5
Vibration Opposition	3.5
Static And Dynamic Balancing	3.6
Static Balancing	3.6
Dynamic Balancing	3.8
Rotor Alignment	3.9
Main Rotor And Tail Rotor Tracking	3.9
Questions	3.13
Answers	3.14

SUB-MODULE 04

TRANSMISSION

Knowledge Requirements	4.1
12.4 - Transmission	4.2
Introduction: Power Transmission	4.2

Gear Boxes, Main And Tail Rotors	4.2
Gear Boxes	4.2
Main and Tail Rotors	4.2
Clutches, Free wheel Units And Rotor Brakes	4.5
Clutches	4.5
Free Wheel Units	4.6
Rotor Brakes	4.6
Tail Rotor Drive Shafts, Flexible Couplings, Bearings, Vibration Dampeners And Bearing Hangers	4.6
Tail Rotor Drive Shafts	4.6
Flexible Couplings	4.7
Bearings	4.8
Bearings for Transmissions	4.8
Elastomeric Bearings	4.8
Maintenance of Bearings	4.8
Vibration Dampers	4.9
Classification of Vibration Dampers	4.9
Resonant Mass	4.9
Nodal Beam	4.9
Pendulum Damper or Bifilar	4.9
Hydraulic Damper	4.9
Computer Controlled Dampers	4.9
Bearing Hangers	4.9
Questions	4.11
Answers	4.12

SUB-MODULE 05

AIRFRAME STRUCTURES

Knowledge Requirements	5.1
12.5 - Airframe Structure	5.2
Part A	5.2
Airworthiness Requirements For Structural Strength	5.2
Certification Specification (CS) 27	5.2
Certification Specification (CS) 29	5.2
Structural Classification, Primary, Secondary, Tertiary	5.3
Primary Structure	5.3
Secondary Structure	5.3
Tertiary Structure	5.3
Fail Safe, Safe Life, Damage Tolerance Concepts ..	5.3
Fail-Safe Concept	5.3
Examples Of Fail Safe Design Techniques	5.4
Safe Life Concept	5.4
Damage Tolerance Concept	5.4
Zonal And Station Identification Systems	5.4
Zonal System	5.4
Station Identification System	5.5

Stress, Strain, Bending, Compression, Shear, Torsion, Tension, Hoop Stress, Fatigue.....	5.6	Bonding.....	5.17
Stress and Strain	5.6	Methods Of Surface Protection: Chromating, Anodizing, Painting, Cladding.....	5.18
Tension	5.6	Chromating.....	5.18
Compression	5.6	Anodizing	5.18
Torsion.....	5.6	Painting	5.18
Shear	5.6	Cladding	5.18
Bending	5.7	Surface Cleaning	5.18
Hoop Stress.....	5.7	Exterior Aircraft Cleaning	5.19
Metal Fatigue	5.7	Airframe Symmetry: Methods Of Alignment And Symmetry Checks	5.19
Drains And Ventilation Provisions	5.8	Lateral Control Of The Tail Position	5.20
Drains	5.8	Horizontal Control Of The Tail Position.....	5.20
Ventilation.....	5.8	Questions	5.25
System Installation Provisions.....	5.8	Answers	5.26
Lightning Strike Protection Provisions.....	5.9		
Bonding Procedures And Precautions	5.9		
Part B	5.10	SUB-MODULE 06	
Construction Methods Of: Stressed Skin Fuselage, Formers, Stringers, Longerons, Bulkheads, Frames, Doublers, Struts, Ties, Beams, Floor Structures, Reinforcement, Methods Of Skinning And Anti-Corrosive Protection.....	5.10	AIR CONDITIONING (ATA 21)	
Truss Type.....	5.10	Knowledge Requirements	6.1
Stressed Skin Fuselage	5.10	12.6 - Air Conditioning (ATA 21)	6.2
Bonded And Composite Construction.....	5.12	12.6.1 - Air Supply.....	6.2
Formers, Stringers, Longerons, Bulkheads, Frames	5.12	Sources Of Air Supply Including Engine Bleed And Ground Cart	6.2
Doublers	5.12	Certification Specifications.....	6.2
Struts And Ties.....	5.12	Extract from EASA CS 29.831 Ventilation ..	6.2
Beams, Floor Structures, And Reinforcements ..	5.12	Ram Air	6.2
Skinning	5.13	Bleed Air.....	6.2
Anti-Corrosive Protection	5.13	Bleed Air From An Engine	6.2
Pylon, Stabilizer, And Undercarriage Attachments	5.14	Bleed Air From An APU.....	6.2
Fuselage and Tail Structure	5.14	Ground Cart	6.3
Pylon	5.14	Heated Air Sources.....	6.3
Stabilizer	5.14	Heaters	6.3
Undercarriage Attachments	5.15	Heat Exchangers	6.3
Seat Installation	5.15	Combustion Heaters	6.3
Doors: Construction, Mechanisms, Operation, And Safety Devices	5.15	Humidity Control.....	6.3
Windows And Windscreen Construction	5.16	12.6.2 - Air Conditioning.....	6.4
Fuel Storage	5.16	Air Conditioning Systems.....	6.4
Firewalls.....	5.17	Vapor Cycle Air Conditioning	6.4
Engine Mounts	5.17	Basic Vapor Cycle	6.5
Structure Assembly Techniques: Riveting, Bolting, Bonding	5.17	Vapor Cycle Air Conditioning System Components	6.5
Riveting, Bolting.....	5.17	Refrigerant	6.5
		Receiver Dryer	6.6
		Thermal Expansion Valve	6.7
		Evaporator	6.8
		Compressor.....	6.10
		Condenser.....	6.10

CONTENTS

Service Valves.....	6.11	Flight Instruments	7.3
Vapor Cycle Air Conditioning Servicing		Engine Instruments	7.4
Equipment.....	6.11	Navigation Instruments	7.4
Manifold Set, Gauges, Hoses, And Fittings..	6.12	Pitot-Static Instruments	7.5
Full Service Refrigerant Recovery, Recycling,		Altimeter, Air Speed Indicator, Vertical Speed	
Evacuation, And Recharging Units.....	6.12	Indicator	7.5
Refrigerant Source	6.13	Pitot Tubes And Static Vents Principle	7.5
Vacuum Pumps	6.14	Altimeters	7.7
Leak Detectors	6.14	Airspeed Indicators.....	7.11
System Servicing.....	6.15	Vertical Speed Indicator	7.12
Visual Inspection	6.15	Gyroscopic Instruments.....	7.13
Leak Test	6.15	Artificial Horizon, Attitude Director, Direction	
Performance Test	6.16	Indicator, Horizontal Situation Indicator, Turn	
Feel Test	6.16	And Slip Indicator, Turn Coordinator	7.13
Purging The System	6.16	Gyroscopic Principles	7.13
Checking Compressor Oil	6.16	Ring Laser Gyro	7.15
Evacuating The System.....	6.16	Micro Electro Mechanical System (MEMS)	7.16
Charging The System	6.17	Artificial Horizon.....	7.16
Air-Cycle Air Conditioning	6.17	Attitude Director	7.18
System Operation	6.17	Direction Indicator	7.18
Pneumatic System Supply.....	6.18	Horizontal Situation Indicator	7.19
Component Operation	6.18	Turn And Slip Indicator.....	7.19
Pack Valves.....	6.18	Turn Coordinators	7.21
Bleed Air Bypass	6.18	Compasses	7.21
Primary Heat Exchanger	6.19	Direct Reading, Remote Reading	7.21
Refrigeration Turbine Unit and		Direct Reading	7.21
Secondary Heat Exchanger	6.19	Magnetic Deviation	7.22
Refrigeration Bypass Valve	6.19	Magnetic Variation	7.23
Distribution Systems	6.20	Dip Error	7.23
Air Ducts	6.20	Vertical Magnetic Compasses	7.23
Flow And Temperature Control Systems	6.20	Remote Reading	7.24
Flow Control System	6.20	Vibration Indicating Systems (HUMS)	7.26
Temperature Control System	6.22	Glass Cockpit.....	7.27
Air Conditioner Control Panel.....	6.22	Other Aircraft System Indications	7.27
Temperature	6.22	Remote Sensing And Indications.....	7.27
Fan Speed	6.22	Synchro Type Remote Indicating Instruments	7.27
Mode Selection	6.22	DC Selsyn Systems	7.28
Protection And Warning Devices.....	6.23	AC Synchro Systems	7.30
Questions	6.25	Remote Indicating	7.30
Answers	6.26	Fuel And Oil Pressure Gauges	7.30
		Mechanical Movement Indicators	7.31
		Tachometers	7.31
		Electric Tachometers	7.32
		Collective Pitch Transmitter	7.33
		Temperature Measuring Instruments.....	7.34
		Non-Electric Temperature Indicators	7.34
		Electric Temperature Indicators	7.35

SUB-MODULE 07

INSTRUMENTS/AVIONIC SYSTEMS

Knowledge Requirements	7.1
12.7 - Instruments/Avionic Systems	7.2
12.7.1 - Instrument Systems (ATA 31)	7.2
Introduction.....	7.2

Ratiometer Electrical Resistance		(TCAS)	7.65
Thermometers.....	7.36	Weather Avoidance Radar	7.65
Thermocouple Temperature Indicators	7.37	Radio Altimeter (RA).....	7.66
Turbine Gas Temperature Indicating Systems	7.38	Questions	7.69
Pressure Measuring Instruments	7.41	Answers	7.70
Types Of Pressure	7.43		
Engine Oil Pressure Instruments	7.43	SUB-MODULE 08	
Manifold Pressure Instruments	7.44	ELECTRICAL POWER (ATA 24)	
Fuel Pressure Instruments	7.45	Knowledge Requirements	8.1
Hydraulic Pressure Instruments	7.45	12.8 - Electrical Power (ATA 24)	8.2
Vacuum Pressure Instruments	7.45	Batteries: Installation And Operation.....	8.2
Pressure Switches	7.45	Lead-Acid Batteries	8.2
12.7.2 - Avionics Systems (ATA 22, 23, 34)	7.46	Valve Regulated (Sealed) Lead-Acid Batteries	
Autoflight (ATA 22)	7.46	(VRLA)	8.2
Stability Augmentation System	7.47	Nickel Cadmium Batteries (NiCd)	8.3
Basic Autopilots (3-Axes)	7.47	Lithium-Ion Batteries	8.3
Superior Modes Of 3-Axes Autopilots.....	7.47	Battery Specifications	8.4
Superior Modes Of 4-Axes Autopilots	7.48	Capacity	8.4
Automatic Transition To The Hover	7.48	Battery Ratings by Specification	8.4
Communications (ATA 23).....	7.48	Battery Installation	8.4
Very High Frequency (VHF) Radios	7.48	Battery Charging	8.5
High Frequency (HF) Radios	7.49	Constant Voltage Charging	8.5
Satellite Communication Systems	7.49	Constant Current Charging	8.5
Service Interphone System	7.49	Battery Maintenance	8.6
Navigation Systems (ATA 34).....	7.49	Battery Overheating.....	8.6
VOR Navigation System.....	7.50	Battery Freezing.....	8.6
Automatic Direction Finder (ADF).....	7.52	Electrolyte Spillage	8.6
Radio Magnetic Indicator (RMI)	7.53	Storage of Batteries	8.6
Instrument Landing Systems (ILS)	7.54	Battery Ventilation Systems	8.6
Localizer	7.54	DC Power Generation; AC Power Generation	8.7
Glideslope	7.55	DC Power Generation	8.7
Compass Locators.....	7.56	AC Power Generation	8.7
Marker Beacons	7.57	Alternator Drive	8.10
Microwave Landing System (MLS).....	7.57	AC Alternator Control Systems	8.12
MLS Expansion Capabilities.....	7.58	Emergency Power Generation.....	8.13
Flight Director Systems; Distance Measuring		Voltage Regulation, Circuit Protection.....	8.13
Equipment (DME)	7.58	Voltage Regulation	8.13
Area Navigation Systems (RNAV)	7.59	Parallel Generator Operations	8.13
Flight Management System	7.60	Differential Voltage.....	8.13
Satellite Navigation Systems.....	7.61	Generator Controls For High Output Generators	8.13
Inertial Navigation System (INS)	7.61	Other Voltage Regulation.....	8.14
Air Traffic Control Transponder, Secondary		Carbon Pile Regulators	8.14
Surveillance Radar	7.62	Three Unit Regulators	8.15
Secondary Surveillance Radar	7.62	Circuit Protection	8.16
Transponder Tests And Inspections.....	7.64	Reverse Current Sensing	8.16
Altitude Encoders.....	7.65	Over Voltage Protection.....	8.16
Traffic Alert And Collision Avoidance System		Over Excitation Protection	8.16

CONTENTS

Current Limiting Devices	8.17	Escape Slides	9.7
Fuses	8.17	Seat Belts And Harnesses.....	9.7
Circuit Breakers	8.17	CS-29.561 Requirements	9.7
Power Distribution	8.18	Passenger Seats.....	9.8
Power Distribution On Small Multi-Engine Aircraft	8.18	Crew Seats	9.8
Power Distribution On Large Aircraft	8.20	Lifting Systems	9.8
Split Bus Systems	8.20	Rescue Hoists	9.8
Parallel Bus Systems.....	8.20	Electric Hoists	9.8
Split Parallel Systems.....	8.21	Hydraulic Hoists	9.10
Inverters, Transformers, And Rectifiers	8.23	Cargo Hooks.....	9.10
Inverters.....	8.23	Four Point Sling Assembly	9.11
Rotary Inverters	8.23	Load Cell	9.11
Permanent Magnet Rotary Inverters.....	8.23	Frangible Link	9.11
Inductor Type Rotary Inverters	8.24	Part B	9.12
Static Inverters	8.25	Emergency Floatation Systems	9.12
Transformers	8.27	Cabin Layout; Cargo Retention	9.12
Voltage Transformers	8.29	Cargo Retention	9.13
Transformer Losses	8.31	Equipment Layout.....	9.13
Power In Transformers.....	8.31	Cabin Furnishing Installation.....	9.14
Rectifiers	8.31	Questions	9.15
Silicon Controlled Rectifiers	8.32	Answers	9.16
Transformer Rectifiers	8.34		
External/Ground Power	8.34	SUB-MODULE 10	
Questions	8.37	FIRE PROTECTION (ATA 26)	
Answers	8.38	Knowledge Requirements	10.1
		12.10 - Fire Protection (ATA 26)	10.2
		Fire Protection	10.2
		Requirements For Fire To Occur	10.2
		Classes Of Fires	10.2
		European Class System	10.2
		American Class System	10.2
		Fire Zones.....	10.2
		Fire Prevention	10.2
		Requirements of EASA Certification	
		Specifications (CS)	10.3
		CS 29.1181 Designated Powerplant Fire	
		Zones Include.....	10.3
		CS 29.1194 Other Surfaces	10.3
		CS 29.1195 Fire Extinguishing Systems	10.3
		Fire And Smoke Detection And Warning Systems	10.3
		Requirements For Overheat And Fire Detection	
		Systems	10.3
		Thermal Switch Systems.....	10.4
		Thermocouple Systems	10.4
		Continuous Loop Systems	10.5
		Fenwal System	10.5
		Kidde System	10.6

SUB-MODULE 09

EQUIPMENT AND FURNISHINGS (ATA 25)

Knowledge Requirements	9.1
12.9 - Equipment and Furnishings (ATA 25).....	9.2
Part A	9.2
Emergency Equipment Requirements	9.2
Fire Extinguishers	9.2
First-Aid Kits.....	9.2
Maintenance Of First-Aid Kits	9.3
Crew Survival Kits	9.3
Life Jackets	9.3
Life Rafts	9.4
Emergency Locator Transmitter (ELT).....	9.4
Types of ELTs	9.5
Emergency Lighting And Marking	9.5
Supplemental Oxygen.....	9.5
Determination Of Oxygen	9.5
Seats, Harnesses, And Belts	9.5
Seats.....	9.5
Emergency Exit Marking.....	9.6

Sensing Elements	10.6	SUB-MODULE 11	
Sensing Element Fault Indication	10.6	FUEL SYSTEMS (ATA 28)	
Combination Fire And Overheat Warning....	10.7	Knowledge Requirements	11.1
Temperature Trend Indication.....	10.7	12.11 - Fuel Systems	11.2
Support Tube Mounted Sensing Elements	10.7	Introduction	11.2
Dual Loop Systems	10.7	Fuel System Layout	11.2
Fire Detection System Maintenance	10.7	Gravity Feed Systems	11.2
Fire Detection System Troubleshooting	10.8	Pressure Feed Fuel System	11.3
Flame Detectors	10.9	Complex Fuel Systems	11.3
Smoke Detection Systems.....	10.9	Fuel Tanks	11.3
Light Refraction Type	10.10	Generalities On Fuel Tanks	11.5
Ionization Type	10.10	Fuel Tank Construction	11.5
Carbon Monoxide Detectors	10.10	Integral Fuel Cells	11.5
Carbon Monoxide Chemical Detectors.....	10.10	Bladder Fuel Tanks	11.5
Carbon Monoxide Monitors (Sensors)	10.10	Fuel Tank Repair	11.6
Fire Extinguishing Systems	10.10	Integral Tanks	11.6
Fire Extinguisher Agents	10.10	Bladder Tanks	11.6
Water - Class A	10.10	Supply Systems.....	11.7
Carbon Dioxide (CO ₂) - Class B or C	10.11	Fuel Feed.....	11.7
Dry Powder Chemicals - Class B, C or D	10.11	Non-Pressurized Fuel Systems	11.7
Halogenated Hydrocarbons - Class A, B, or C	10.11	Pressurized Fuel Systems	11.8
Fixed Container Fire Extinguishing Systems	10.12	Fuel System Components	11.9
Containers	10.12	Lines And Fittings.....	11.9
Discharge Valves	10.12	Fuel Valves	11.10
Pressure Indication.....	10.13	Generalities On Fuel Valves	11.10
Two Way Check Valve	10.13	Manual Valves	11.11
Discharge Indicators	10.13	Motor Operated Valves	11.11
Thermal Discharge Indicator (Red Disk)	10.13	Solenoid Operated Valves	11.12
Normal Discharge Indicator (Yellow Disk) ..	10.13	Fire Shut Off Valves.....	11.12
Fire Switch	10.13	Fuel Pumps	11.12
Fire Extinguisher System Maintenance.....	10.14	Generalities On Fuel Pumps	11.13
Container Pressure Check	10.14	Centrifugal Boost Pumps	11.13
Discharge Cartridges	10.14	Ejector Pumps	11.15
Agent Containers	10.14	Fuel Filters	11.15
Portable Fire Extinguishers.....	10.14	Gaskets, Seals and Packings.....	11.17
Portable Extinguisher Types.....	10.15	Troubleshoot The Fuel System	11.18
Halon Fire Extinguishers	10.15	Dumping, Venting And Draining.....	11.18
Pressurized Water Extinguishers	10.15	Dumping.....	11.18
Non-Suitable Extinguishers.....	10.16	Fuel Vent Systems	11.18
Maintenance And Inspection	10.16	Fuel System Drains.....	11.19
System Tests.....	10.16	Cross Feed And Transfer.....	11.20
Continuous Loop Fire Detection System	10.16	Lateral Balance Systems	11.20
Dual Loop Systems Automatic Self		Cross Feed And Transfer	11.20
Interrogation.....	10.17	Indications And Warnings	11.21
Fire Detection Control Unit	10.17	Fuel Quantity Indicating Systems	11.21
Questions	10.19	Ratiometer Type.....	11.21
Answers	10.20	Capacitance Type	11.21

CONTENTS

Mechanical Type	11.23
Fuel Flow Meters	11.23
Fuel Heating	11.25
Fuel Pressure Gauges	11.25
Pressure Warning Signal	11.26
Fueling And Defueling	11.26
Fueling	11.26
Refueling By Gravity	11.27
Pressure Refueling	11.27
Defueling	11.27
Fire Hazards When Fueling Or Defueling	11.28
Fuel Contamination	11.29
Water	11.29
Solid Particle Contaminants	11.29
Surfactants	11.30
Microorganisms	11.30
Improper Fuel.....	11.31
Laboratory Testing.....	11.32
Questions	11.33
Answers	11.34

SUB-MODULE 12

HYDRAULIC POWER (ATA 29)

Knowledge Requirements	12.1
12.12 - Hydraulic Power	12.2
System Layout	12.2
Open Center Hydraulic Systems	12.2
Closed Center Hydraulic Systems	12.3
Evolution Of Hydraulic Systems	12.3
Hydraulic Power Pack System	12.4
Modern High Performance Systems	12.4
Hydraulic Fluids	12.4
Hydraulic Fluid Properties	12.4
Viscosity	12.4
Chemical Stability	12.4
Flash Point	12.5
Fire Point	12.5
Types Of Hydraulic Fluids	12.5
Mineral Base Fluids	12.5
Polyalphaolefin Base Fluids	12.6
Phosphate Ester Base Fluids	12.6
Intermixing of Fluids.....	12.6
Compatibility With Aircraft Materials.....	12.6
Hydraulic Reservoirs And Accumulators	12.6
Reservoirs	12.6
Non Pressurized Reservoirs	12.7
Pressurized Reservoirs	12.8
Air Pressurized Reservoirs.....	12.8
Fluid Pressurized Reservoirs	12.9
Reservoir Servicing	12.10
Accumulators	12.10
Types of Accumulators.....	12.10
Spherical.....	12.11
Cylindrical	12.12
Maintenance of Accumulators.....	12.12
Heat Exchangers.....	12.12
Pressure Generation: Electric, Mechanical, and Pneumatic	12.12
Mechanical, Electrical, And Pneumatic Driven Pumps	12.12
Hand Pumps	12.13
Single Action Hand Pumps.....	12.13
Double Action Hand Pumps	12.13
Rotary Action Hand Pumps	12.14
Classification Of Pumps.....	12.14
Constant Displacement Pumps	12.14
Gear Type Power Pump.....	12.14
Gerotor Pump	12.15
Piston Pumps	12.15
Bent Axis Piston Pump	12.16
Inline Piston Pump	12.16
Vane Pump	12.16
Variable Displacement Pumps	12.17
Basic Pumping Operation.....	12.17
Normal Pumping Mode.....	12.18
Depressurized Mode	12.19
Hydraulic Seals	12.20
Packings	12.21
V-Rings	12.21
U-Ring	12.21
O-Rings	12.21
Gaskets	12.22
Wipers	12.22
Emergency Pressure Generation	12.22
Hydraulic Motors	12.23
Power Transfer Units (PTUs).....	12.25
Hydraulic Motor Driven Generators (HMDG)	12.26
System Contamination And Filters	12.26
Hydraulic Fluid Contamination.....	12.26
Contamination Check	12.26
Hydraulic Sampling Schedule	12.26
Contamination Control	12.27
Hydraulic System Flushing	12.27
Filters	12.27

SUB-MODULE 13

Knowledge Requirements	13.1
12.13 - Ice And Rain Protection (ATA 30).....	13.2
Ice Formation, Classification And Detection	13.2
Types of Aircraft Ice	13.2
Clear Ice	13.2
Rime Ice	13.2
Gleam Ice	13.3
Hoarfrost	13.3
Icing Effects	13.3
Ice Detection.....	13.3
Pressure Ice Detectors	13.3
Vibrating Ice Detectors	13.4
Hot Rod Ice Detector	13.4
Serrated Rotor Ice Detector Head.....	13.4
Anti-Icing And De-Icing Systems: Electrical, Hot Air And Chemical	13.5
Thermal Anti-Ice Systems	13.6
Thermal Engine Anti-Ice (EAI)	13.6

SUB-MODULE 14

Knowledge Requirements	14.1
12.14 - Landing Gear (ATA 32)	14.2
Landing Gear Construction And Shock Absorbing	14.2
Skid Gears.....	14.2
Floats	14.2
Wheels	14.3
Tail Wheel Type	14.3
Tricycle Nose Wheel Type.....	14.3
Quadricycle Type	14.3
Classification of Landing Gear	14.4
Non-Articulated or Telescopic Type	14.4
Articulated or Levered Suspension Type	14.4
Four-Bar Linkage Mechanism	14.5
Wheelbase	14.5
Wheel Track.....	14.5
Semi-Articulated or Semi-Levered Suspension Type.....	14.5
Fixed and Retractable Landing Gear	14.5
Landing Gear Attachment	14.6
Landing Gear Elements	14.7
Main Landing Gear Elements.....	14.7
Shock Strut Assembly	14.7
Weight-On-Wheels Switch	14.7
Nose/Tail Landing Gear Elements	14.7
Shock Strut Assembly	14.7

CONTENTS

Trailing Arm Assembly	14.9	Outboard Wheel Half	14.29
Fork and Axle Assembly	14.9	On Aircraft Wheel Inspection	14.30
Centering Cams (Locating Cams).....	14.9	Proper Installation	14.31
Landing Gear Material	14.9	Axle Nut Torque	14.31
Corrosion Protection	14.10	Off Aircraft Wheel Inspection	14.31
Shock Absorbing.....	14.10	Disassembly Of The Wheel	14.31
Shock Struts	14.10	Inspection Of The Wheel Halves	14.32
Shock Strut Construction	14.10	Tie Bolt Inspection	14.32
Metering Pins.....	14.10	Key And Key Screw Inspection.....	14.32
Damping Or Snubbing Devices.....	14.11	Fusible Plugs	14.32
Axles.....	14.11	Balance Weights.....	14.32
Valve Fitting Assembly	14.11	Wheel Bearings	14.33
Torque Links	14.11	Inspection Of Wheel Bearings	14.33
Nose Gear Shock Struts.....	14.12	Lubrication of Bearings	14.33
Tail Bumper Assembly.....	14.12	Tires And Tubes	14.34
Jacking Points And Towing Lugs	14.12	Tire Classification	14.34
Shock Strut Instruction Plate	14.12	Ply Rating.....	14.34
Shock Strut Operation.....	14.13	Tube Type Or Tubeless	14.34
Servicing Valves	14.14	Bias Ply Or Radial	14.34
Servicing Shock Struts.....	14.15	Tire Terminology.....	14.34
Bleeding Shock Struts	14.15	Bead	14.34
Extension/Retraction Systems: Normal And		Carcass Plies.....	14.35
Emergency	14.16	Tread.....	14.35
Hydraulic Extension And Retraction Systems ..	14.16	Sidewall	14.36
Hydraulic System Components	14.16	Helicopters Tire Types.....	14.36
Selector Valves	14.16	Tire Inspection.....	14.36
Safety Locks	14.16	Inflation	14.36
Downlock And Uplock Mechanisms	14.17	Tread Condition.....	14.37
Ground Locks	14.18	Tread Damage	14.38
Sequence Valves	14.18	Sidewall Condition	14.39
Actuators	14.18	Tire Storage	14.40
Electric Extension And Retraction Systems	14.19	Tubes	14.40
Electric/Hydraulic Extension And Retraction		Tube Construction And Selection.....	14.40
Systems	14.20	Tube Storage And Inspection	14.41
Pneumatic Extension And Retraction Systems ..	14.20	Tire Mounting	14.41
Normal Extension.....	14.21	Tube Type Tires	14.42
Emergency Extension Systems.....	14.22	Tire Balancing	14.43
Mechanical Emergency Extension Systems ..	14.22	Brakes	14.43
Hydraulic Emergency Extension Systems.....	14.23	Types And Construction Of Helicopter	
Landing Gear Retraction Test	14.24	Brakes	14.44
Indications And Warning	14.24	Single Disc Brakes	14.44
Safety Switches	14.26	Floating Disc Brakes	14.44
Squat Switches, Proximity Sensors	14.26	Fixed Disc Brakes	14.46
Wheels, Tires, Brakes	14.28	Dual Disc Brakes	14.47
Wheels	14.28	Multiple Disc Brakes	14.47
Wheel Construction	14.29	Carbon Brakes	14.47
Inboard Wheel Half.....	14.29	Electric Carbon Brakes	14.48

Brake Actuating Systems	14.48	SUB-MODULE 15	
Independent Master Cylinders	14.48	LIGHTS (ATA 33)	
Boosted Brakes	14.50	Knowledge Requirements	15.1
Brake Metering Valve, Hydraulic And		12.15 - Lights	15.2
Pressure Transducers	14.50	Light Sources	15.2
Parking Brakes	14.51	High Intensity Discharge Bulbs (HID).....	15.2
Emergency Brakes	14.51	HID Precautions	15.2
Brake Inspection and Service.....	14.52	Light Emitting Diodes (LED).....	15.2
On Aircraft Servicing.....	14.52	Xenon Flash Tubes	15.3
Lining Wear	14.52	External: Navigation, Landing, Taxiing, Ice	15.3
Air In The System	14.53	Navigation/Position Lights	15.4
Fluid Quantity And Type	14.54	Anti-Collision Lights	15.5
Inspection For Leaks	14.54	Rotating Beacons	15.5
Proper Bolt Torque.....	14.54	Strobe Lighting	15.6
Off-Aircraft Brake Servicing and Maintenance	14.55	Landing Lights	15.6
Bolt And Threaded Connections	14.55	Taxi Lights	15.6
Discs	14.55	Ice Inspection Lights	15.7
Automatic Adjuster Pins	14.55	Internal: Cabin, Cockpit, Cargo	15.7
Torque Tube	14.55	Fluorescent Lights.....	15.7
Brake Housing And Piston Condition	14.55	Fluorescent Lamp Operating Circuit	15.7
Seal Condition	14.56	Flight Deck Lighting	15.8
Brake Malfunctions And Damage	14.56	Integral Instrument Lighting	15.9
Overheating	14.56	Cabin Lighting	15.9
Dragging	14.56	Cargo and Baggage Compartments Lights	15.9
Chattering Or Squealing	14.56	Emergency Lighting	15.10
Steering	14.57	Electroluminescence	15.10
Nose Wheel Steering	14.57	Self Illuminating Signs	15.10
Shimmy Dampers	14.57	Floor Mounted Escape Path Lighting	15.11
Piston Type.....	14.57	Emergency Exit Lighting Activation	15.11
Vane Type.....	14.58	Questions	15.13
Non-Hydraulic Shimmy Damper	14.58	Answers	15.14
Landing Gear System Maintenance.....	14.59		
Landing Gear Rigging and Adjustment	14.59	SUB-MODULE 16	
Adjusting Landing Gear Latches	14.59	PNEUMATIC/VACUUM (ATA 36)	
Drag And Side Brace Adjustment	14.60	Knowledge Requirements	16.1
Air-Ground Sensing	14.61	12.16 - Pneumatic/Vacuum (ATA 36).....	16.2
Skids And Floats	14.62	High Pressure Systems	16.2
Skids	14.62	System Layout.....	16.2
Skids And Shock Absorbers	14.63	Sources	16.2
Skid Dampeners.....	14.63	Storage.....	16.3
Skid and Wheels	14.64	Charging	16.3
Floats.....	14.64	Distribution.....	16.3
Fixed Utility Floats	14.64	Supply Regulation.....	16.3
Emergency Pop-Out Floats	14.64	Emergency Back-Up Systems And Pneudraulics	16.4
Questions	14.67	Nitrogen Bottles.....	16.4
Answers	14.68	Gear Emergency Extension Cable and Handle	16.5
		Dump Valve	16.5

CONTENTS

Emergency Extension Sequence	16.5
High Pressure Pneumatic Power System Maintenance	16.5
Medium Pressure Pneumatic Systems	16.5
System Layout.....	16.5
Sources	16.6
Storage.....	16.6
Pressure Control	16.6
Distribution.....	16.6
Pressure and Vacuum Pumps	16.7
Overview.....	16.7
Classification Of Pumps.....	16.8
Types of Pumps.....	16.8
Vane Pump, Wet Type and Dry Type	16.8
Piston Pump.....	16.8
Centrifugal Impeller Pump	16.9
Turbine Engine Compressor	16.9
Roots Type Blower.....	16.9
Vacuum Pumps.....	16.10
Flight Deck Indications	16.10
Indications and Warnings	16.10
Interface With Other Systems.....	16.11
Questions	16.13
Answers	16.14

SUB-MODULE 17

INTEGRATED MODULAR AVIONICS (ATA 42)

Knowledge Requirements	17.1
12.17 - Integrated Modular Avionics (ATA 42)	17.2
Integration Of Avionics.....	17.2
Digital Data Bus Use Reduces Wiring.....	17.3
Core Systems	17.4
Common Core Systems Concepts	17.5
Core Processor Input/Output Module (CPIOM)	17.5
Network Components	17.5
Data Transmission On The Network	17.6
AFDX Switch	17.7
AFDX Switch Software.....	17.7
Questions	17.9
Answers	17.10

SUB-MODULE 18

ON BOARD MAINTENANCE SYSTEMS (ATA 45)

Knowledge Requirements	18.1
12.18 - On Board Maintenance Systems (ATA 45)	18.2
Central Maintenance Computers	18.2

Built-In Test Equipment (BITE).....	18.4
Data Loading Systems.....	18.5
Electronic Library System.....	18.6
Printing	18.6
Structure Monitoring	18.7
Questions	18.9
Answers	18.10

SUB-MODULE 19

INFORMATION SYSTEMS (ATA 46)

Knowledge Requirements	19.1
12.19 - Information Systems (ATA 46).....	19.2
Adoption by the Helicopter Operators	19.2
Aircraft General Information Systems	19.2
The Airbus System.....	19.3
Network Server System	19.3
Secure Communication Interface	19.3
Central Data Acquisition Module.....	19.3
Data Loading and Configuration Systems	19.3
Flight Deck Information System	19.3
Maintenance Information System.....	19.4
Electronic Logbooks.....	19.4
Passenger Cabin Information System	19.5
Cabin Wireless Connectivity	19.5
Leaky Line Antennas.....	19.5
Wireless Media Streamer.....	19.5
Questions	19.7
Answers	19.8
Acronym Index.....	A.1

12.2 - FLIGHT CONTROL SYSTEMS

INTRODUCTION

There are three major controls in a helicopter used by the pilot during flight: the collective pitch control, the cyclic pitch control, and the anti-torque pedals or tail rotor control. Sometimes in addition to these major controls, the pilot must also use the throttle control, which is usually mounted directly to the collective pitch control for controlling engine power. (*Figure 2-1*)

The control systems described in this chapter are not limited to the single main rotor type helicopter but are used in one form or another in most helicopter configurations. All examples refer to a counterclockwise main rotor blade rotation, such as viewed from above. If flying a helicopter with a clockwise rotation, left and right references must be reversed, particularly in the areas of rotor blade pitch change, anti-torque pedal movement, and tail rotor thrust.

CYCLIC CONTROL

The cyclic pitch control is usually projected upward from the cockpit floor, between the pilot's legs or in some models between the two pilot's seats. (*Figure 2-2*)

The purpose of the cyclic-pitch control is to cause the tip-path plane of the main rotor to tilt as required to provide for movement of the helicopter in a desired direction: forward, rearward, left, and right.

As discussed in *Sub-Module 01*, the total lift force is always perpendicular to the tip-path plane of the main rotor. The main rotor tilts in the direction called for by the control, and the helicopter moves as directed. When the control stick is in neutral, the helicopter remains stationary in the air (hover). If wind is present, the helicopter drifts in the direction of wind unless sufficient cyclic movement (rotor thrust) is applied to cancel the effect of the wind.

The rotor disk is also subject to the effect of gyroscopic precession (as described in *Sub-Module 01*). To counteract this effect, the mechanical linkages for the cyclic control rods are rigged in such a way that they decrease the pitch angle of each rotor blade at approximately 90° in the point of the rotor's rotation as it reaches the direction of cyclic displacement (*Figure 1-17*) and increases the pitch angle of the rotor blade at approximately 90° after



Figure 2-1. Helicopter controls on the flight deck.



Figure 2-2. Location of cyclic pitch control.

it passes the direction of displacement. An increase in pitch angle increases the angle of attack; a decrease in pitch angle decreases the angle of attack. When the cyclic is moved forward, the angle of attack decreases as the rotor blade passes the right side of the helicopter (with the advancing blade in a rotor system turning counterclockwise) and increases on the left side (on the retreating blade). This results in a maximum downward

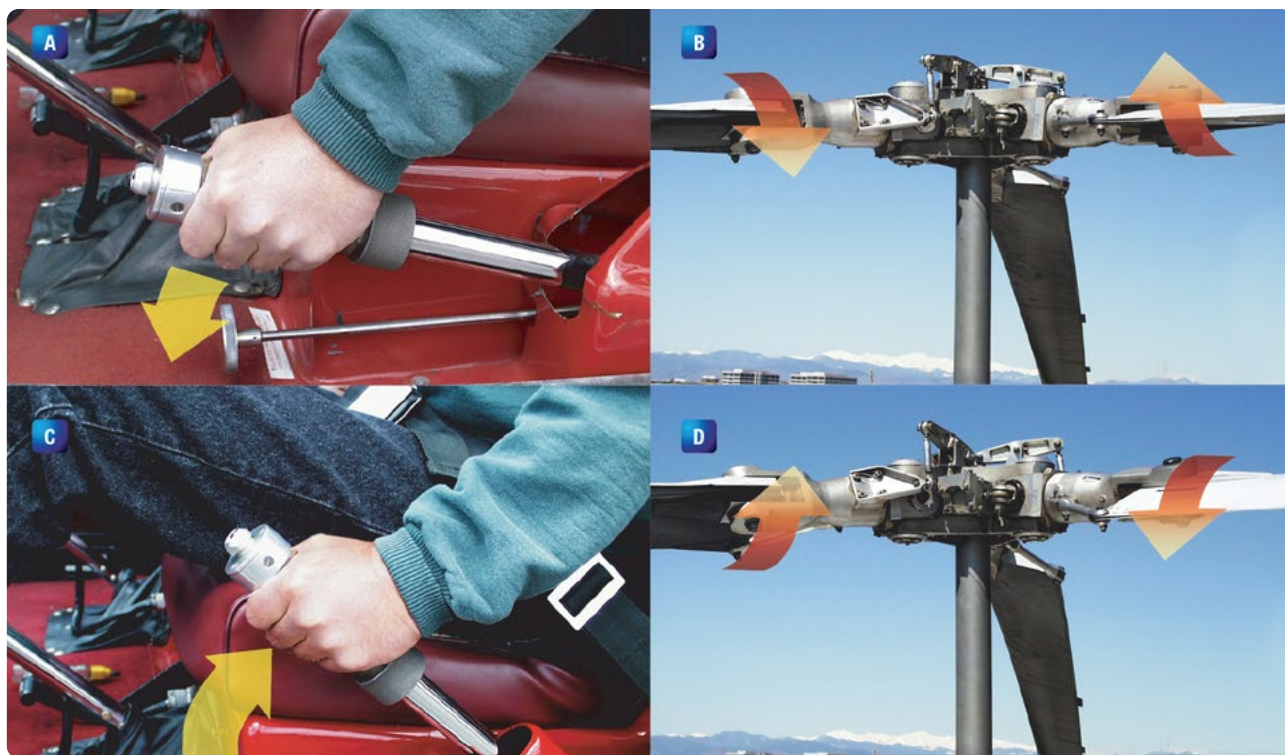


Figure 2-3. Movement of collective pitch control-throttle and effect on rotor blades.

deflection of the rotor blade in front of the helicopter and a maximum upward deflection behind it, causing the rotor disk to tilt forward.

COLLECTIVE CONTROL

The collective pitch control (or simply "collective" or "thrust lever") is located on the left side of the pilot's seat and is operated with the left hand. The collective is used to make changes to the pitch angle of the main rotor blades and acts simultaneously, or "collectively". Through a series of mechanical linkages, as the collective lever is raised, there is a simultaneous and equal increase in pitch angle of all main rotor blades. As it is lowered, there is an equal decrease in pitch angle. The amount of movement in the collective lever determines the amount of blade pitch change. (*Figure 2-3*) An adjustable friction control helps prevent inadvertent collective lever movement.

With a change in pitch angle comes a change in the load on each blade, which affects the speed or Revolutions Per Minute (RPM) of the main rotor. As the pitch angle increases, the blade takes a bigger bite of air that increases the load on the blade, and so the rotor RPM decreases. Decreasing pitch angle decreases the load on the blade, and RPM increases. To maintain a constant rotor RPM, which is essential in helicopter

operations, a proportionate change in power is required to compensate for the change in load on the blades. This is accomplished with the throttle control or governor, which automatically adjusts engine power according to the position of the collective.

In *Figure 2-3A* the collective pitch control is lowered, which causes the blade angle and the amount of lift created to decrease along with applying a proportional decrease in engine power. (*Figure 2-3B*). In *Figure 2-3C* the collective is raised to increase the lift created by the blades *Figure 2-3D*, and the governor or throttle increases the engine power to maintain the rotor RPM.

Throttle Control

The function of the throttle and the governor is to regulate engine RPM by increasing or decreasing fuel flow towards the engine when the collective is raised or lowered. If the governor is an automatic system, to maintain RPM the throttle must be moved manually with the twist grip. The throttle control is much like a motorcycle throttle and works the same way. Twisting the throttle to the left increases RPM. Twisting to the right decreases RPM. As with any aircraft control, large adjustments of either collective pitch or throttle should be avoided. All corrections should be made using smooth pressure.

Correlator

A correlator is an automated mechanical connection between the collective lever and the engine throttle. When the collective lever is raised, power is automatically increased; when lowered, power is decreased. This system maintains RPM close to the desired value, but still requires adjustment of the throttle for fine tuning.

Governor

A governor is a sensing device that monitors rotor and engine RPM and makes the necessary adjustments to keep rotor RPM constant. In normal operations, once the rotor RPM is set, the governor keeps it constant and there is no need to make any throttle adjustments. Governors are common on all turbine powered helicopters as they are a function of the fuel control system and are used on some piston engine helicopters.

SWASHPLATE

When a pilot moves the collective or cyclic controls on the flight deck, a signal is sent to the main rotor blades to cause them to change their angles. From the flight deck, the signal can originate as the movement of cables and pulleys, push/pull tubes, or even an electronic signal. The command for a change in blade or rotor angle must start from the non rotating fuselage and find its way to the main rotor blades which are rotating. This is a similar challenge faced by an airplane with rotating propellers that are capable of changing propeller blade angle, only more complicated because the helicopter rotor must be able to change multiple angles at once. The device which permits these changes is called a swashplate. (*Figure 2-4*)

The swashplate is made of two circular plates, one on the bottom that is attached to the frame of the helicopter and does not rotate, and one on the top that is attached to the rotating blade assembly. The plates are separated by a set of bearings allowing the top plate to rotate over the bottom plate while physically being in contact with it, so forces can be transferred. *Figure 2-5* shows a simplified swash plate as part of a main rotor system.

A swashplate assembly consists of the parts shown in *Figure 2-6*. The lower swashplate is locked in rotation by the fixed scissor. This scissor is connected between the top of the main gearbox and the lower swashplate. This plate is actuated by the control rods of the cyclic and collective linkages has two possibilities of movement.



Figure 2-4. Light helicopter swashplate.

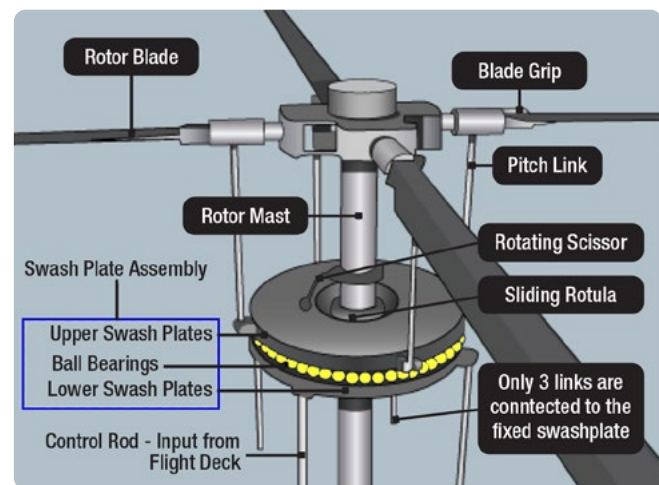


Figure 2-5. Simplified figure of a helicopter swashplate.

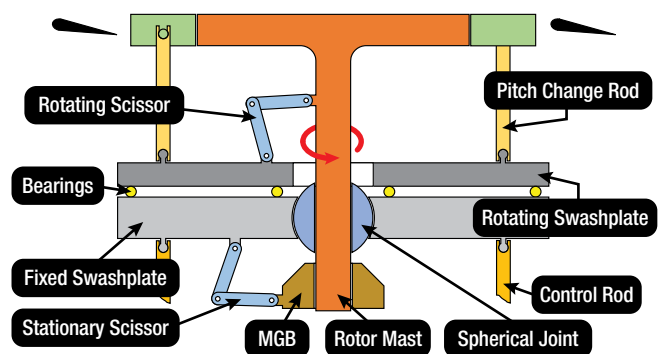


Figure 2-6. Swashplate component.

As each blade rotates through the tip-path plane, the variation of the blade pitch is accomplished through the tilting of a fixed swashplate and its mechanical linkages (pitch angle rods).

The Cyclic Movement And The Swashplate

When the pilot moves the cyclic pitch control, this command sends the lower swashplate around a ball joint and tilts the upper swashplate which remains in parallel with the rotor due to its two bearings. The rotary swashplate now spins in an inclined circle. This means that the pitch change rods are constantly undergoing up and down movements. As they are attached to the rotor they will constantly change the blade pitches between high to low values with each revolution, thus creating high lift at one point on the rotating disc and low at 180° from that point. (Figure 2-7)

In other words, the swashplate will tilt the main rotor in the requested direction and therefore the helicopter will also move in this desired direction. To define the plane represented by the swashplate, it is necessary to connect three points which define the different tilting axis. (Figure 2-8) These three points are coming from the cyclic stick which give only two pure movements; the longitudinal and the lateral. (Figure 2-9)

Longitudinal And Lateral Movement

When the cyclic is moved on a light helicopter, one rod moves the swashplate in longitudinal motion and two rods in lateral movement. (Figure 2-10) After changing direction with a bellcrank, the control movement tilts the swashplate around the lateral axis (Figure 2-11) to change the angle of attack of the blades, to move the helicopter forward as explained previously. The same is true if the pilot pulls the cyclic stick to back up. The rod will tilt the swashplate in the opposite direction.

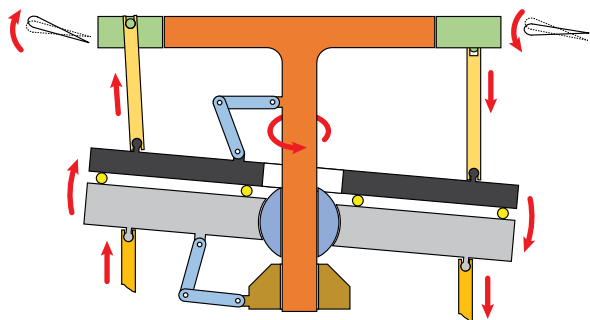


Figure 2-7. Cyclic movement.

To move the helicopter to the left or to the right, lateral rods pass through a transformer system which provides the lateral movement. (Figure 2-12) These two outer lines are moving from the same place but in opposite direction. These movements permit, the rods and bellcranks to tilt the swashplate around the longitudinal axis and create the lateral movement of the helicopter. (Figure 2-13)

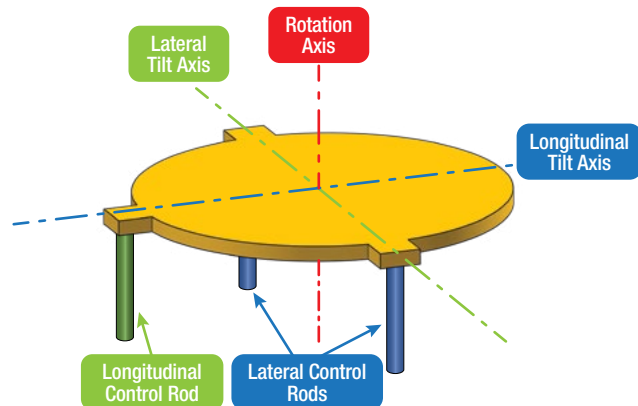


Figure 2-8. Light helicopter axis description.

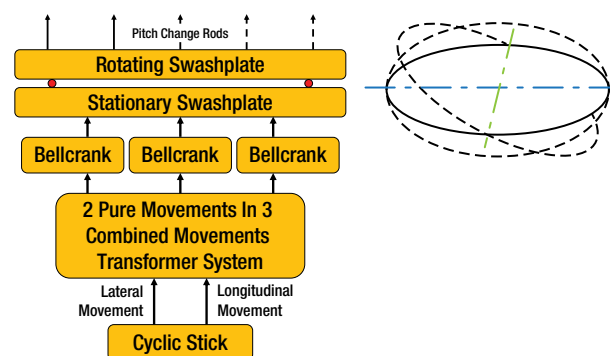


Figure 2-9. Cyclic synoptic.

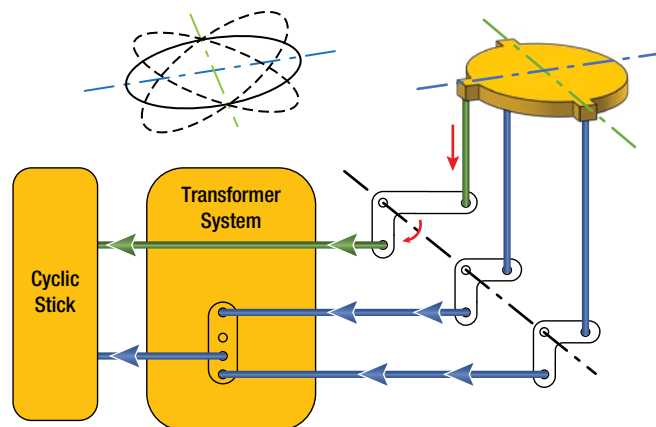


Figure 2-10. Cyclic cinematic.

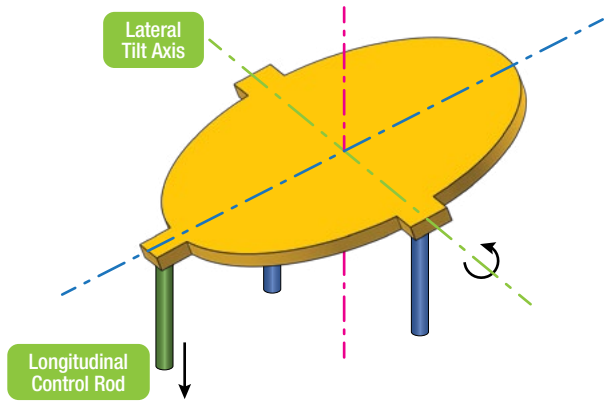


Figure 2-11. Longitudinal swashplate movement.

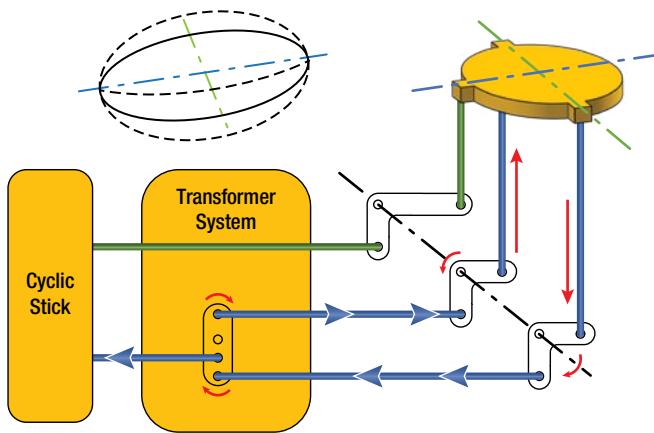


Figure 2-12. Cyclic provided lateral movement to the swashplate.

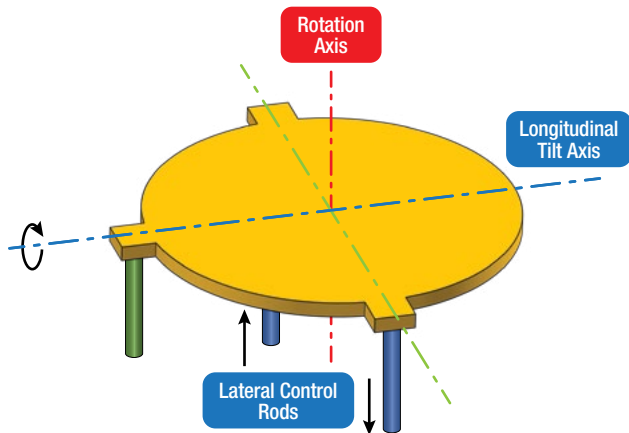


Figure 2-13. Lateral swashplate movement.

To move laterally and longitudinally the cyclic is moved in the diagonal direction and the consequence will be the automatic addition of the two movements. If the control is in neutral, the helicopter will fly and remain in a hover.

The Collective Movement And The Swashplate

The lower swashplate is connected to a ball joint that slides up and down along the rotor mast. When the pilot pulls the collective control, a command is sent to the lower swashplate by three connecting rods as shown in *Figure 2-5* as "input from flight deck".

These three rods push the lower swash plate in parallel upwards, which also pushes the upper swashplate and ball joint as one unit. The upper swash plate, through these links, applies force to the rotor blades and so changing the angle of attack of all the blades in the same direction regardless of the inclination of the swashplate. (*Figure 2-14*)

To create this parallel movement, the three rods described above must move in the same direction. To perform this movement, a lever called the mixer, receives the collective pitch order, and moves the three bellcrank's rotation axis in the same direction and for the same value resulting in the variation of lift.

(*Figure 2-15 and Figure 2-16*)

This modification in turn, tilts the three cyclic bellcranks which move the control rods of the swashplate. This collective action (same movement, in the same direction,

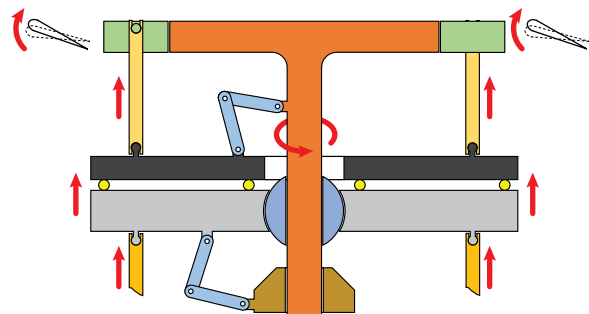


Figure 2-14. Collective movement.

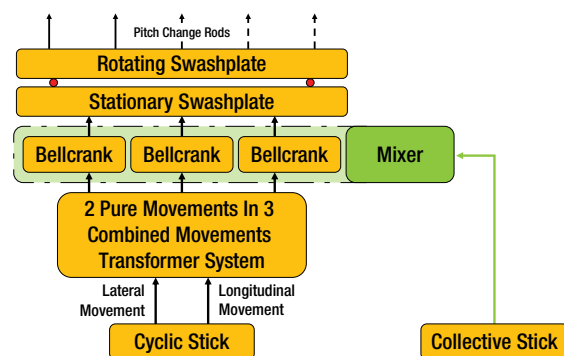


Figure 2-15. Collective synoptic.

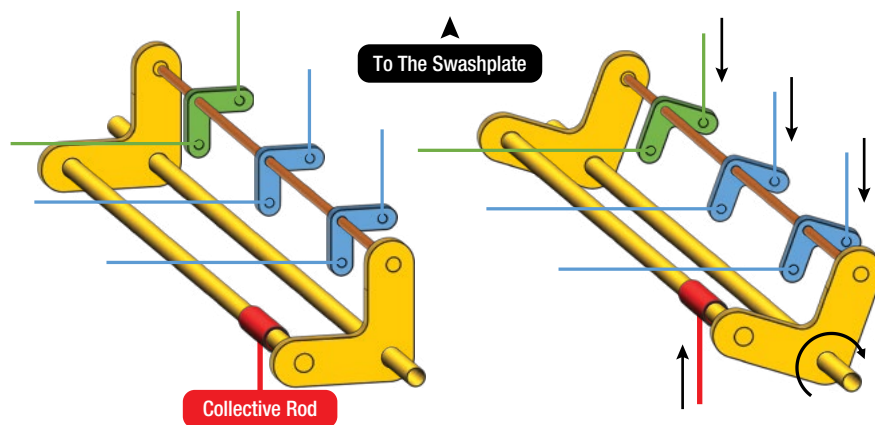


Figure 2-16. Mixer.

at the same time) causes the swashplate to move parallel to its position, modifying the angle of attack of all the blades for the same value and reducing, in this case, the total lift.

It is possible to operate the cyclic stick and the collective stick simultaneously. In that case all the bellcranks move, transmitting a specific movement to the swashplate which acts to control the angle of attack of each blade as the pilot wishes.

YAW CONTROL: ANTI-TORQUE CONTROL, TAIL ROTOR, BLEED AIR

ANTI-TORQUE CONTROL, TAIL ROTOR

Yaw for an aircraft (helicopter or airplane) is a movement that takes place around the vertical axis. The three axes of rotation for a helicopter are shown in *Figure 2-17*. For a helicopter with a single main rotor yaw control is accomplished by the tail rotor (anti-torque rotor).

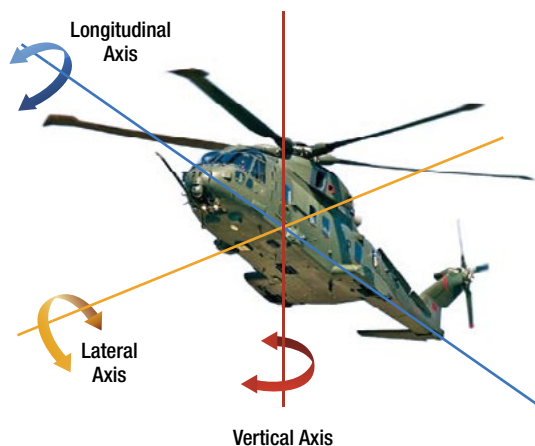


Figure 2-17. Three axes of rotation for a helicopter.

One method to counteract torque is to place a small propeller at the end of the tail boom. Its purpose is to create thrust that acts in the opposite direction of the helicopter's tendency to rotate. The tail rotor force, in newtons, multiplied by the distance from the tail rotor to the main rotor, in meters, creates a torque in newton meters that counteracts the main rotor torque. This concept is shown in *Figure 1-17* of *Sub-Module 01*. The main difference is that there is no cyclic control as it is not necessary to modify the direction of the lift but simply to increase or decrease thrust as a collective command. (*Figure 2-18*)

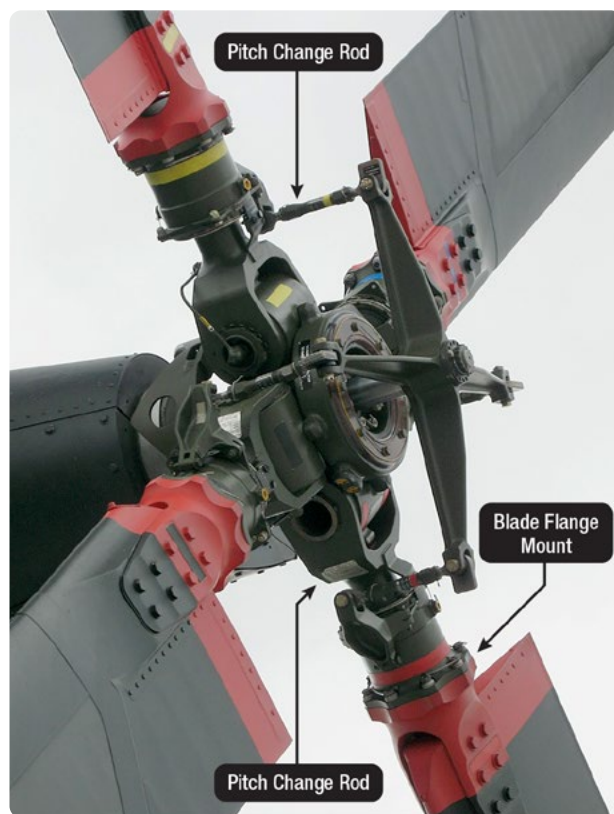


Figure 2-18. Tail rotor description.