MODULE 12

FOR B1.3/B1.4 CERTIFICATION

HELICOPTER AERODYNAMICS STRUCTURES AND SYSTEMS

Aviation Maintenance Technician Certification Series

COMPLIANT WITH EASA European Aviation Safety Agency EASA PART 66/147

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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.

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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:
a. The applicant should be familiar with the basic elements of the subject.
b. The applicant should be able to give a simple description of the whole subject, using common words and examples.
c. 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:
a. The applicant should be able to understand the theoretical fundamentals of the subject.
b. The applicant should be able to give a general description of the subject using, as appropriate, typical examples.
c. The applicant should be able to use mathematical formula in conjunction with physical laws describing the subject.
d. The applicant should be able to read and understand sketches, drawings and schematics describing the subject.
e. 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:
a. The applicant should know the theory of the subject and interrelationships with other subjects.
b. The applicant should be able to give a detailed description of the subject using theoretical fundamentals and specific examples.
c. The applicant should understand and be able to use mathematical formula related to the subject.
d. The applicant should be able to read, understand and prepare sketches, simple drawings and schematics describing the subject.
e. The applicant should be able to apply his knowledge in a practical manner using manufacturer's instructions.
f. The applicant should be able to interpret results from various sources and measurements and apply corrective action where appropriate.

	LEVELS B1.3 B1.4
12.1 – Theory of Flight – Rotary Wing Aerodynamics 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.	2
12.2 – Flight Control Systems 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.	3
12.3 – Blade Tracking and Vibration Analysis Rotor alignment; Main and tail rotor tracking; Static and dynamic balancing; Vibration types, vibration reduction methods; Ground resonance.	3
12.4 – Transmission 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.	3
12.5 – Airframe Structures (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;	2

LEVELS
B1.3
B1.4

(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. 2
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.

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; 3
Distribution systems;
Flow and temperature control systems;
Protection and warning devices.

12.7 – Instruments / Avionic Systems

12.7.1 – Instrument Systems (ATA 31)
Pitot static: altimeter, air speed indicator, vertical speed indicator; 2
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.

12.7.2 – Avionic Systems
Fundamentals of system layouts and operation of: 1
Auto Flight (ATA 22);
Communications (ATA 23);
Navigation Systems (ATA 34).

	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

	LEVELS B1.3 B1.4
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

	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. 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.	2

HELICOPTER AERODYNAMICS STRUCTURES AND SYSTEMS

SUB-MODULE 01

THEORY OF FLIGHT – ROTARY WING AERODYNAMICS

SUB-MODULE 02

FLIGHT CONTROL SYSTEMS

SUB-MODULE 03

BLADE TRACKING AND VIBRATION ANALYSIS

SUB-MODULE 04

TRANSMISSION

SUB-MODULE 05

AIRFRAME STRUCTURES

SUB-MODULE 06
AIR CONDITIONING (ATA 21)

SUB-MODULE 07
INSTRUMENTS/AVIONIC SYSTEMS

SUB-MODULE 08
ELECTRICAL POWER (ATA 24)

SUB-MODULE 09

EQUIPMENT AND FURNISHINGS (ATA 25)

SUB-MODULE 10

FIRE PROTECTION (ATA 26)

SUB-MODULE 11

FUEL SYSTEMS (ATA 28)

SUB-MODULE 12

HYDRAULIC POWER (ATA 29)

SUB-MODULE 13
ICE AND RAIN PROTECTION (ATA 30)

SUB-MODULE 14
LANDING GEAR (ATA 32)

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LIGHTS (ATA 33)

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PNEUMATIC/VACUUM (ATA 36)

SUB-MODULE 17
INTEGRATED MODULAR AVIONICS (ATA 42)

SUB-MODULE 18
ON BOARD MAINTENANCE SYSTEMS (ATA 45)

SUB-MODULE 19
INFORMATION SYSTEMS (ATA 46)

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***)

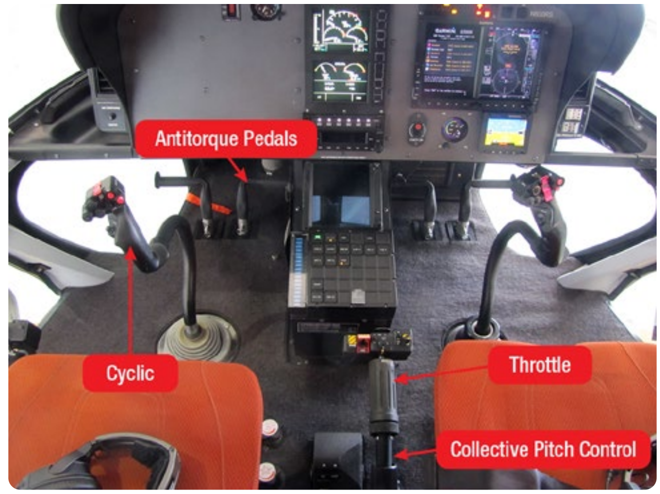

Figure 2-1. Helicopter controls on the flight deck.

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***)

Figure 2-2. Location of cyclic pitch control.

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 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

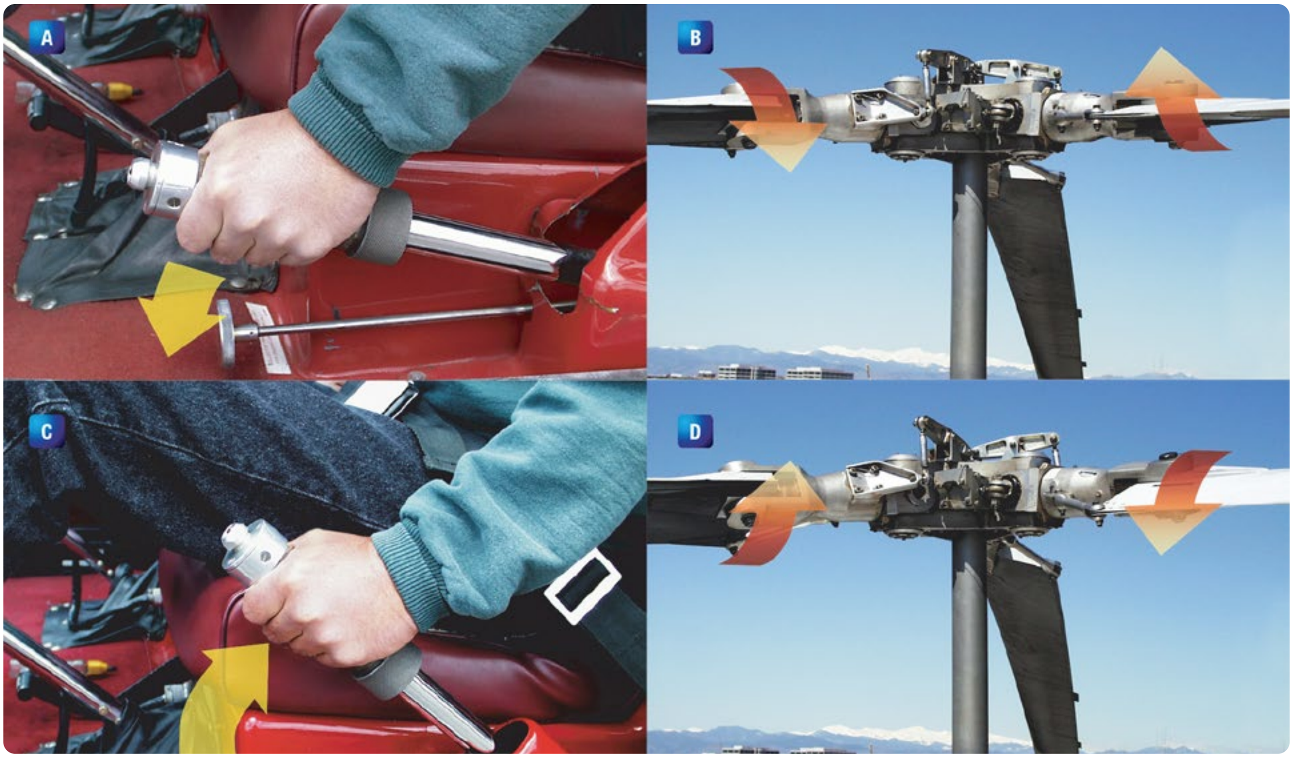

Figure 2-3. Movement of collective pitch control-throttle and effect on rotor blades.

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***)

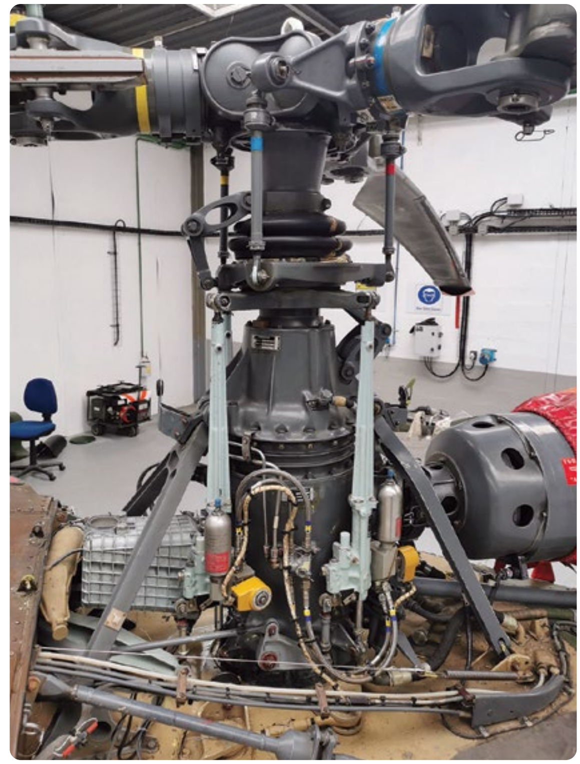

Figure 2-4. Light helicopter swashplate.

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.

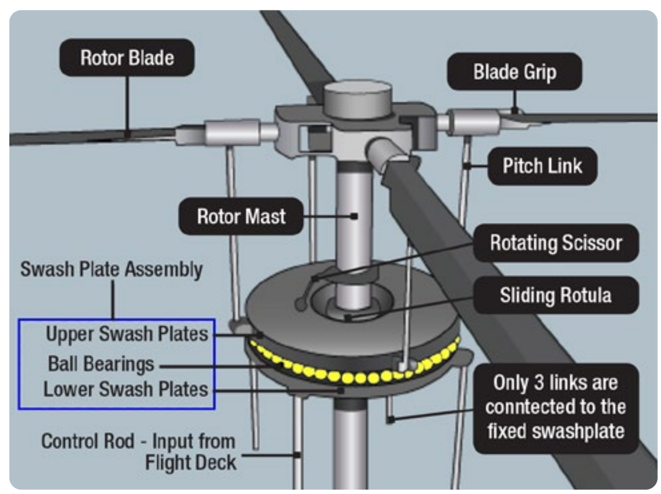

Figure 2-5. Simplified figure of a helicopter swashplate.

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.

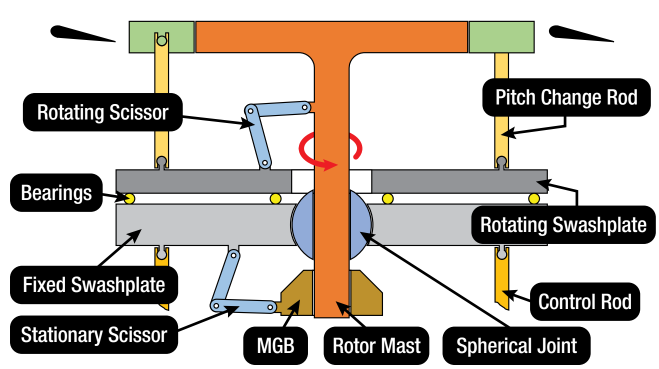

Figure 2-6. Swashplate component.

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.

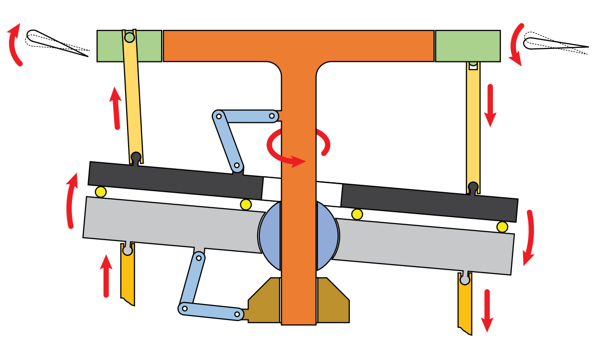
Figure 2-7. Cyclic movement.

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***)

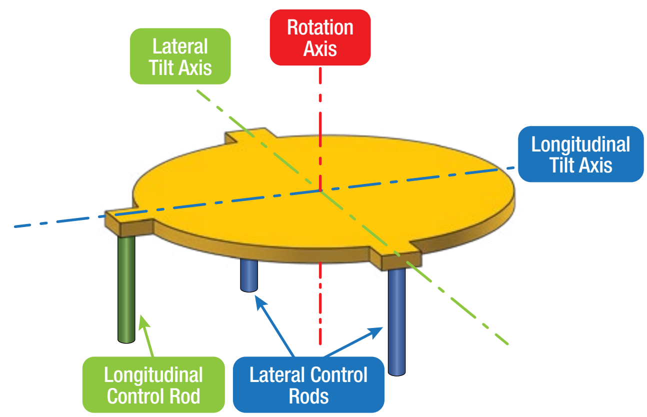

Figure 2-8. Light helicopter axis description.

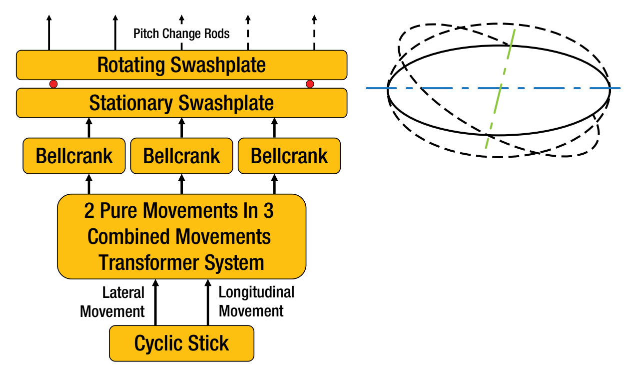

Figure 2-9. Cyclic synoptic.

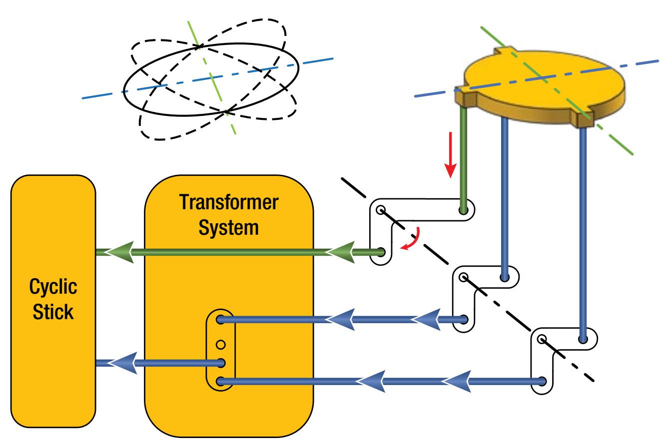

Figure 2-10. Cyclic cinematic.

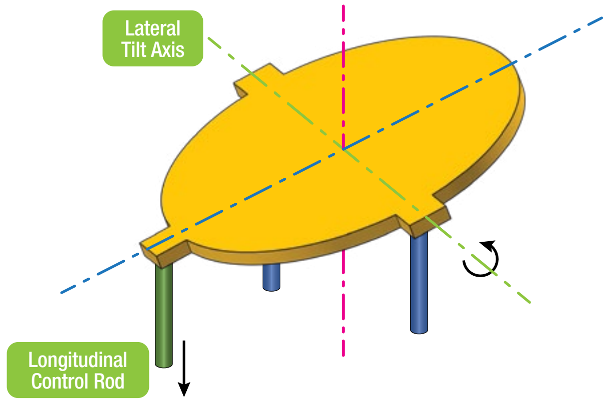

Figure 2-11. Longitudinal swashplate movement.

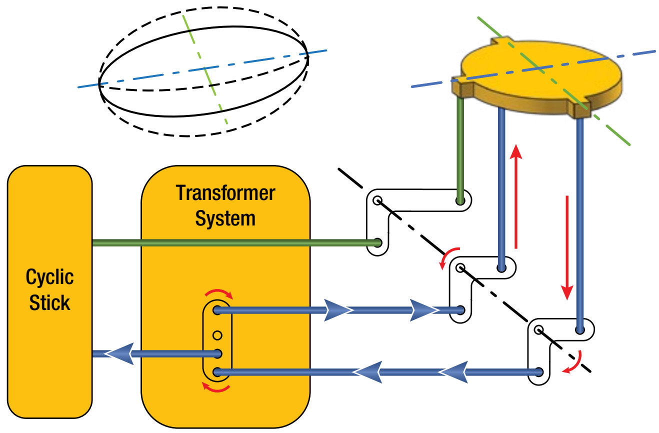

Figure 2-12. Cyclic provided lateral movement to the swashplate.

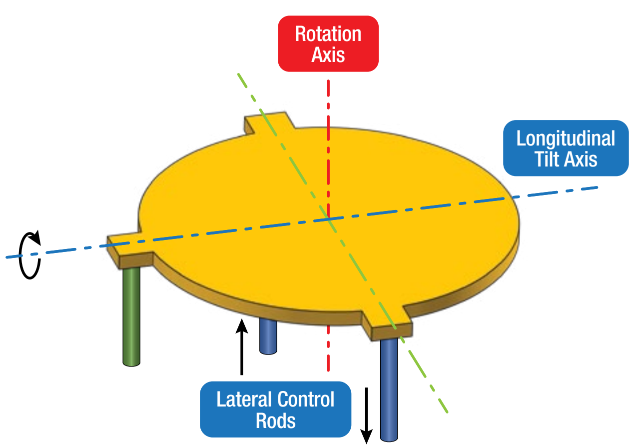

Figure 2-13. Lateral swashplate movement.

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,

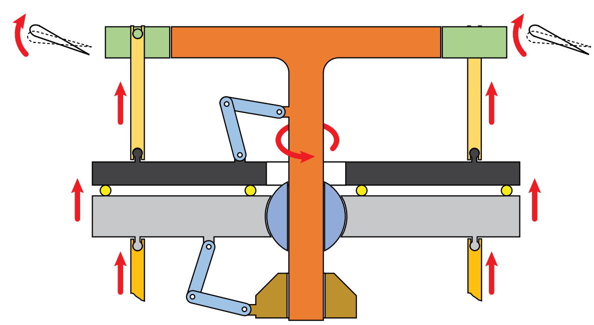
Figure 2-14. Collective movement.

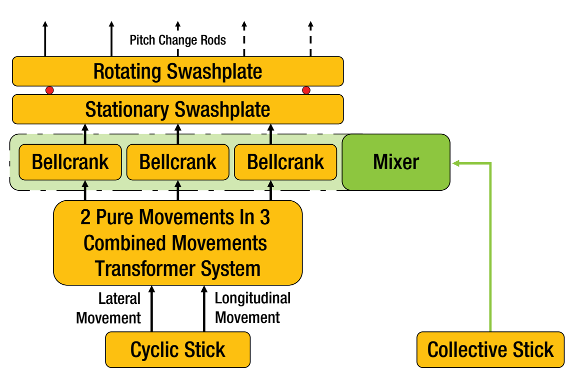

Figure 2-15. Collective synoptic.

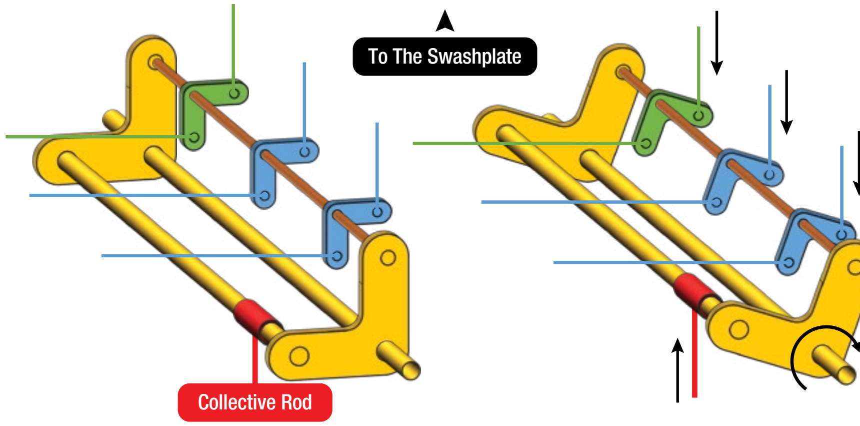

Figure 2-16. Mixer.

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).

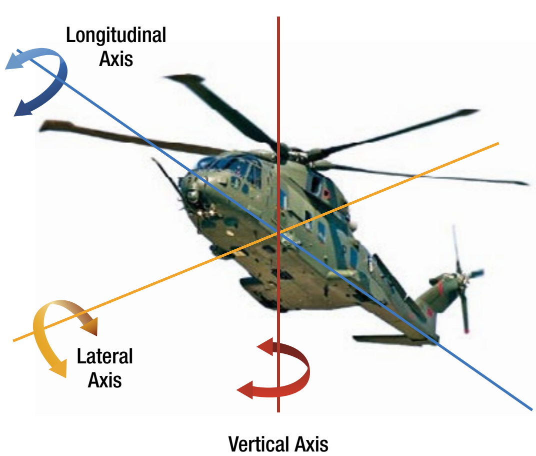

Figure 2-17. Three axes of rotation for a helicopter.

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.