TRAINING PROGRAM (Syllabus) IN THE FIELD OF THEORETICAL KNOWLEDGE FOR PPL(H) LICENSE

1. AIR LAW AND AIR TRAFFIC CONTROL PROCEDURES - number of lectures / time: 16 hours (+online session: 2 hours)

International law: conventions, agreements and organizations
Convention on International Civil Aviation (Chicago Convention) Doc 7300/6

Part I - Air navigation:
Relevant parts of the following chapters:
- (a) general principles and application of the Convention;
- (b) flight over territory of Contracting States;
- (c) nationality of aircraft;
- (d) measures to facilitate air navigation;
- (e) conditions to be fulfilled on aircraft
- (f) international standards and recommended practices (SARPs);
- (g) validity of endorsed certificates and licenses;
- (h) notification of differences.

Part II - The International Civil Aviation Organization (ICAO):
Objectives and structure
ICAO Annex 8 - Airworthiness of Aircraft
Introduction and definitions
Certificate of airworthiness
ICAO Annex 7 - Aircraft Nationality and Registration Marks
Introduction and definitions
Nationality marks, common marks and registration marks
Certificate of registration and nationality marks
ICAO Annex 1 - Personnel Licensing
Definitions
Relevant parts of ICAO Annex 1 regarding Part-FCL and Part-Medical
ICAO Annex 2 - Rules of the Air
Basic definitions, application of air traffic rules, general rules (except water operations), visual flight rules, signals and interception of civil aircraft
Altimeter-setting procedure (including ICAO Doc 7030 - Regional Supplementary Procedures)
Basic requirements (except for tables), procedures applicable to operators and pilots (except for tables)
Secondary surveillance radar
Procedures for operation of transponders (including ICAO Doc 7030 - Regional Supplementary Procedures)
Operation of transponders
Phraseology
ICAO Annex 11: Doc 4444 - Air Traffic Management
Definitions
General provisions for air traffic services
Visual separation in the vicinity of aerodromes
Procedures for aerodrome control services
Radar services
Flight information service and alerting service
Phraseology
Procedures related to emergency situations, communication failure and emergency plans
ICAO Annex 15: Aeronautical Information Service
Introduction, basic definitions of AIP, NOTAM, AIRAC and AIC
ICAO Annex 14, Vol. 1 and 2: Aerodromes
Definitions
Aerodrome data: conditions of the movement area and related facilities
Visual navigation aids:
- (a) indicators and signaling devices;
- (b) markings;
- (c) lights;
- (d) signs;
- (e) markers.

Visual aids to mark obstacles:
- (a) objects marking;
- (b) objects lighting.

Visual aids for denoting obstacles.

Aerodrome operational services:
(a) rescue and fire fighting;
(b) apron management service.

ICAO Annex 12: Search and Rescue

Basic definitions

Operating procedures:
(a) procedure for the pilot-in-command at the scene of the incident;
(b) the procedure for the pilot-in-command who took over the correspondence regarding danger;
(c) search and rescue signals.

Search and rescue signals:
(a) signals used to communicate with vehicles and ground units;
(b) the code of visual signals "ground-to-air";
(c) "air-to-air" signals.

ICAO Annex 17: Aviation Security: Safeguarding International Civil Aviation against Acts of Unlawful Interference

General information: purpose and assumptions

ICAO Annex 13: Aircraft Accident and Incident Investigation

Basic definitions

Application

National law

National law and differences in relation to the ICAO Annexes and relevant EU regulations.

2. HUMAN PERFORMANCE AND LIMITATIONS - number of lectures / time: 4 hours. (+online session: 1 hour)

Human factors in aviation

Becoming a competent pilot

Basics of physiology and maintaining health in aviation

Atmosphere:
(a) composition;
(b) laws of physics of gases (gas laws).

Respiratory system and cardiovascular system:
(a) oxygen requirement of tissues;
(b) functional anatomy;
(c) the main forms of hypoxia (hypoxic and anemic):
    (1) Sources, effects and countermeasures against carbon monoxide;
    (2) remedies to prevent hypoxia;
    (3) symptoms of hypoxia.
(d) hyperventilation;
(e) the impact of acceleration on the cardiovascular system;
(f) hypertension and coronary heart disease.

Man and environment

Central, peripheral and autonomic nervous system

Vision:
(a) functional anatomy;
(b) visual field, foveal and peripheral vision;
(c) binocular and monocular vision;
(d) monocular vision;
(e) night vision;
(f) visual scanning and detection techniques and importance of ‘look-out’;
(g) defective vision.

Hearing:
(a) functional and descriptive anatomy;
(b) hearing hazards related to the operation of flights;
(c) hearing loss.

Equilibrium:
(a) functional anatomy;
(b) motion and acceleration;
(c) kinetosis.

Integration of sensory inputs:
(a) spatial disorientation: form, recognition and avoidance;

Health and hygiene

Personal hygiene: personal fitness

Body rhythm and sleep

(a) rhythm disturbances;

(b) symptoms, effects and management.

Problem areas for pilots:

(a) common minor ailments including cold, influenza and gastro-intestinal upset;

(b) flatulence and barotrauma (as a result of scuba diving);

(c) obesity;

(d) food hygiene;

(e) contagious diseases,

(f) nutrition;

(g) various toxic gases and substances.

Intoxication:

(a) prescribed medication;;

(b) tobacco;

(c) alcohol and drugs;

(d) caffeine;

(e) self- medication.

Basics of aeronautical psychology

Information processing by a human

Attention and vigilance:

(a) selectivity of attention;

(b) divided attention.

Perception:

(a) perceptual illusions;

(b) subjectivity of perception;

(c) perceptual processes.

Memory:

(a) sensory memory;

(b) working memory or short-term memory;

(c) long-term memory including motor memory (skills).

Human error and reliability

The reliability of human behavior

Error generation: social environment (group, organization)

Decision-making

Decision making concepts:

(a) structure (phase);

(b) limits;

(c) risk assessment,

(d) practical application.

Avoiding and managing errors: cockpit management

Safety awareness:

(a) awareness of risk areas;

(b) situational awareness.

Communication: verbal and non-verbal communication

Human behavior

Personality and attitudes:

(a) development;

(b) environmental influences.

Identification of hazardous attitudes (error proneness)

Human overload and underload

Arousal

Stress:

(a) definition / definitions;

(b) anxiety and stress;

(c) effects of stress.

Management of fatigue and stress:
(a) types, causes and symptoms of fatigue;
(b) fatigue effects;
(c) remediation strategies;
(d) management techniques;
(e) health and fitness programs.

3. METEOROLOGY - number of lectures / time: 10 hours (+online session: 2 hours)

Atmosphere
Composition, structure and vertical division
Structure of the atmosphere
Troposphere

Air temperature
Definitions and units
Vertical distribution of temperature
Transfer of heat
Lapse rates, stability and instability of air
Development and types of inversions
Temperature near the Earth's surface, surface effects, daily and periodic changes, effect of clouds and effect of wind

Atmospheric pressure
Barometric pressure and isobars
Pressure variation with height
Reduction of pressure to the mean sea level
Relationship between surface pressure centers and pressure centers aloft.

Air density
Relationship between pressure, temperature and density

International Standard Atmosphere (ISA)

ICAO Standard Atmosphere
Altimeter settings
Terminology and definitions
Altimeter and altimeter settings
Calculations
Effect of accelerated airflow due to topography

Wind
Definition and measurement of wind

The primary cause of wind formation
The primary cause of wind formation, pressure gradient, Coriolis force and gradient wind
Variation of wind direction and speed in the friction layer
Effects of convergence and divergence

4. COMMUNICATIONS - number of lectures / time: 3 hours (+online session: 1 hour)

VFR COMMUNICATIONS
Definitions
Meanings and importance of associated terms
Air Traffic Services abbreviations
Q-code groups commonly used in RTF air-ground communications
Categories of messages

General operating procedures
Transmission of letters
Transmission of numbers (including level information)
Transmission of time
Transmission technique
Standard words and phrases (including relevant radio-telephony phraseology)
R / T call signs for aerodromes, including the use of short call signs
R / T call signs for aircraft, including the use of abbreviated call signs
Transfer of communication
Test procedures including readability scale
Read-back and acknowledgement requirements

Relevant meteorological information terms (VFR)
Aerodrome weather
Meteorological information broadcast

Action to be taken in the event of communication failure

Distress and urgency procedures
Distress (definition, frequencies, watch of distress frequencies, distress signal, distress message)
Urgency (definition, frequencies, urgency signal, urgency message)

General principles of VHF propagation and allocation of frequencies

5. PRINCIPLES OF FLIGHT - number of lectures / time: 12 hours (+online session: 2 hours)

5.1 PRINCIPLES OF FLIGHT - HELICOPTER

Basic concepts, laws and definitions

Conversion of units

Definitions and basic concepts about air:
(a) the atmosphere and International Standard Atmosphere;
(b) density;
(c) influence of pressure and temperature on density.

Newton's laws:
(a) Newton's second law: Momentum equation;
(b) Newton's third law: action and reaction.

Basic concepts about airflow:
(a) steady airflow and unsteady airflow;
(b) Bernoulli's equation;
(c) static pressure, dynamic pressure, total pressure and stagnation point;
(d) TAS and IAS;
(e) two-dimensional airflow and three-dimensional airflow;
(f) viscosity and boundary layer.

Two-dimensional airflow

Aerofoil section geometry:
(a) aerofoil section;
(b) chord line, thickness and thickness to chord ratio of a section;
(c) camber line and camber;
(d) symmetrical and asymmetrical aerofoils sections.

Aerodynamic forces on aerofoil elements:
(a) angle of attack;
(b) pressure distribution;
(c) lift and lift coefficient
(d) relation lift coefficient: angle of attack;
(e) profile drag and drag coefficient;
(f) relation drag coefficient: angle of attack;
(g) resulting force, centre of pressure and pitching moment.

Stall:
(a) boundary layer and reasons for stalling;
(b) variation of lift and drag as a function of angle of attack;
(c) displacement of the centre of pressure and pitching moment.

Disturbances due to profile contamination:
(a) ice contamination;
(b) ice on the surface (frost, snow and clear ice).
The three-dimensional airflow round a wing and a fuselage

The wing:
(a) planform, rectangular and tapered wings;
(b) wing twist.

Airflow pattern and influence on lift:
(a) span wise flow on upper and lower surface;
(b) tip vortices;
(c) span-wise lift distribution.

Induced drag: causes and vortices

The airflow round a fuselage:
(a) components of a fuselage;
(b) parasite drag;
(c) variation with speed.

Transonic aerodynamics and compressibility effects

Airflow velocities

Airflow speeds:
(a) speed of sound;
(b) subsonic, high subsonic and supersonic flows.

Shock waves:
(a) compressibility and shock waves;
(b) the reasons for their formation at upstream high subsonic airflow;
(c) their effect on lift and drag.

Influence of wing planform: sweep-angle

Rotorcraft types

Rotorcraft

Rotorcraft types:
(a) autogyro;
(b) helicopter.

Helicopters

Helicopters configurations: the single main rotor helicopter

The helicopter, characteristics and associated terminology:
(a) general lay-out, fuselage, engine and gearbox;
(b) tail rotor, fenestron and NOTAR;
(c) engines (reciprocating and turbo shaft engines);
(d) power transmission;
(e) rotor shaft axis, rotor hub and rotor blades;
(f) rotor disc and rotor disc area;
(g) teetering rotor (two blades) and rotors with more than two blades;
(h) skids and wheels;
(i) helicopter axes and fuselage centre line;
(j) roll axis, pitch axis and normal or yaw axis;
(k) gross mass, gross weight and disc loading.

Main rotor aerodynamics

Hover flight outside ground effect

Airflow through the rotor discs and round the blades:
(a) circumferential velocity of the blade sections;
(b) induced airflow, through the disc and downstream;
(c) downward fuselage drag;
(d) equilibrium of rotor thrust, weight and fuselage drag;
(e) rotor disc induced power;
(f) relative airflow to the blade;
(g) pitch angle and angle of attack of a blade section;
(h) lift and profile drag on the blade element;
(i) resulting lift and thrust on the blade and rotor thrust;
(j) collective pitch angle changes and necessity of blade feathering;
(k) required total main rotor-torque and rotor-power;
(l) influence of the air density.

Anti-torque force and tail rotor:
(a) force of tail rotor as a function of main rotortorque;
(b) anti-torque rotor power;
(c) necessity of blade feathering of tail rotor blades and yaw pedals.

Maximum hover altitude OGE:
(a) total power required and power available;
(b) maximum hover altitude as a function of pressure altitude and OAT.

Vertical climb

Relative airflow and angles of attack:
(a) climb velocity VC, induced and relative velocity and angle of attack;
(b) collective pitch angle and blade feathering.

Power and vertical speed:
(a) induced power, climb power and profile power;
(b) total main rotor power and main rotor torque;
(c) tail rotor power;
(d) total power requirement in vertical flight.

Forward flight

Airflow and forces in uniform inflow distribution:
(a) assumption of uniform inflow distribution on rotor disc;
(b) advancing blade (90°) and retreating blade (270°);
(c) airflow velocity relative to the blade sections, area of reverse flow;
(d) lift on the advancing and retreating blades at constant pitch angles;
(e) necessity of cyclic pitch changes;
(f) compressibility effects on the advancing blade tip and speed limitations;
(g) high angle of attack on the retreating blade, blade stall and speed limitations;
(h) thrust on rotor disc and tilt of thrust vector;
(i) vertical component of the thrust vector and gross weight equilibrium;
(j) horizontal component of the thrust vector and drag equilibrium.

The flare (power flight):
(a) thrust reversal and increase in rotor thrust;
(b) increase of rotor RPM on non governed rotor.

Power and maximum speed:
(a) induced power as a function of helicopter speed;
(b) rotor profile power as a function of helicopter speed;
(c) fuselage drag and parasite power as a function of forward speed;
(d) tail rotor power and power ancillary equipment;
(e) total power requirement as a function of forward speed;
(f) influence of helicopter mass, air density and drag of additional external equipment;
(g) translational lift and influence on power required.

Hover and forward flight in ground effect

Airflow in ground effect and downwash: rotor power decrease as a function of rotor height above the ground at constant helicopter mass

Vertical descent

Vertical descent, power on:
(a) airflow through the rotor, low and moderate descent speeds;
(b) vortex ring state, settling with power and consequences.

Autorotation:
(a) collective lever position after failure;
(b) up flow through the rotor, auto-rotation and antiautorotation rings;
(c) tail rotor thrust and yaw control;
(d) control of rotor RPM with collective lever;
(e) landing after increase of rotor thrust by pulling collective and reduction in vertical speed.

Forward flight: Autorotation

Airflow through the rotor disc:
(a) descent speed and up flow through the disc;
(b) the flare, increase in rotor thrust, reduction of vertical speed and ground speed.

Flight and landing:
(a) turning;
(b) flare;
(c) autorotative landing;
(d) height or velocity avoidance graph and dead man’s curve.

Main rotor mechanics

Flapping of the blade in hover

Forces and stresses on the blade:
(a) centrifugal force on the blade and attachments;
(b) limits of rotor RPM;
(c) lift on the blade and bending stresses on a rigid attachment;
(d) the flapping hinge of the articulated rotor and flapping hinge offset;
(e) the flapping of the hinge less rotor and flexible element.

Coning angle in hover:
(a) lift and centrifugal force in hover and blade weight negligible
(b) flapping, tip path plane and disc area.

Flapping angles of the blade in forward flight

Forces on the blade in forward flight without cyclic feathering:
(a) aerodynamic forces on the advancing and retreating blades without cyclic feathering;
(b) periodic forces and stresses, fatigue and flapping hinge;
(c) phase lag between the force and the flapping angle (about 90°);
(d) flapping motion of the hinged blades and tilting of the cone and flap back of rotor;
(e) rotor disc attitude and thrust vector tilt.

Cyclic pitch (feathering) in helicopter mode, forward flight:
(a) necessity of forward rotor disc tilt and thrust vector tilt;
(b) flapping and tip path plane, virtual rotation axis or no flapping axis and plane of rotation;
(c) shaft axis and hub plane;
(d) cyclic pitch change (feathering) and rotor thrust vector tilt;
(e) collective pitch change, collective lever, swash plate, pitch link and pitch horn;
(f) cyclic stick, rotating swash plate and pitch link movement and phase angle.

Blade lag motion

Forces on the blade in the disc plane (tip path plane) in forward flight:
(a) forces due to the Coriolis effect because of the flapping;
(b) alternating stresses and the need of the drag or lag hinge.

The drag or lag hinge:
(a) the drag hinge in the fully articulated rotor;
(b) the lag flexure in the hinge less rotor;
(c) drag dampers.

Ground resonance:
(a) blade lag motion and movement of the centre of gravity of the blades and the rotor;
(b) oscillating force on the fuselage;
(c) fuselage, undercarriage and resonance.

Rotor systems

See-saw or teetering rotor

Fully articulated rotor:
(a) three hinges arrangement;
(b) bearings and elastomeric hinges.

Hinge less rotor and bearing less rotor

Blade sailing:
(a) low rotor RPM and effect of adverse wind;
(b) minimising the danger;
(c) droop stops.

Vibrations due to main rotor:
(a) origins of the vibrations: in plane and vertical;
(b) blade tracking and balancing.

Tail rotors

Conventional tail rotor

Rotor description:
(a) two-blades tail rotors with teetering hinge;
(b) rotors with more than two blades;
(c) feathering bearings and flapping hinges;
(d) dangers to people and to the tail rotor, rotor height and safety.

Aerodynamics:
(a) induced airflow and tail rotor thrust;
(b) thrust control by feathering, tail rotor drift and roll;
(c) effect of tail rotor failure and vortex ring.

The fenestron: technical lay-out

The NOTAR: technical lay-out

Vibrations: high frequency vibrations due to the tail rotors

Equilibrium, stability and control

Equilibrium and helicopter attitudes

Hover:
(a) forces and equilibrium conditions;
(b) helicopter pitching moment and pitch angle;

(c) helicopter rolling moment and roll angle.

Forward flight:
(a) forces and equilibrium conditions;
(b) helicopter moments and angles;
(c) effect of speed on fuselage attitude.

Control

Control power
(a) fully articulated rotor;
(b) hinge less rotor;
(c) teetering rotor.

Static and dynamic roll over

Helicopter performances

Engine performances

Piston engines:
(a) power available;
(b) effects of density altitude.

Turbine engines:
(a) power available;
(b) effects of ambient pressure and temperature.

Helicopter performances

Hover and vertical flight:
(a) power required and power available;
(b) OGE and IGE maximum hover height;
(c) influence of AUM, pressure, temperature and density.

Forward flight:
(a) maximum speed;
(b) maximum rate of climb speed;
(c) maximum angle of climb speed;
(d) range and endurance;
(e) influence of AUM, pressure, temperature and density.

Manoeuvring:
(a) load factor;
(b) bank angle and number of g's;
(c) manoeuvring limit load factor.

Special conditions:
(a) operating with limited power;
(b) over pitch and over torque.

6. OPERATIONAL PROCEDURES - **number of lectures / time: 5 hours. (+online session: 1 hour)**

General Regulations
Operation of aircraft: ICAO Annex 6, General requirements
Definitions
Applicability
Special operating procedures and hazards (general aspects)

Noise abatement
Noise abatement procedures
Impact of the flight procedure (departure, cruise, approach)
Runway incursion awareness (meaning of surface
markings and signals)

Fire or smoke
Carburetor fire
Engine fire
Fire in the cabin and cockpit (selection of extinguishing agents according to fire classification and use of fire extinguishers)
Smoke in the cockpit (effects and actions to be taken) and smoke in the cockpit and in the cabin (effects and actions to be taken)

Windshear and microburst
Effects and recognition during departure and approach
Actions to avoid and actions to be taken during encounter

Wake turbulence
Cause

List of relevant parameters
Actions to be taken when crossing traffic, during take-off and landing

Emergency and precautionary landings
Definition
Cause
Information for passengers
Evacuation
Action after landing
Rotor downwash
Operation influence by meteorological conditions (helicopter)
White out, sand or dust
Strong winds
Mountain environment

Emergency procedures

Influence by technical problems
Engine failure
Fire in cabin, cockpit or engine
Tail, rotor or directional control failure
Ground resonance
Blade stall
Settling with power (vortex ring)
Overpitch
Overspeed: rotor or engine
Dynamic rollover
Mast bumping

7. FLIGHT PERFORMANCE AND PLANNING - number of lectures / time: 5 hours. (+online session: 1 hour)

7.1. MASS AND BALANCE

The purpose of considering mass and balance
Mass limitations
Importance in regard to structural limitations
Importance in regard to performance limitations

CG limitations
Importance in regard to stability and controllability
Importance in regard to performance

Loading
Terminology
Mass terms
Load terms (including fuel terms)

Mass limits
Structural limitations
Performance limitations
Baggage compartment limitations

Mass calculation
Maximum masses for take-off and landing
The use of standard masses for passengers, luggage and crew
Basics of center of gravity calculation (CG)
Definition of center of gravity
Conditions of equilibrium (balance of forces and balance of moments)

Basic calculations of center of gravity
Detailed information on the mass and balance of aircraft
Content of mass and balance documentation
Datum and moment arm
Position of the center of gravity as the distance from datum

Extraction of basic mass and balance data from aircraft documentation
BEM
Position of the center of gravity or moment at BEM
Deviation from the standard configuration

Determining the position of the center of gravity

Methods
Arithmetic method
Graphic method

Load and trim sheet
General considerations
Load sheet and CG envelope for light aircraft

7.2 PERFORMANCES – HELICOPTERS

General
Introduction
Stages of flight
Effect on performance of atmospheric,
airport or heliport and helicopter conditions
Applicability of airworthiness requirements
Definitions and terminology
Performance: SE helicopters
Definitions of terms
(a) masses;
(b) velocities: vx, vy;
(c) velocity of best range and of maximum endurance;
(d) power limitations;
(e) altitudes.
Take-off, cruise and landing performance
Use and interpretation of diagrams and tables:
(a) Take-off:
  (1) take-off run and distance available;
  (2) take-off and initial climb;
  (3) effects of mass, wind and density altitude;
  (4) effects of ground surface and gradient.
(b) Landing:
  (1) effects of mass, wind, density altitude and approach speed;
  (2) effects of ground surface and gradient.
(c) In-flight:
  (1) relationship between power required and power available;
  (2) performance diagram;
  (3) effects of configuration, mass, temperature and altitude;
  (4) reduction of performance during climbing turns;
  (5) autorotation;
  (6) adverse effects (icing, rain and condition of the airframe).

7.3 FLIGHT PLANNING AND FLIGHT MONITORING

Flight planning for VFR flights
VFR navigation plan
Routes, airfields, heights and altitudes from VFR charts
Courses and distances from VFR charts
Aerodrome charts and aerodrome directory
Data for communication and radio navigation planning
Completing the navigation plan

Fuel planning
General knowledge

Pre-flight calculations of required fuel
Calculation of additional fuel
Filling the fuel section of the navigation plan and calculating the total fuel
Pre-flight preparation

AIP and NOTAM briefing
Ground facilities and services
Departure, destination and alternate aerodromes
Airway routings and airspace structure
Meteorological briefing

Extraction and analysis of relevant data from meteorological documents

ICAO flight plan (ATS flight plan)
Individual flight plan
Flight plan format
Completion of the flight plan
Submission of the flight plan

Flight monitoring and re-planning during the flight
Flight monitoring
Monitoring of track and time
Fuel management during the flight
Re-planning during the flight in case of deviations from planned data

8. AIRCRAFT GENERAL KNOWLEDGE- number of lectures / time: 19 hours. (+online session: 4 hours)

8.1 AIRFRAME AND SYSTEMS, ELECTRICS, POWERPLANT AND EMERGENCY EQUIPMENT

System design, load, stress, maintenance
Loads and combined loads applied to an aircraft's structure

Airframe structure
Fuselage, door, floor, wind-screen and windows
Design and construction
Structural components and materials
Stresses
Structural limitations

Flight and control surfaces
Design and construction
Structural components and materials
Stresses and aero elastic vibrations
Structural limitations

Hydraulics
Hydromechanics: basic principles
Hydraulic systems
Hydraulic fluids: types and characteristics, limitations
System components: design, operation, degraded modes of operation, indications and warnings

Landing gear, wheels, tyres and brakes
Landing gear
Types and materials
Brakes
Types and materials
System components: design, principles of operation, indications and warnings

Wheels and tyres
Types and operational limitations
Helicopter equipments

Flight control system
Mechanical or powered
Control systems and mechanical
System components: design, operation, indications and warnings, degraded modes of operation and jamming

Anti-icing systems
Types and principles of operation (pitot tube and windshield)

Fuel system
Piston engine
System components: design, operation, degraded modes of operation, indications and warnings

Turbine engine
System components: design, operation, degraded modes of operation, indications and warnings

Electrics
Electrics: general information and definitions
Direct current: voltage, current, resistance, conductivity, Ohm's law, power and work
Alternating current: voltage, current, amplitude, phase, frequency and resistance

Circuits: series and parallel
Magnetic field: effects in electrical circuits

Batteries
Types, characteristics and limitations
Battery charging devices, characteristics and limitations

Static electricity: general information
Basic principles
Static discharges
Protection against interference
Lightning effects

Generators: production, distribution and application
DC generation: types, design, operation, degraded modes of operation, indications and warnings
AC generation: types, design, operation, degraded modes of operation, indications and warnings

Electric components
Basic elements: basic principles of switches, circuit-breakers and relays

Distribution
General information:
(a) busbar, common earth and priority
(b) AC and DC comparison.

Piston engines
General information
Types of internal combustion engines internal combustion: basic principles and definitions
Engine: design, operating principles, components and materials

Fuel
Types, grades, characteristics and limitations
Alternate fuel: characteristics and limitations

Carburetor or injection system
Carburetor: design, operating principles, degraded modes of operation, indications and warnings
Injection: design, operating principles, degraded modes of operation, indications and warnings

Icing

Air cooling systems
Design, operation, degraded modes of operation, indications and warnings

Lubrication systems
Lubricants: types, characteristics and limitations
Design, operating principles, degraded modes of operation, indications and warnings

Ignition systems
Design, operation, degraded modes of operation

Mixture
Definition, characteristic mixtures, control instruments, associated control levers and indications

Performance and engine handling
Performance: influence of engine parameters, influence of atmospheric conditions, limitations and power augmentation systems
Engine handling: power and mixture settings during various flight phases and operational limitations

Turbine engines
Definitions
Coupled turbine engine: design, operation, components and materials

Free turbine engine: design, operation, components and materials

Fuel
Types, characteristics and limitations
Main engine components

Compressor:
(a) types, design, operation, components and materials;
(b) stresses and limitations;
(c) stall, surge and means of prevention.

Combustion chamber:
(a) types, design, operation, components and materials;
(b) stresses and limitations;
(c) emission problems.

Turbine:
(a) types, design, operation, components and materials;
(b) stresses, creep and limitations.

Exhaust:
(a) design, operation and materials;
(b) noise reduction.

Fuel control units: types, operation and sensors
Helicopter air intake: different types, design,
operation, materials and optional equipments

Additional components and systems
Helicopter additional components and systems:
lubrication system, ignition circuit, starter, accessory gearbox, free wheel units: design, operation and components

Performance aspects
Torque, performance aspects, engine handling and limitations:
(a) engine ratings;
(b) engine performance and limitations;
(c) engine handling.

Protection and detection systems
Fire detection systems
Operation and indications
Miscellaneous systems

Rotor design
Rotor heads
Main rotor
Types
Structural components and materials, stresses and structural limitations
Design and construction
Adjustment

Tail rotor
Types
Structural components and materials, stresses and structural limitations
Design and construction
Adjustment

Transmission
Main gear box
Different types, design, operation and limitations

Rotor brake
Different types, design, operation and limitations
Auxiliary systems
Drive shaft and associated installation

Intermediate and tail gear box
Different types, design, operation and limitations

Blades
Main rotor blade
Design and construction
Structural components and materials
Stresses
Structural limitations
Adjustment
Tip shape

Tail rotor blade
Design and construction
Structural components and materials

Stresses
Structural limitations
Adjustment

8.2 INSTRUMENTATION

Instrument and indication systems
Pressure gauge
Different types, design, principles of operation, characteristics and accuracy

Thermometer
Different types, design, principles of operation, characteristics and accuracy

Fuel gauge
Different types, design, principles of operation, characteristics and accuracy

Flowmeter
Different types, design, principles of operation, characteristics and accuracy

Position transmitter
Different types, design, principles of operation, characteristics and accuracy

Torque meter
Design, principles of operation, characteristics and accuracy

Tachometer
Design, principles of operation, characteristics and accuracy

Measurement of aerodynamic parameters
Pressure measurement
Static pressure, dynamic pressure, density and definitions
Design, principles of operation, errors and accuracy

Temperature measurement: helicopter
Design, principles of operation, errors and accuracy
Displays

Altimeter
Standard atmosphere
Different barometric references (QNH, QFE and 1013.25)
Height, indicated altitude, true altitude, pressure altitude and density altitude
Design, principles of operation, errors and accuracy
Displays

Vertical speed indicator
Design, principles of operation, errors and accuracy
Displays

Air speed indicator
Different speeds IAS, CAS, TAS: definition, application and relationships
Design, principles of operation, errors and accuracy
Displays

Magnetism: direct reading compass
Earth's magnetic field
Direct reading compass
Design, principles of operation, data processing, accuracy and deviation
Turning and acceleration errors

Gyroscopes instruments
Gyroscope: basic principles
Definitions and application
Basic properties
Drifts

Turn and bank indicator
Design, principles of operation and errors

Attitude indicator
Design, principles of operation, errors and accuracy

Directional gyroscope
Design, principles of operation, errors and accuracy

Communication systems
Transmission modes: VHF, HF and SATCOM
Principles, bandwidth, operational limitations and application

Voice communication
Definitions, general information and applications

Alerting systems and proximity systems
Flight warning systems
Design, operation, indications and alarms

Radio-altimeter
Design, operation, errors, accuracy and indications x x

Rotor or engine over speed alert system
Design, operation, displays and alarms x x

Integrated instruments: electronic displays

Display units
Design, different technologies and limitations

9.1 NAVIGATION - number of lectures / time: 10 hours. (+online session: 2 hours)

9.1 GENERAL NAVIGATION
Basics of navigation
Solar system
Seasonal and apparent movements of the sun
The Earth
Great circle, small circle and rhumb line
Latitude and difference of latitude
Longitude and difference of longitude
Use of latitude and longitude coordinates to locate a specific position

Time and time conversion
Apparent time
Universal Time Coordinated (UTC)
Local Mean Time (LMT)
Standard times
Dateline
Definition of sunrise, sunset and civil twilight

Directions
True north, magnetic north, compass north
Compass deviation
The magnetic pole, isogons, relationship between true and magnetic north

Distance
Units of distance and height used in navigation: nautical miles, statute miles, kilometers, meters and feet
Conversion from one unit to another
Relationship between nautical miles and minutes of latitude and longitude

Magnetism and compass
General principles
Earth magnetism
Resolution of the earth's total magnetic force into vertical and horizontal components
Annual change
Magnetism of the aircraft
The resulting magnetic field
Keeping magnetic materials clear of the compass

Charts
General properties of different types of projections
Direct Mercator
Lambert conformal conic

Representation of meridians, parallels, great circles and rhumb lines
Direct Mercator

Lambert conformal conic

Application of current aeronautical charts
Plotting positions
Methods of indicating scale and relief (ICAO topographical chart)
Conventional signs
Measurement of tracks and distance
Plotting bearings and distances

Dead reckoning navigation
Basics of dead reckoning navigation
Track
Heading (compass north, magnetic north, true north)
Wind velocity
Air speed (IAS, CAS and TAS)
Groundspeed
Estimated time of arrival (ETA)
Drift and wind correction angle
Dead reckoning navigation, position, navigation point

Application of a navigational computer
Speed
Time
Distance
Fuel consumption
Conversions
Air speed
Wind velocity
True altitude

The triangle of velocities
Heading
Groundspeed
Wind velocity
Track and drift angle
Measurement of dead reckoning navigation elements (DR)
Calculation of altitude
Determining the right speed
Navigation during the flight

Use of visual observation and application to in-flight navigation
Navigating in cruising flight, applying a fix to revise the navigation data
Correction of groundspeed
Off-track corrections
Calculation of wind speed and direction
ETA correction
Flight log

9.2 RADIO NAVIGATION

Basics of the theory of radio wave propagation
Antennas
Characteristics
Propagation of waves
Propagation with frequency bands

Radio aids
Ground-based radio direction finder (DF)
Principles of operation
Presentation and interpretation
Coverage area
Range
Errors and accuracy
Factors affecting range and accuracy

NDB / ADF
Principles of operation

Presentation and interpretation
Coverage area
Range
Errors and accuracy
Factors affecting range and accuracy

VOR
Principles of operation
Presentation and interpretation
Coverage area
Range
Errors and accuracy
Factors affecting range and accuracy

DME
Principles of operation
Presentation and interpretation
Coverage area
Range
Errors and accuracy
Factors affecting range and accuracy

Radar
Ground radar
Principles of operation
Presentation and interpretation
Coverage area
Range
Errors and accuracy
Factors affecting range and accuracy

Secondary surveillance radar and transponder
Principles of operation
Presentation and interpretation
Operating modes and codes

GNSS
GPS, GLONASS or GALILEO
Principles of operation
Operation
Errors and accuracy
Factors affecting accuracy