This course can be adapted to virtual classroom mode

Aircraft Turbo Engines

4 days **MFCAERO-EN-A**

Overview

LEVEL

Knowledge

PURPOSE

This course provides newcomers and staff working in the field of aeronautics with a deeper knowledge on characteristics of the main engine operation of aircrafts (airplanes and helicopters) and technologies.

It gives an overview of the design of turbo engines.

LEARNING OBJECTIVES

Upon completion of the course, participants will be able to:

know the needs and constraints related to aircraft turbo engines based on their use,

know the main stages of life of aircraft turbo engines in propulsion and auxiliary power supply,

master the basic principles and specifications of turbo engines,

understand the components characteristics of aircraft turbo engines,

understand the operation of the elements constituting the jets and turboprops,

calculate simple characteristics and parameters of a turbo engine,

understand and know the certification requirements of these technologies.

WAYS AND MEANS

This course is an introduction to aircraft turbo engines and gives an overview of technologies and issues, illustrated by real examples.

Mainly interactive, it addresses the main technical areas of turbo engines, it focuses on the jets and turboprops for example.

Exercises of engines and associated systems help to consolidate the know-how.

Agenda

INTRODUCTION TO AIRCRAFT TURBO ENGINE SPECIFICATIONS — 0.5 d

Aeronautical technology reminders. Reminders an airplane and a helicopter structure. Reminders on the principles of operation.
Positioning technique: positioning technical turbo engines (ramjet, pulsejet, turbojet, turboprop and turboshaft) in the world of aviation engines; type of use (propulsion and auxiliary power generation), conditions of use, range of power, efficiency propulsion, aircraft type associated.
Issues and context: consumption, noise, mass, specific power, reliability, safety, durability, performance, maintenance, integration, pollution, cost of manufacturing.
Engines mission profiles by type of aircraft and type of aircraft operations. Stages of life. Operating points, operating times. Definition of power requirement. Stabilized and transient operations related to flight mechanics. Influence of the environment: altitude, pressure, temperature, speed, ice, resistance to damage (lightning, obstacles, etc.).
Specifications for auxiliary power generation unit (APU).
Design and production: digital model, the various materials used in aircraft piston engines and their locations, assembling and producing.

Regulation and certification.

AIRCRAFT TURBO ENGINE PERFORMANCE — 0.5 d

Detailed operation of turbo engines: technology and operation; focus on the operation of turbojet, turbofan and turboprops.
Turbo engines performance: Brayton thermodynamic cycle; thermal and propulsive efficiency; calculating results; parameters optimization, bypass ratio effect; application to the study of a turbojet and a turboprop; design of a turbojet and turboprop; effect of engine integration; impact of architectural choices and choice of materials; performance depending on the mission profile of the flight; calculation exercises and sizing.

TURBO ENGINE COMPRESSORS — 0.75 d

Reminders of air flows: physical properties, boundary layer, shock wave, similar problems.
Profiles: geometrical, aerodynamic forces, stall, transonic conditions. Gas velocity mach. Notion of static pressure, dynamic and total pressure.
Reminders on the principles of compressors: conservation of mechanical energy, energy balance of compressible fluids, taking account of losses and energy transfers; adiabatic compression and actual compression.
Aeronautical technology compressors and aviation fans: operating principles, features, characteristics, changes in pressure and temperature, relative velocity and absolute axial and radial in the benchmark, aerodynamic compressors, compressor field, pumping and remedies, steering wheel input, variable-pitch stator, discharge valve, exercises calculation and dimensioning.

TURBO ENGINES COMBUSTION CHAMBER — 0.75 d

Fundamentals of combustion fuel, oxidizer, calorific reaction enthalpy. Influence of aerodynamics. Chemical equilibrium and chemical kinetics. Combustion in open systems. Combustion control.
Type of fuel for aviation applications: formulation and specifications, biofuels and aviation.
Technology and operation of a combustion chamber: specifications; constraints; combustion chambers architectures; injector (pre-spray); room reverse flow; cooling of the combustion chambers; dilution rate; release of energy, temperature, pressure, emissions in a combustion chamber; exercises calculation and dimensioning.

TURBO ENGINES COMBUSTION TURBINES — 0.75 d

Reminders on the principles of turbines: relaxation adiabatic and real relaxation, characteristics of turbines, control principles, energy balance.
Technology of turbo engines: specifications of turbines, architecture turbines (axial and radial turbines, turbines staged).
Operating principles. Features. Mechanical characteristics. Aerodynamics of turbines. Changes in pressure and temperature. Cooling blades and discs. Creep and corrosion. Exercises calculation and dimensioning.

AUXILIARY SYSTEMS & PLATFORMS — 0.5 d

Internal systems: air system (cooling, …), fuel system, lubrication system, control system and anti-icing, box accessories.
Start ignition: boot, re-ignition.
The nacelle: air intakes, engine mounts and nozzles.
Air inlet: functional, sonic and subsonic operation, design parameters; divergent, additional air intake, supersonic air intake, sock.
Nozzle: convergent, convergent-divergent, variable section; inner cone; noise attenuators; afterburner.
Engine integration, engine maintenance.

TURBO ENGINE EVOLUTIONS — 0.25 d

Issues: improved performance (thermal efficiency, propulsion efficiency and specific fuel consumption, pollutants, noise, vibration).
Technological developments: double Turbofan body, Turbofan with gearbox, open rotor, pusher and puller configurations, energy recovery, intercooling; evolution materials; generations N +1, N +2 and N +3 aircraft and propulsion aviation projects.