



Collège  
Édouard-Montpetit  
École nationale d'aérotechnique

**280-1C5-EM**  
**FALL 2009**  
**Propulsion**

## **COURSE OUTLINE**

**COURSE :**           **The Operation of Aircraft Piston Engines**

**PROGRAM :**        280.C0 Aircraft Maintenance Technology

**DISCIPLINE :**     280 Aeronautics

**WEIGHTING :**     Theory : 3                           Practical Work : 2                   Personal Study : 2

<b>Instructor(s)</b>	<b>Office</b>	<b>☎ Extension</b>	<b>✉ Email or Web site</b>
Champagne Robert	D-113C	4696	robert.champagne@college-em.qc.ca

### **OFFICE HOURS**

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning					
Afternoon	14-15h			13-14h	11-12h / 13-14h

<b>Coordinator(s)</b>	<b>Office</b>	<b>☎ Extension</b>	<b>✉ Email or Web site</b>
Gauvreau Réjean	D-113D	4730	rejean.gauvreau@college-em.qc.ca

## **CONTEXT OF THIS COURSE IN THE PROGRAM**

This course is given during the first session of the program.

By the end of the course, students will have developed their abilities to :

- Distinguish various types of aircraft piston engines.
- Explain the basic principles of piston engine operation and of their system
- Recognize the components, parts and accessories of an engine and their functions.
- Explain the operation of different engine systems.
- Identify health and safety regulations in the workplace involving piston engines.
- Identify the laws, standards and regulations of Transport Canada associated with piston engines.
- Use a variety of manuals and documents associated with piston engines.
- Distinguish systems and their components and carry out the necessary operations to operate them.
- Diagnose defects.

This course is a pre-requisite for Courses 280-234-EM and 280-526-EM.

Students must keep this course outline for the duration of their studies as it will be useful for the comprehensive assessment at the end of the program.

## **MINISTERIAL OBJECTIVE(S) AND COMPETENCIES**

**025V** Carry out activities related to inspecting the operation of aircraft piston engines.

**025Y** Carry out activities related to the overhaul of aircraft piston engines.

## **TEACHING AND LEARNING STRATEGIES**

### **Theory:**

A variety of pedagogical methods are used including presentations using a multi-media projector or the blackboard, use of propulsion models and engine parts, and lectures with formative exercises at the end of certain themes.

### **Practical Work:**

#### Teaching Strategy:

Using a variety of teaching methods, the practical work involves a hands-on approach to learning about the components and systems that make up an aircraft piston engine as well as explaining laboratory technologies using lectures and demonstrations.

## **COURSE PLAN – THEORY**

The theoretical part of the course is divided into three phases:

First: GENERAL POINTS ABOUT ENGINES covers the overall operation of various piston engines used in aerospace.

Second: SYSTEMS covers the systems necessary for the operation of four-cycle aircraft piston engines

Third: Performance calculations related to the operation of aircraft engines.

### **ACTIVITY PERIODS:**

#### **PHASE 1: General points about engines (Weeks 1 to 4)**

---

##### **Learning Objectives: 1.1, 1.2, 1.3, 1.5**

- To compare the different types of engines and describe their power cycle.
- To name and explain the use of the parts that make up a piston engine.

##### **Content**

#### **1.1 Distinguish different types of aircraft piston engines.**

- Overview of the history and evolution of aircraft piston engines over the years.
- Types of engines, cylinder arrangement and operation modes.
- Piston engine systems and accessories such as: supercharging, cooling, ignition, carburation and others
- Definition of an engine, engine group, cycle, stroke, bore, reliability, operating time, flexibility, lightness, balance, operating costs.

#### **1.2 Explain the basic principles of piston engine operation**

- Define engine strokes, intake, compression, combustion, exhaust
- Study the Otto cycle and two-stroke engine, valve synchronization and its effect on the engine
- Determine the factors that influence the output and performance of a piston engine.

#### **1.3 Associate engines with their use on aircraft**

- Differentiate types of engines and their applications in aeronautics
- Diagnose engine operation related to operation stresses

#### **1.5 List components, parts and accessories of an engine and describe their functions**

- Learn the names and definitions of engine parts and types of materials along with their functions and features.

**PHASE 2 : Systems (Weeks 5 to 12)**

---

**Learning Objectives: 1.4, 1.6, 3.1, 4.1, 5.1, 6.1, 7.1**

**Content**

**1.4 Distinguish types of fuel for piston engines**

- Learn the properties and characteristics of Avgas (aviation gasoline) and 100LL (100 low-lead)

**1.6 Explain the operation of different engine systems**

- Become familiar with engine systems such as carburetion, ignition, cooling, supercharging, induction, exhaust, lubrication

**3.1 Distinguish types of ignition systems and identify their components and functions**

- Magneto, electronic and pressurized ignition systems; starting systems using induction vibrator, impulse coupling, booster coil. vibration induction, impulse coupler (coupling), overvoltage ignition coil
- Cable assembly (cable harness) : manufacturers, insulators, sleeves, internal, lead wire, terminals and installation
- Spark plugs: model number coding, manufacturers, assembly, operation, types of electrodes and insulators, maintenance
- Inertia starters (propeller), electric, gear, clutch system

**4.1 Distinguish types of carburetion systems and identify their components and functions**

- Float carburetor, injection systems, anti-freeze, preheat, pressurized carburetor

**5.1 Distinguish types of lubricating systems and identify their components and functions**

- Complete circuits : reservoir, pump, filter, oil passages, pressure and temperature probe indicators, pressure-regulator valve, bypass check valve, oil cooler, etc.
- Dry and wet sump systems, acrobatic sump systems, oil dilution
- Knowledge of oil types, their properties and usage

**6.1 Distinguish types of measuring chains and identify their components and functions**

- Dynamometer (dyno), engine readings such as : oil pressure and temperature, exhaust gas temperature (EGT), cylinder heads temperature (CHT), manifold absolute pressure (MAP), speed/revolutions per minute (RPM), fuel flow

**7.1 Distinguish types of engine control systems and identify their components and functions**

- Speed control, fuel mixture, propeller blade pitch and supercharging

**PHASE 3: Performance Calculations (Weeks 13 and 14)**

---

**Learning Objective: 9.3**

**Content**

**9.3 Verify the performance and limits stipulated by the manufacturer**

- Performance calculations, comparisons with manufacturer's chart

**Personal Study Activities**

Every week students must read the assigned readings before the course. As the course advances, they are also expected to answer the formative questions in the course notes.

## **COURSE PLAN – LABORATORY**

The laboratory part of the course is divided into two major themes : Piston Engine Operation and The Operation of Different Peripheral Systems.

In the practical part of the course, students are exposed to laboratory technology through a variety of teaching methods. Short lectures are generally followed by hands-on activities that allow students to develop a detailed understanding of the operation of aircraft piston engines and their systems.

### **THEME 1: Piston Engine Operation (Weeks 1 to 8)**

---

**Learning Objectives : 1.5, 1.7, 8.1, 8.2, 8.3**

#### **Content**

#### **1.5 Listing components, parts and accessories of an engine and identify their functions.**

- Learn the names and definitions of engine parts and types of materials along with their functions and features.

#### **1.7 Identifying health and safety regulations in the workplace related to piston engines.**

- Precautions to take around propellers and in the hangar; establishing a security zone
- Identifying work (posting warning labels)
- Safety equipment (gloves, protective eyewear, boots, visers, etc.)
- Work safety equipment such as safety bars, cotter pins, retainers

#### **8.1 Keeping order in the workplace**

- Put away any items such as buckets, scales, lights, etc.
- Sweep the floor and make sure the work area is clean and safe.

#### **8.2 Return to the appropriate place any components, equipment and tools used such as ladders, scaffolding, jacks, adapters, cables, dynamometric keys and others.**

#### **8.3 Apply health and safety regulations in the workplace**

- Dispose of fluids in the appropriate place
- Throw rags away in the appropriate containers as well as any other toxic products that were used
- Make sure the work area is clean and safe

### **THEME 2: The operation of different peripheral systems (Weeks 9 to 15)**

---

**Learning Objectives: 3.2 to 3.6, 4.2 and 4.3, 5.2 to 5.6, 6.2 to 6.6, 7.2 to 7.6**

#### **Content**

#### **3.2 Inspect components of the ignition system**

- Inspect spark plugs, electrode clearance, cleaning and adjustment, spark quality
- Inspect high tension wires : visual inspection of the wire and its insulator and terminals
- Inspect magnetos: Electrode gap (E-gap), electrode wear, spark quality, distributor, capacitor, magnet
- Inspect on-off switch : test electrical continuity, visual inspection of parts
- Inspect the battery and starter : wires, terminals, brush, etc.

### **3.3 Carry out ignition system operation test**

- Check manufacturer's standards
- Verify that the operations comply with the applicable health and safety standards
- Assure that the required equipment and instrumentation is being used for the task
- Check spark quality, ignition synchronisation, intensity

### **3.4 Tag defects of operation**

- Identify types of defects
- Make system adjustments

### **3.5, 5.5, 6.5, 7.5 Complete required documentation**

- Label parts, fill out logbook and other documents.
- Certify that work complies with Transport Canada and the manufacturer's standards

### **3.6 Apply safety regulations related to inspections of aircraft piston engine ignition systems**

- Use protective equipment, assure a safety zone, respect usage precautions while handling materials, use appropriate tools and equipment

### **4.2 Inspect components of the piston engine fuel system**

- Inspect float chamber, throttle, venturi, filters, accelerator pump, passages, etc.
- Inspect pump, injectors, fuel flow distributor, fuel mixture controller

### **4.3 Carry out piston engine fuel system operation tests**

- Inspect fuel flow and fuel mixture according to manufacturer's standards
- Start engine following the list of procedures, inspect operation and make adjustments
- Check fluid level, adjust mixture and rate, check for leaks and inspect overall operation
- Apply manufacturer's tests and standards
- Assure operations comply with applicable health and safety standards
- Assure required equipment and instrumentation is used for the task

### **5.2 Inspect piston engine lubrication system components**

- Inspect system components according to the standards
- Drain and analyse oil (metallic particles detection, spectrometric oil analysis procedure (SOAP))

### **5.3 Carry out piston engine lubrication system operation tests**

- Start engine following the list of procedures, inspect operations and make adjustments, check pressure and temperature according to manufacturer's standards, check oil level and fuel consumption
- Check manufacturer's standards for fuel consumption, temperature and pressure.
- Assure operations comply with the applicable health and safety standards.

### **5.4, 6.4, 7.4 Tag operation defects**

- Detect defects, make analyses and resolutions
- Adjust systems

**5.6 Apply safety regulations related to inspections of aircraft piston engine lubrication systems**

- Use protective equipment, set up safety zone, respect usage precautions while handling material, use appropriate tools and equipment

**6.2 Inspect components of the piston engine measuring chain system**

- Inspect components of the system according to standards such as the calibration date, general condition of the indicating systems.

**6.3 Carry out tests of the piston engine measuring chain systems**

- Start engine and compare data against manufacturer's standards

**6.6 Apply safety regulations related to inspections of the operation of the piston engine measuring chain system**

- Use protective equipment, assure a safety zone, respect precautions regarding usage while handling material, use appropriate tools and equipment.

**7.2 Inspect piston engine control system components**

- Inspect cables, lever, terminals for safety and condition according to standards

**7.3 Carry out piston engine control system operation tests**

- Check manufacturer's standards
- Assure operations comply with the applicable health and safety standards
- Use required equipment and instrumentation for the task
- Inspect and adjust controls (rigging)
- Inspect lever movement and component responses associated with the engine in operation
- Check for attained engine performance and compare it with the manufacturer's chart.

**7.6 Apply safety regulations related to piston engine control system operation inspections**

- Use protective equipment, assure safety zone, respect usage precautions while handling material, use appropriate tools and equipment

**Personal Study Activities**

Every week students must read the assigned readings before the course. As the course advances, they are also expected to answer the formative questions in the course notes.



**SYNTHESIS OF EVALUATION METHODS**

Traditional and/or multiple choice evaluations are used

**Theory**

Description of the evaluation activity	Context	Learning Objective(s)	Due Date (date assignment is due or exam date)	Weighting (%)
Exam	Individual; duration up to 3 hours	1.1 to 1.3, 1.5	Week 5	15%
Exam	Individual; duration up to 3 hours	1.4, 1.6, 3.1, 4.1, 5.1, 6.1, 7.1	Week 10	15%
Exam	Individual; duration up to 3 hours	1.1 to 1.6 3.1, 4.1, 5.1, 6.1, 7.1, 9.3	Week 15	20%

Sub-total: 50%

**Practical Work**

Description of the evaluation activity	Context	Learning Objective(s)	Due Date (date assignment is due or exam date)	Weighting (%)
Exam	Individual; duration up to 2 hours	1.5, 1.7, 3.2 to 3.6, 5.2 to 5.6, 8.1 to 8.3	Week 7	20%
Research assignment on aircraft piston engine lubrication circuit	In teams	5.2 to 5.6	Week 14	5%
Exam	Individual; duration up to 2 hours.	1.5, 1.7, 3.2 to 3.6 4.2, 4.3, 5.2 to 5.6, 6.2 to 6.6 7.2 to 7.6, 8.1 to 8.3	Week 15	25%

Sub-total: 50%

**TOTAL: 100%**

**SCHEDULE OF THEORY AND PRACTICE COURSES**

<b>Wk</b>	<b>Theory 3 hours</b>	<b>Practice 2 hours</b>
1	Course Outline Introduction / historical overview Classification	Course Outline Laboratory procedures Team assignments and distribution of engines
2	Operation of 4-stroke internal combustion engine and its components	Disassembly of a small engine
3	<b>Continuation</b> : Operation of 4-stroke internal combustion engine and its components	Disassembly of a small engine Internal operation inspection
4	Operation of a 2-stroke internal combustion engine, Wankel, diesel and their components	Engine assembly
5	<b>Exam</b>	Engine assembly
6	Introduction of different engine systems Combustion process Fuel systems, types of fuel. Operation and components.	Small engine: nominal adjustments and starting.
7	<b>Continuation:</b> Fuel systems, types of fuel. Operation and components.	<b>Continuation:</b> Nominal adjustments and starting <b>Exam</b>
8	Introduction to ignition systems	Fuel system Carburetor disassembly, inspection, reassembly
9	<b>Continuation:</b> Ignition systems: operation and components	Model of carburetor and engine controls.
10	<b>Exam</b>	Model of injection system
11	Engine control system (rate, mixture, pitch of the blade, supercharging)	Introduction to the test bench
12	Lubricating system Cooling systems	Magneto internal synchronisation Spark plug adjustment and verification
13	Performance calculations	Magneto synchronisation on the engine (Bendix and Slick)
14	<b>Continuation:</b> Performance calculations and exercises.	Lubricating system
15	<b>Final Exam</b> (Comprehensive, Wks 1-15)	<b>Final Exam</b> (Comprehensive, Wks 1-15)

## **REQUIREMENTS TO PASS THE COURSE**

### **(1) Passing Mark**

The passing mark for this course is 60%.

### **(2) Presence at Summative Evaluations**

Presence is required at summative evaluations.

### **(3) Submitting Assignments**

Assignments must be submitted by the date, place and time determined by the instructor.

Any assignment submitted after the due date will be penalized 10% per day for each day it is late up to a week. After one week, the assignment will receive a zero (0) unless other arrangements have been made with the instructor.

### **(4) Presentation of Written Work**

Students must follow the standards adopted by the College for written work (« *Normes de présentation matérielle des travaux écrits* »). These can be found in the documentation centre on the College web site (<http://ww2.college-em.qc.ca/biblio/normes.pdf> ) under the heading « **Aides à la recherche** »

## **CLASS PARTICIPATION EXPECTATIONS**

**Theory:** The instructor may have specific requirements or prohibitions to improve class management. These may be explained at the beginning of the course or during the session.

**Practical Work :** The teacher may have specific requirements or prohibitions to improve class management. These may be explained at the beginning of the course or during the session.

## REQUIRED MATERIAL

- Course notes and appropriate manuals
- Calculator (ENA)
- Overalls (ENA)
- Cleaning rag (ENA)
- Safety glasses
- Safety footwear

## MEDIAGRAPHY

### BOOKS in French:

<u>Le moteur diesel</u> , Schulz	621.4368S388d
<u>Manuel de réparation</u> , Briggs & Stratton	621.437B854m
<u>Manuel complet de l'automobile</u> , Reader's Digest CAA	629.28722S464m

### BOOKS in English:

<u>Aircraft Fuel Metering Systems</u> , International Aviation Publishers	629.134351C891a
<u>Aircraft Powerplants</u> , Kroes & Wild	629.13435M158a
<u>Airframe and Powerplant Mechanics</u> , AC65-12A, FAA	629.1343E83a-4
<u>Automotive Engines Theory &amp; Servicing</u> , James D. Halderman	629.2504E46a
<u>Illustrated Parts Catalog for C-75, C-85, C-90 and O-200 Aircraft Engines</u> , Teledyne Continental Motors	X30011A1985
<u>Sky Ranch Engineering Manual</u> , John Schwaner	629.134353S398s
<u>Aircraft Powerplant Maintenance</u> . Avotek Information Resources®	

### AUDIO-VISUAL :

Vidéo <u>Carburator</u>	629.2533c264a
Vidéo <u>Moteur</u>	

## INSTITUTIONAL POLICIES AND REGULATIONS

All students enrolled at Collège Édouard-Montpetit must become familiar with and comply with the institutional policies and regulations. In particular, these policies address learning evaluations, maintaining admission status, French language policies, maintaining a violence-free and harassment-free environment, and procedures regarding student complaints. The French titles for the policies are: *Politique institutionnelle d'évaluation des apprentissages, les conditions particulières concernant le maintien de l'admission d'un étudiant, la Politique de valorisation de la langue française, la Politique pour un milieu d'études et de travail exempt de harcèlement et de violence, les procédures et règles concernant le traitement des plaintes étudiantes.*

The full text of these policies and regulations is accessible on the College web site at the following address: [www.college-em.qc.ca](http://www.college-em.qc.ca). If there is a disparity between shortened versions of the text and the full text, the full text will be applied and will be considered the official version for legal purposes.

## OTHER DEPARTMENTAL REGULATIONS

Students are encouraged to consult the website for the specific regulations for this course:

[www.college-em.qc.ca/ena/propulseur/reglements](http://www.college-em.qc.ca/ena/propulseur/reglements)

## APPENDIX

Activity periods written in the course outline for the Propulsion Department serve as a general guideline. Modifications may be made to accommodate any logistical problems that may arise.