

## COURSE OUTLINE

**COURSE:** Aircraft Piston Engines

**PROGRAM:** 280.C0 Aircraft Maintenance

**DISCIPLINE:** 280 Aeronautics

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

Instructor(s)	Office	☎ Extension	✉ Email or Web site
Marc-André Farkouh	D-113d	4437	<a href="mailto:marc-andre.farkouh@cegepmontpetit.ca">marc-andre.farkouh@cegepmontpetit.ca</a>

### OFFICE HOURS

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning					
Afternoon	13 :00 - 14 :00	12 :00 - 13 :00		14 :00 - 15 :00	

Coordinator(s)	Office	☎ extension	✉ e-mail
Louis Deschênes	D-113D	4607	<a href="mailto:louis.deschenes@cegepmontpetit.ca">louis.deschenes@cegepmontpetit.ca</a>

## CONTEXT OF THIS COURSE IN THE PROGRAM

This course is given during the first semester 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 280-3A4-EM and 280-5A6-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.**

**Transport Canada:** This course outline meets the requirements of Training Organisation Certification Manual (MCF) of Transport Canada. The Department applies Transport Canada standard which allows a maximum absence of 5% for the course (theory and laboratory). The department compiles absences of all students enrolled in Aircraft Maintenance (280.C0) and Avionics (280.D0) according to Transport Canada requirements. The application of Transport Canada policies regarding absences is available on the college website and in the student agenda under the heading « Privilèges accordés par Transports Canada ».

## COMPETENCIES OF THE EXIT PROFILE (STUDENT SKILL PROFILES)

Perform engine maintenance

## MINISTERIAL OBJECTIVE(S) AND COMPETENCIES

**025V** Perform activities related to the verification of the operation of aircraft piston engines.

**025Y** Perform activities related to the overhaul of aircraft piston engines

## TERMINAL OBJECTIVE OF THE COURSE (FINAL COURSE OBJECTIVE)

At the end of the course, the student will be able to explain the operation of various piston engines as well as their systems.

## 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)**

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##### **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)

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**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)**

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**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)**

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**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)**

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**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 SUMMATIVE EVALUATION METHODS**

Traditional and/or multiple choice evaluations are used

**Theory**

Description of the evaluation activity	Context	Learning Objective(s)	Evaluation Criteria	Due Date (date assignment is due or exam date)	Weighting (%)
Types, uses, principles of operation and motor nomenclature.	Individually lasting up to 3 hours. Closed book.	1.1 to 1.3, 1.5	Good identifications and explanations of the types of engines and their appropriate uses. Explain principles of engine operation. Usage of the right engine nomenclature.	Week 5	15%
Fuel and ignition systems.	Individually lasting up to 3 hours. Closed book.	1.4, 1.6, 3.1, 4.1	Good component identifications and fair explanations of the different fuel and ignition systems.	Week 10	15%
Lubrication system, supercharging, engine control and verify engine performance.	Individually lasting up to 3 hours. Closed book.	5.1, 6.1, 7.1, 9.3	Good component identifications and correct explanations of the different engine systems. Steps and fair results of performance calculations.	Week 15	20%

Sub-total: 50%

**Practical Work**

Description of the evaluation activity	Context	Learning Objective(s)	Evaluation Criteria*	Due Date (date assignment is due or exam date)	Weighting (%)
Honda engine operation and nomenclature. Gap of spark plug electrodes and valve adjustment.	Individually lasting up to 2 hours. Open book.  Theoretical and practical evaluation.	1.5, 1.7, 3.2 to 3.6 5.2 to 5.6	Good explanations of engine operation and identification of components. Accuracy in the evaluation of the gap at the electrodes and execution in the adjustment of the valves.	Week 8	20%
Engine systems and test bench.	Individually lasting up to 2 hours. Open book.  Theoretical and practical evaluation.	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	Good explanations of the carburetor operation, injection, ignition and lubrication systems. Correct identification of methods to adjust systems. Appropriate use of test bench results for performance calculations.	Week 15	30%

Sub-total: 50%

**TOTAL: 100%**

**SCHEDULE OF THEORY AND PRACTICE COURSES**

Week	Theory 3 hours	Practice 2 hours
1	Course Outline. Engine evolution and historical overview. Type, systems and use of engines.	Course Outline. Laboratory procedures. Team assignments and distribution of engines.
2	Operation and nomenclature of 4-stroke internal combustion engines and their components.	Engine disassembly.
3	Operation and nomenclature of 4-stroke internal combustion engines and their components.	Engine disassembly.
4	Operation and nomenclature of 4-stroke internal combustion engines and their components.	End of engine disassembly. Engine assembly.
5	<b>Exam 1 (15%)</b>	Engine assembly.
6	Process of combustion and fuel. Fuel systems, operation and components.	Engine assembly.
7	Fuel systems, operation and components.	End of engine assembly. Nominal adjustments and engine starting.
8	Ignition systems, operation and components.	<b>Mid-term exam (20%)</b> Engine starting.
9	Ignition systems, operation and components.	Carburetor disassembly, inspection and reassembly. Carburetor system mock-up and engine controls.
10	<b>Exam 2 (15%)</b>	Injection system mock-up.
11	Supercharging systems. Engine control system (rate, mixture, pitch of the blade, supercharging).	Piston engine test bench.
12	Lubricating system. Cooling systems.	Magneto internal synchronisation (Bendix).
13	Performance calculations.	Magneto synchronisation on the engine.
14	Performance calculations.	Lubricating system.
15	<b>Final Exam (20%)</b>	<b>Final Exam (30%)</b>

## REQUIRED MATERIAL

Course notes and Coop booklet # 5609 (Part 1) and # 5586 (Part 2).

SHARP EL531 calculator.

## MEDIAGRAPHY

### BOOKS in French:

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

### BOOKS in English:

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

### AUDIO-VISUAL:

Vidéo <u>Carburetor</u>	629.2533c264ad
Vidéo <u>Moteur</u>	629.13435M

## **REQUIREMENTS TO PASS THE COURSE**

### **1. Passing Mark**

The passing mark for this course is 60% by adding the marks for the theory and practical work for the course.

### **2. Tardiness**

Students who arrive late after the beginning of the first period of a course are considered absent for this period.

### **3. Attendance for Summative Evaluations**

Students must be present for summative evaluations and must comply with the instructions given by the instructor to carry out the evaluation activity and written in the course outline. Unexcused tardiness for a summative evaluation could result in being excluded from the activity. Any absence from a summative evaluation that is not due to serious reasons (illness, death in the family, etc.) could result in a mark of zero (0) for the activity.

Students are responsible for meeting with the instructor before an evaluation activity is held or immediately upon returning to ENA to explain the reason for an absence. Proper documentation, such as a medical certificate, a death certificate, legal papers, etc., must be shown if the reason for absence is serious and recognized as such by the instructor(s), arrangements will be made between the instructor(s) and the student to make up the activity.

### **4. Submitting Assignments**

All assignments must be submitted by the date, hour and location designated by the instructor(s). Late assignments will be penalized 10% per day that they are late and will receive a mark of zero (0) after one week.

### **5. Presentation of Written Work**

The instructor(s) will provide students with information and guidelines regarding the presentation of written work. When the presentation of an assignment is unacceptable, the work will be penalized as a late assignment until an acceptable version is submitted. In this case, the penalties for late work will be applied.

Students must follow the standards adopted by the Cégep for written work (« *Normes de présentation matérielle des travaux écrits* »). These can be found in the documentation center on the Cégep web site [www.cegepmontpetit.ca/normes](http://www.cegepmontpetit.ca/normes) under the heading **Liens éclair, Bibliothèques, « Méthodologie »**.

## 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.

### Port of mandatory safety equipment in the laboratory

- The wearing of safety equipment is mandatory in the laboratory classes:

- Safety shoes
- Safety glasses
- Work gloves
- Workclothes ÉNA
- Rags (ÉNA).

## OTHER DEPARTMENTAL REGULATIONS

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

<http://guideena-en.cegepmontpetit.ca/departement-rules/>

## INSTITUTIONAL POLICIES AND REGULATIONS

All students enrolled at Cégep 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* (PIEA), la *Politique institutionnelle de la langue française* (PILF), la *Politique pour un milieu d'études et de travail exempt de harcèlement et de violence* (PPMÉTEHV), les *Conditions d'admission et cheminement scolaire*, la *Procédure concernant le traitement des plaintes étudiantes dans le cadre des relations pédagogiques*.

The full text of these policies and regulations is accessible on the Cégep web site at the following address: <http://www.cegepmontpetit.ca/ena/a-propos-de-l-ecole/reglements-et-politiques>. 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.

## 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.