

## COURSE OUTLINE

**COURSE:** Aircraft Instrumentation

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

**DISCIPLINE :** 280 Aeronautics

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

<u>Instructor(s)</u>	<u>Office</u>	<u>Extension</u>	<u>e-mail or web site</u>
Mora Joaquin	C-186	4220	<a href="mailto:joaquin.mora@cegepmontpetit.ca">joaquin.mora@cegepmontpetit.ca</a>

### OFFICE HOURS

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning					
Afternoon					

<u>Coordinator(s)</u>	<u>Office</u>	<u>extension</u>	<u>e-mail or website</u>
Éric Goudreault	C-186	4691	<a href="mailto:eric.goudreault@cegepmontpetit.ca">eric.goudreault@cegepmontpetit.ca</a>
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## **CONTEXT OF THIS COURSE IN THE PROGRAM**

This course is offered during the fourth session of the program. It is intended for future Category M Aircraft Maintenance Engineers (AME). The objective is to enable them to diagnose and determine appropriate maintenance intervention for various aircraft instruments. In order to do this, they must know the terminology, their roles and operating principles. They must also be able to interpret the technical documentation provided by aircraft manufacturers.

This course presents a fairly complete overview of all types of instruments found onboard an aircraft.

**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 maintenance of aircraft systems.

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

**0263** Verify the operation of simple alternating-current circuits on an aircraft.

**0265** Verify communications, navigation and instrumentation systems.

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

At the end of the course, the student will be able to perform functional checks, recognize and diagnose any deviations from the standards established by the manufacturer and Transport Canada and certify the operation of a several navigation instruments.

## **TEACHING AND LEARNING STRATEGIES**

**THEORY:** Formal lectures, audio-visual support and short videos.

### **LABORATORY:**

Teaching and learning strategies

Students perform different instrumentation checks in teams of three or four. The semester has 8 laboratories in total.

- Weeks 1 and 2, the teacher will explain the basic instructions as well as the safety regulations. It will also demonstrate the first 4 test benches of the laboratory.
- In the following weeks, students perform each lab activity in teams of three or four until the first four labs are completed. The first exam will be held when the first four labs are completed, the week before the school break.
- The same procedure will be repeated for the last 4 laboratories, followed by a review on them.
- The exercises are performed using the course book and the manuals available in the laboratory.

- Laboratory manuals may include:
  - excerpts from CAR standards
  - extracts from aircraft maintenance manuals
  - extracts from component maintenance manuals
  - procedure manuals for the use of test equipment
- For each exercise, the student will have to complete the data sheets included in the laboratory notebook.
- The information entered by the student in his or her course book will serve as a study guide for both exams.

## COURSE PLAN – THEORY

Learning Objective	Content	Personal Study Activities	No. of hours
1.1 Distinguish and describe the elements and characteristics common to the instruments.	<ul style="list-style-type: none"> <li>▪ Presentation of the Course Outline</li> <li>▪ The elements of an instrument</li> <li>▪ The characteristics of an instrument</li> <li>▪ Types of errors</li> </ul> <p style="text-align: right;">TC Appendix C, part 2, 22.4.1, 22.4.2, 22.4.16</p>	Read course notes and personal notes. ▪ Quiz	3
1.2 Describe different methods of transmitting and displaying information.	<ul style="list-style-type: none"> <li>▪ Electro-mechanical and mechanical indicators</li> <li>▪ Liquid crystal alphanumeric or electroluminescent diode indicators</li> <li>▪ Cathode ray tubes (CRTs) and liquid crystal screens</li> <li>▪ Synchro transmitters</li> <li>▪ Digital transmission line (digital ARINC Bus)</li> </ul>		3
1.3 Describe the role and operation of atmospheric reference instruments.	<ul style="list-style-type: none"> <li>▪ Atmosphere and atmosphere type</li> <li>▪ Pitot and static circuits</li> <li>▪ Altimeter</li> <li>▪ Vertical speed indicator</li> <li>▪ Pressurization control instruments</li> </ul>		3
1.4 Recognize the requirements for maintaining navigability.	<ul style="list-style-type: none"> <li>▪ Anemometer, machmeter, excessive speed warning</li> <li>▪ Aerodynamic data computer</li> <li>▪ Applicable airworthiness standards</li> <li>▪ Inspection, common maintenance, precautions</li> </ul>		3
1.5 Describe the operation and role of basic magnetic and gyroscopic instruments.	<ul style="list-style-type: none"> <li>▪ Magnetic compass</li> <li>▪ Characteristics and properties of a gyroscope</li> <li>▪ Gyroscope training</li> <li>▪ Turn and side slope indicator and turn coordinator</li> <li>▪ Artificial horizon</li> <li>▪ Gyroscopic compass</li> <li>▪ Erector systems</li> <li>▪ Gyromagnetic compass</li> <li>▪ Introduction to the inertial navigation system</li> <li>▪ Gyrolaser</li> <li>▪ Applicable airworthiness standards</li> <li>▪ Inspection, common maintenance, precautions</li> </ul>		3
Exam 1			3

<b>Learning Objective</b>	<b>Content</b>	<b>Personal Study Activities</b>	<b>No. of hours</b>
1.6 Describe the role and operation of engine control and aircraft system instruments.	<ul style="list-style-type: none"> <li>▪ Temperature measurement</li> <li>▪ Pressure measurement</li> <li>▪ Quantity gauges</li> <li>▪ Tachometers</li> <li>▪ Synchroscope</li> <li>▪ Flowmeter</li> <li>▪ Torquemeter</li> <li>▪ Engine pressure ratio</li> <li>▪ Vibration measurement</li> <li>▪ Angle of attack measurement</li> <li>▪ Stall protection system</li> </ul>	<ul style="list-style-type: none"> <li>▪ Read course notes and personal notes.</li> </ul>	7
1.7 Describe the role, architecture and operation of a centralized failure management system.	<ul style="list-style-type: none"> <li>▪ An example of architecture</li> <li>▪ EICAS (Engine indicating &amp; crew alerting system) or ECAM (Electronic centralized aircraft monitoring)</li> <li>▪ Maintenance diagnostic system</li> </ul>	Read course notes and personal notes.	5
Exam 2			3
1.8 Describe the role and operation of navigation instruments.	<ul style="list-style-type: none"> <li>▪ ADF</li> <li>▪ VOR</li> <li>▪ DME</li> <li>▪ ILS</li> <li>▪ Radio altimeter</li> <li>▪ INS</li> <li>▪ GPS</li> <li>▪ ATC transponder</li> <li>▪ Collision avoidance system (TCAS)</li> <li>▪ Ground proximity warning system (GPWS)</li> <li>▪ Weather radar</li> </ul>	Read course notes and personal notes.	8
1.9 Describe the operation of the autopilot and flight director systems.	<ul style="list-style-type: none"> <li>▪ Architecture of an autopilot system</li> <li>▪ Basic and higher functions</li> <li>▪ Auto-throttle</li> <li>▪ Flight director</li> </ul>	Read course notes and personal notes.	2
1.10 Describe the role and operation of the flight management system.	<ul style="list-style-type: none"> <li>▪ Introduction to flight management system (FMS)</li> </ul>	Read course notes and personal notes.	1
1.11 Describe the role and operation of the flight recorders.	<ul style="list-style-type: none"> <li>▪ Flight data acquisition recording system (FDARS)</li> <li>▪ Flight data acquisition unit (FDAU)</li> <li>▪ Flight data recorder (FDR)</li> <li>▪ Quick access recorder (QAR)</li> <li>▪ Cockpit voice recorder (CVR)</li> </ul>	Read course notes and personal notes.	1
Exam 3			3

**LABORATORY – Practical Part**

**Teaching and learning strategies**

Students will perform various inspection activities of onboard instruments in teams of two.

- Weeks 1, 2, 3, the teacher will demonstrate various test benches in the instruments laboratory.
- The following weeks the students perform each activity in teams of two.
- The exercises are performed using the manuals available in the laboratory.
- The laboratory manuals may include:
  - excerpts from CAR standards
  - excerpts from aircraft maintenance manuals
  - manuals of components
  - procedural manuals for use of test equipment
- For each exercise, students will need to complete the data sheets included in the laboratory course notes.
- The information students record in their course notes will serve as a study guide for the two exams.

**COURSE PLAN – PRACTICAL WORK (LABORATORY)**

**Activity Period: Weeks 1 and 2**

Learning Objective	Content	Personal Study Activities	No. of hours
1.1 Learn the concepts and principles of operation of instruments and equipment test laboratory. 1.2 Performing the work in accordance with safety rules and operating procedures of the laboratory equipment.	<ul style="list-style-type: none"> <li>▪ Presentation of course outline.</li> <li>▪ Demonstration of various test benches.</li> <li>▪ Descriptions of tests to be carried out during the course.</li> <li>▪ Procedures and precautions.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Prior reading of the lab.</li> </ul>	4

**Activity Periods: Weeks 3 to 6**

Learning Objective	Content	Personal Study Activities	#hours
2.0 Perform checks on pitot-static circuits. 2.1 Identify compliance standards and appropriate procedures. 2.2 Use appropriate testing equipment. 2.3 Compare data obtained for each check in order to comply with CAR and manufacturer’s standards. 2.4 Meticulously record the results of the checks that were carried out.	<ul style="list-style-type: none"> <li>▪ Excerpts of CAR standards. Leak test (CAR 571), calibration test (CAR 605/625).</li> <li>▪ Excerpts from aircraft maintenance manuals (where applicable).</li> <li>▪ Components manuals.</li> <li>▪ Procedures of manufacturer’s test bench.</li> <li>▪ Calibrating test equipment.</li> <li>▪ Frequency of performing tests.</li> <li>▪ Test points to simulate.</li> <li>▪ Tolerances.</li> <li>▪ Description of testing equipment: components and operation principle.</li> <li>▪ Description of pitot-static circuit: components and operation principle.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reading.</li> <li>▪ Complete data sheets.</li> </ul>	2

**Activity Periods: Weeks 3 to 6**

Learning Objective	Content	Personal Study Activities	# hours
<p><b>3.0 Perform tests on a manometer</b></p> <p>3.1 Identify compliance standards and appropriate procedures.</p> <p>3.2 Use appropriate testing equipment.</p> <p>3.3 Compare the data for each test to ensure compliance with the standards of manufacturers, builders and CARs.</p> <p>3.4 Meticulously record the results of the checks performed.</p>	<ul style="list-style-type: none"> <li>▪ Test bench specification.</li> <li>▪ Calibration of test equipment.</li> <li>▪ Tolerances.</li> <li>▪ Tests to run: scale error, friction error, hysteresis error.</li> <li>▪ Description of the test equipment : components, operation.</li> <li>▪ Description of the tachometer : components, operation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reading.</li> <li>▪ Complete data sheets.</li> </ul>	2

**Activity Periods: Weeks 3 to 6**

Learning Objective	Content	Personal Study Activities	# hours
<p><b>4.0 Perform checks on the altimeter.</b></p> <p>4.1 Identify compliance standards and appropriate procedures.</p> <p>4.2 Use appropriate testing equipment.</p> <p>4.3 Compare data obtained for each check in order to comply with the manufacturer and CAR's standards.</p> <p>4.4 Meticulously record the results of the checks that were carried out.</p>	<ul style="list-style-type: none"> <li>▪ CAR standards.</li> <li>▪ Components manuals.</li> <li>▪ Manufacturer's test bench procedure.</li> <li>▪ Calibrating test equipment.</li> <li>▪ Frequency of performing tests.</li> <li>▪ Test points to simulate.</li> <li>▪ Tolerances.</li> <li>▪ Scale error, hysteresis error, persistence, friction error, case sealing, barometric scale error.</li> <li>▪ Description of testing equipment; digital barometer, vacuum chamber, vacuum pump.</li> <li>▪ Description of barometric altimeter; ID plate, components, operation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reading.</li> <li>▪ Complete data sheets.</li> </ul>	2

**Activity Periods: Weeks 3 to 6**

Learning Objective	Content	Personal Study Activities	# hours
<p><b>5.0 Perform checks on turn and bank indicator.</b></p> <p>5.1 Identify compliance standards and appropriate procedures.</p> <p>5.2 Use appropriate testing equipment.</p> <p>5.3 Compare data obtained for each check in order to comply with the manufacturer and CAR's standards.</p> <p>5.4 Meticulously record the results of the checks that were carried out.</p>	<ul style="list-style-type: none"> <li>▪ Manufacturer's specifications</li> <li>▪ Calibrating test equipment</li> <li>▪ Tests: check inclinometer, needle</li> <li>▪ Tolerances</li> <li>▪ Description of testing equipment : power source, turntable, strobe light</li> <li>▪ Description of turn and side slope turn indicator : ID plate, components, operation</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reading.</li> <li>▪ Complete data sheets.</li> </ul>	2

**Activity Period: Week 8**

Learning Objective	Content	Personal Study Activities	# hours
<b>Exam 1</b>	Labs 1 to 4		2

**Activity Periods: 9 to 12**

Learning Objective	Content	Personal Study Activities	# hours
<b>6.0 Perform checks on a directional gyro</b> 6.1 Identify compliance standards and appropriate procedures. 6.2 Use appropriate testing equipment 6.3 Compare the data for each check to comply with CAR and the manufacturer's standards. 6.4 Meticulously record results from the checks performed.	<ul style="list-style-type: none"> <li>▪ Manufacturer's specifications.</li> <li>▪ Calibration of test equipment.</li> <li>▪ Tests: free rotation of the rotor, rotor speed, drift, erector mechanism, locking mechanism, starting the rotor, housing seal, flow.</li> <li>▪ Tolerances.</li> <li>▪ Description of the testing equipment: pneumatic power source, Scorsby table.</li> <li>▪ Description of the directional indicator: ID plate, components, operation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reading.</li> <li>▪ Complete data sheets.</li> </ul>	2

**Activity Periods: 9 to 12**

Learning Objective	Content	Personal Study Activities	# hours
<b>7.0 Perform checks on a tachometer.</b> 7.1 Identify compliance standards and appropriate procedures. 7.2 Use appropriate testing equipment. 7.3 Compare the data for each check to ensure compliance with the standards of the manufacturer's builders and CARs. 7.4 Meticulously record the results of the checks performed.	<ul style="list-style-type: none"> <li>▪ CAR standards.</li> <li>▪ Test bench specification.</li> <li>▪ Calibration of test equipment.</li> <li>▪ Tolerances.</li> <li>▪ Tests to run : scale error, friction error, hysteresis error.</li> <li>▪ Description of the test equipment : components, operation.</li> <li>▪ Description of the tachometer : components, operation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reading.</li> <li>▪ Complete data sheets.</li> </ul>	2

**Activity Periods: 9 to 12**

Learning Objective	Content	Personal Study Activities	# hours
<b>8.0 Perform tests with the magnetic compass.</b> 8.1 Identify compliance standards and appropriate procedures. 8.2 Use appropriate testing equipment. 8.3 Compare the data for each test to ensure compliance with the standards of manufacturers, builders and CARs. 8.4 Meticulously record the results of the checks performed.	<ul style="list-style-type: none"> <li>▪ RAC standards.</li> <li>▪ Running procedure.</li> <li>▪ Calibration of test equipment.</li> <li>▪ Run frequency, test points to simulate, tolerances.</li> <li>▪ Tests to run: liquid, compensation mechanism, friction, magnet neutralisation, compensation chart.</li> <li>▪ Description of the master compass : components, operation.</li> <li>▪ Description of the magnetic compass : components, operation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reading.</li> <li>▪ Complete data sheets.</li> </ul>	2

**Activity Period: Weeks 13 and 14**

Learning Objective	Content	Personal Study Activities	# hours
<b>9.0 Troubleshooting connected to the pitot-static system on an aircraft.</b> 9.1 Perform system testing of protection against the frost of pitot-static circuits. 9.2 Check for leaks in the pitot-static system of the King Air.	<ul style="list-style-type: none"> <li>▪ Aircraft maintenance manuals.</li> <li>▪ Manufacturer's parts manuals.</li> <li>▪ Locations of components on available aircraft.</li> <li>▪ Checklists.</li> <li>▪ Precautions.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reading.</li> </ul>	4

**Activity Period: Week 15**

Learning Objective	Content	Personal Study Activities	# hours
Exam 2	Labs 5 to 8 and supplemental activities		2

**SYNTHESIS OF SUMMATIVE EVALUATION METHODS**

Description of Evaluation Activity	Context	Learning objective(s)	Evaluation Criteria	Due Date (approximate date assignment due or exam given)	Weighting (%)
<b>Theory (60%)</b>					
Exam 1 on material from weeks 1 to 4	Individually. Multiple choice and short answer exam No notes allowed	1.1 to 1.5	- Comprehension of instruments principle of operation. - Precision of vocabulary used. - Concision of answers.	Week 5	15%
Exam 2 on material from weeks 6 to 9	Individually. Multiple choice and short answer exam No notes allowed	1.6 to 1.7	- Functional understanding of instruments. - Calculations related to instruments. - Troubleshooting instruments following short scenario. - Precision of vocabulary used. - Concision of answers.	Week 10	15%
Exam 3 on material from weeks 11 to 14	Individually. Multiple choice and short answer exam No notes allowed	1.1 to 1.11	- Functional understanding of instruments. - Calculations related to instruments. - Troubleshooting instruments following short scenario. - Precision of vocabulary used. - Concision of answers.	Week 15	30%
Total for theory part:					60%



Description of Evaluation Activity	Context	Learning objective(s)	Evaluation Criteria	Due Date (approximate date assignment due or exam given)	Weighting (%)
<b>Practical Part (40%)</b>					
Exam 1 on labs 1 to 4	Individually. Multiple choice and short answer open book exam	2 to 5	- Functional understanding of instruments. - Calculations related to instruments. - Troubleshooting instruments following short scenario. - Precision of vocabulary used. - Concision of answers.	Week 7	20%
Exam 2 on labs 5 to 8 (and supplemental labs)	Individually. Multiple choice and short answer open book exam	6 to 9		Week 15	20%
Total for practical part:					40%
<b>TOTAL</b>					<b>100 %</b>

## REQUIREMENTS TO PASS THE COURSE

### (1) Passing Mark

The passing mark for this course is 60%.

### (2) Attendance for Summative Evaluations

Students must be present for summative evaluations.

### (3) Submitting Assignments

All assignments must be submitted by the date, hour and location designated by the instructor(s). Late assignments will be penalized in the following manner:

### (4) Presentation of Written Work

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 centre on the Cégep web site <http://ena.cegepmontpetit.ca/liens-eclair> under the heading **Liens éclair**, **Bibliothèques**, « Aide ».

## REQUIRED MATERIAL

- Personal notes.
- For the laboratory part, the only two authorized dresses are the gray ENA polo shirt with black work trousers OR the properly worn ENA blue coverall.
- Safety glasses and safety shoes are also mandatory. Any student who does not comply with this dress code will not be admitted to the laboratory.

## MEDIAGRAPHY

- ASH Georges et collaborateurs, Les capteurs en instrumentation industrielle, Éditeur Dunod, 1983. 620.0044 A 812 C 1983
- Aviation Technician Training Series, Avionics Fundamentals, Éditeur I.A.P. 1987.
- CHAPPUY J.P. : Grégori J.P. Instruments de bord, Éditeur Paris, Institut Aéronautique Jean Mermoz, 1978. 629.135 C 4671 1978
- Tome 1 : mesure de vitesse, incidence, température, dispositifs de sécurité, compas de navigation, contrôle moteurs.
- Tome 2 : équipements électroniques.
- Tome 3 : instruments gyroscopiques, altimètre, variomètre, compas magnétique.
- CRANE Dale, Aircraft Instruments Systems, Éditeur Aviation Maintenance Publishers Inc. 629.135 C 891a
- Orford Air Training School, Navigation aérienne, Les aides radio, Éditeur Modulo. P 629.1351 098 r 4Fq
- Oxford Air Training School, Navigation aérienne, Instruments de bord, Québec, Ministère de l'éducation, SGME 1981. 629.1352 098 i Fq.
- PALLETT EHJ, Automatic Flight Control, Éditeur Granada, Toronto, 1983. 629.1352 p 166 1983
- PALLETT EHJ, Aircraft Instruments, Éditeur Pitman Publishing Limited, 629.135 p 1662 Édition 1972-79, 629.135 p 1662 Édition 1981.
- PALLETT EHJ, Aircraft Instruments and Integrated System, édition Longman Scientific & Technical, 1992.629.135 P 166 ai
- POWELL J, Aircraft Radio Systems, Éditeur Pitman Publishing Limited, 1981. 629.135 p 8843
- R. Galan, Avionique 2002, Éditeur : Institut Aéronautique Jean Mermoz, 1993 629.1355G146
- Transports Canada, Règlement de l'aviation canadien (RAC 523, 525, 571, 605-625
- Jeppesen, Avionics Fundamentals. Éditeur : Sanderson Training Products. 629.135A958

## 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, les conditions d'admission et cheminement scolaire, la Politique relative à l'usage, à la qualité et à la 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 Cégep web site at the following address: <http://ena.cegepmontpetit.ca/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.

## OTHER DEPARTMENTAL REGULATIONS

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

<http://www.cegepmontpetit.ca/>

<http://ena.cegepmontpetit.ca/etudiants-actuels/programmes-d-etudes/departements-d-enseignement#a2>

**NOTE:** This Course Outline is a translation of the *Plan de cours* for 280-605-EM: *Instrumentation d'aéronefs*. If there is a disparity, then the original French version will be considered the official version for legal purposes.