



## COURSE OUTLINE

**COURSE:** **Alternate-Current Avionics Systems**

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

**DISCIPLINE:** 280 Aeronautics

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

Instructor(s)	Office	☎ Extension	✉ email
Boyer, Serge	A-192	4546	serge.boyer@college-em.qc.ca
Boileau, Michel	A-192	4685	michel.boileau@college-em.qc.ca
Dagher, Maya	A-192	4682	maya.dagher@college-em.qc.ca
Dubois, Marcel	A-192	4680	marcel.dubois@college-em.qc.ca
Gere, Andrei	A-187	4649	andrei.gere@college-em.qc.ca
Gillard, Pierre	A-187	4552	pierre.gillard@college-em.qc.ca
Gosselin, Raymond	A-187	4650	raymond.gosselin@college-em.qc.ca
Laurin, Nicholas	A-192	4665	nicholas.laurin@college-em.qc.ca
Lemoyne, Pierre	A-192	4681	pierre.lemoyne@college-em.qc.ca
Rădulescu, Andrei	A-187	4648	andrei.radulescu@college-em.qc.ca
Rivière, Frantz	A-192	4675	frantz.riviere@college-em.qc.ca
Trần, Quốc Túy	A-187	4232	quoctuy.tran@college-em.qc.ca
Tremblay, Éric	A-187	4662	eric.tremblay@college-em.qc.ca

### OFFICE HOURS

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning					
Afternoon					

Coordinator(s)	Office	☎ extension	✉ e-mail or website
Gosselin, Raymond	A-187	4650	raymond.gosselin@college-em.qc.ca
Laurin Nicholas	A-192	4665	nicholas.laurin@college-em.qc.ca

This course outline is the translation of "Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif". In case of any contradictions, the French version, which is the original, prevails.

## CONTEXT OF THIS COURSE IN THE PROGRAM

This course is offered during the fourth session of the program.

By the end of the course, students will have developed:

- the ability to analyze circuits and electrical systems, generation circuits, distribution control of single and twin engine aircraft and various electric and electronic systems found in aeronautics
- the ability to apply methods and procedures to solve simple problems commonly encountered in aircraft electrical systems.

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

### **025T Perform the maintenance of direct-current circuits on an aircraft. (duration of training : 100 class periods)**

Distribution of Competence 025T in the program:

3 <sup>rd</sup> session	280-3D4-EM : Direct-Current Avionics Systems	55 periods out of 100
▶ 4 <sup>th</sup> session	280-4A4-EM : Alternate-Current Avionics Systems	30 periods out of 100
6 <sup>th</sup> session	280-6A3-EM : Avionics Maintenance	15 periods out of 100
Total:		100 periods

### **0263 Verify the operation of simple alternating-current circuits on an aircraft (duration of training : 70 class periods)**

Distribution of Competence 0263 in the program:

3 <sup>rd</sup> session	280-3D4-EM : Alternate-Current Avionics Systems	5 periods out of 70
▶ 4 <sup>th</sup> session	280-4A4-EM : Direct-Current Avionics Systems	30 periods out of 70
4 <sup>th</sup> session	280-4C5-EM : Aircraft Instrumentation	5 periods out of 70
6 <sup>th</sup> session	280-6A3-EM : Avionics Maintenance	30 periods out of 70
Total :		70 periods

## TEACHING AND LEARNING STRATEGIES

### **Theory:**

The theoretical course will be delivered in a lecture format with multimedia support when possible and appropriate.

### **Practical Work:**

Acquisition of the theoretical knowledge will be facilitated by a series of experiments divided into 15 laboratory sessions.

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

COURSE PLAN

**025T Maintain direct-current circuits on an aircraft.**

Element of the Ministerial Objective	Learning Objective	Content	Personal Study Activities	Transport Canada Reference
#2 Inspect the direct current operation of passive components	1. Describe the characteristics of a capacitor.	<ul style="list-style-type: none"> <li>• Description of basic elements</li> <li>• Physical characteristics</li> <li>• Definition of the capacity of a capacitor, units used and Farad sub-multiples</li> <li>• Types of fixed or variable capacitors</li> <li>• Operating characteristics</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework : Problems to solve.	22.1.8
	2. Analyze circuits formed by a DC voltage source, a resistor and capacitors.	<ul style="list-style-type: none"> <li>• Accumulation of charges and stored energy</li> <li>• Description of charge and discharge phenomena</li> <li>• Time constant of RC circuit</li> <li>• Calculation of equivalent capacity of a series or parallel combination of two or more capacitors</li> </ul>		
	3. Describe the basic characteristics of a coil.	<ul style="list-style-type: none"> <li>• Description of the physical characteristics that influence the inductance value of a coil</li> <li>• Inductance; units and sub-multiples used</li> <li>• Types of coils</li> <li>• Description of the field produced by a single coil. Influence of each parameter on the field.</li> </ul>		
	4. Analyze a circuit formed by a DC voltage source, a resistor and coils.	<ul style="list-style-type: none"> <li>• Time constant of the RL circuit</li> <li>• Description of the phenomena in an RL circuit</li> <li>• Calculation of equivalent induction of two series or parallel coils</li> </ul>		

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

Element of the Ministerial Objective	Learning Objective	Content	Personal Study Activities	Transport Canada Reference
	5. Interpret blueprints and diagrams that include semi-conductor elements.	<ul style="list-style-type: none"> <li>Recognize various rectifier circuits</li> <li>Other types of diodes (Zener)</li> <li>Bipolar transistor symbols (NPN and PNP)</li> <li>Operation of various circuits using switching transistors (2)</li> <li>Symbols of various types of SCRs</li> <li>Operation of circuits using SCRs</li> </ul>		22.1.8. 22.1.18 22.2.40. 22.2.43.
#3. Inspect the direct-current electrical power supply and distribution system of an aircraft.	1. Describe the general theory of magnetization; make a connection between magnetic permeability and temporary and permanent magnets; define residual magnetism.	<ul style="list-style-type: none"> <li>Properties of a magnet</li> <li>Magnetic field and specific variables that describe it</li> <li>Magnetization curves, magnetic hysteresis curves</li> <li>Types of magnetic materials</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework : Problems to solve.	Appendix C Part 2 22.1.2
	2. Describe the general theory of electromagnetism and analyze the principles.	<ul style="list-style-type: none"> <li>Magnetic field produced by electric current</li> <li>Resultant forces from the reaction between the magnetic field of a magnet and that of an electrical current</li> <li>Analysis of the principle of operation of electric motors</li> <li>Electromagnetic induction, induced voltage and polarity</li> <li>The generator and the dynamo</li> <li>Lenz – Faraday Law and its applications</li> </ul>		
	3. Check the operation of a DC generator.	<ul style="list-style-type: none"> <li>Principle of the production of electric direct current and components of a DC generator</li> <li>Controlling a generator and analysis of the devices used to accomplish this task</li> <li>Maintenance procedures and troubleshooting of DC generators</li> </ul>		22.1.9 22.1.17 22.2.44 22.3.8 22.3.17 22.3.19 22.3.21 22.3.45 22.3.41

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

Element of the Ministerial Objective	Learning Objective	Content	Personal Study Activities	Transport Canada Reference
	4. Check the operation of a DC electric motor.	<ul style="list-style-type: none"> <li>• Operation of a DC motor</li> <li>• Aeronautical applications of DC motors</li> <li>• Maintenance procedures and troubleshooting of DC motors</li> </ul>		22.1.9 22.1.17 22.3.2 22.3.12 22.3.25 22.3.44 22.3.45
	5. Check a DC system (alternator paralleling controlled by a single control box) of a pistons twin-engine aircraft.  6. Check a DC system (with alternator paralleling each controlled by a regulator in continuous operation) of a pistons twin-engine aircraft.	Check the following elements : <i>(Within the context of this competence, the inspection is limited to performing a test procedure)</i> <ul style="list-style-type: none"> <li>- Aircraft power supplied by Battery and Ground Power Unit</li> <li>- Aircraft power supplied by left alternator</li> <li>- Aircraft power supplied by right alternator</li> <li>- Power supplied by left alternator using the left control box</li> <li>- Power supplied by right alternator using the left control box</li> <li>- Power supplied by left alternator using the right control box</li> <li>- Power supplied by right alternator using right control box</li> <li>- Interlock circuits</li> <li>- Load distribution between the two alternators</li> <li>- Overvoltage Protection</li> <li>- Regulation at low speed and cruising speed</li> <li>- Engine run-up on a twin-engine piston using one control box at a time</li> </ul>		22.3.9 22.3.27 22.3.41 22.3.42 22.3.45

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

Element of the Ministerial Objective	Learning Objective	Content	Personal Study Activities	Transport Canada Reference
#3. Inspect the direct-current electrical power supply and distribution system of an aircraft.	7. Check a DC generation system of a turbine twin-engine aircraft	<p>Check the following elements :</p> <p><i>(Within the context of this competence, the inspection is limited to performing a test procedure)</i></p> <ul style="list-style-type: none"> <li>- Aircraft power supplied by Battery and Ground Power Unit</li> <li>- Aircraft power supplied by left starter-generator</li> <li>- Aircraft power supplied by right starter-generator</li> <li>- Interlock circuits</li> <li>- Paralleling starter-generators</li> <li>- Load balancing system between the two starter-generators</li> <li>- Control and protection systems with discrete components</li> <li>- Voltage Regulation</li> <li>- Paralleling efficiency at various turbine rotation speeds</li> </ul>		<p>22.3.9</p> <p>22.3.27</p> <p>22.3.41</p> <p>22.3.42</p> <p>22.3.45</p>
	8. Check the DC distribution system in a pistons twin-engine aircraft and a turbine twin-engine aircraft while respecting safety procedures.	<p>Check the following elements :</p> <ul style="list-style-type: none"> <li>- Electric distribution protection devices                             <ul style="list-style-type: none"> <li>- circuit-breakers</li> <li>- fuses</li> </ul> </li> <li>- Electric distribution Control devices                             <ul style="list-style-type: none"> <li>- on-off switches</li> <li>- relays</li> </ul> </li> <li>- electric components of the model or aircraft                             <ul style="list-style-type: none"> <li>- Electrical wiring</li> </ul> </li> </ul>		<p>22.3.5</p> <p>22.3.15</p> <p>22.3.27</p> <p>22.3.30</p>
	9. Diagnose the malfunctions of the DC power and distribution systems of a pistons twin-engine aircraft and a turbine twin-engine aircraft	<p>Malfunctions identification by comparing the intended operation and the current operation of the aircraft's electrical generation system</p>		<p>22.3.27</p> <p>22.3.34</p> <p>22.3.45</p>

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

Element of the Ministerial Objective	Learning Objective	Content	Personal Study Activities	Transport Canada Reference
#7. Perform the Electrical-Load Analysis of a direct-current circuit in an aircraft.	<ol style="list-style-type: none"> <li>Identify relevant information for Electrical-Load Analysis for a twin-engine :                             <ul style="list-style-type: none"> <li>AC 43 13</li> <li>FAR 23</li> <li>JAR 23</li> <li>Manufacturer's Manuals</li> </ul> </li> <li>Identify the regulations concerning requirements to create a new Electrical-Load Analysis</li> </ol>	<ul style="list-style-type: none"> <li>Type of monitoring</li> <li>Capacity of the electrical generation system</li> <li>Calculation of the maximum allowable electrical load in normal flight and in case of loss of one of the two sources</li> <li>Calculation of the aircraft's actual electric load</li> <li>Measurement of the aircraft's actual electrical load</li> <li>Conclusions on the aircraft's Electrical-Load Analysis</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework: Problems to solve.	

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

Element of the Ministerial Objective	Learning Objective	Content	Personal Study Activities	Transport Canada Reference
#1. Inspect alternating-current circuits on an aircraft.	1. Identify a sinusoidal wave form and its characteristics	<ul style="list-style-type: none"> <li>period</li> <li>frequency</li> <li>period frequency link</li> <li>instantaneous value</li> <li>peak value</li> <li>peak to peak value</li> <li>RMS (root-mean-square) value</li> <li>Mean value</li> <li>Angular velocity</li> <li>Phase angle</li> <li>Phase difference between two sinusoids</li> <li>AC single phase and three phase</li> <li>Comparison between DC and AC (RMS)</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework: Problems to solve.	22.2.2 22.2.12 22.2.13 22.2.14 22.2.23 22.2.24 22.2.17
	2. Use Ohm's Law and Kirchhoff's Laws to calculate the parameters of a resistive circuit powered by an alternative source.	<ul style="list-style-type: none"> <li>Simple circuits with a single loop</li> </ul>		22.2.41
	3. Define the characteristics of AC-powered passive components: coils, capacitors, etc.	<ul style="list-style-type: none"> <li>Capacitive reactance</li> <li>Voltage-current phase shift in a capacitor</li> <li>Inductive reactance</li> <li>Voltage-current phase shift in an inductor</li> </ul>		22.2.4 22.2.5 22.2.18 22.2.20 22.2.21 22.2.23 22.2.45

This course outline is the translation of "Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif". In case of any contradictions, the French version, which is the original, prevails.

Element of the Ministerial Objective	Learning Objective	Content	Personal Study Activities	Transport Canada Reference
#1. Inspect alternating-current circuits on an aircraft.	4. Analyze AC-powered circuits containing resistors, capacitors and coils.	<ul style="list-style-type: none"> <li>• Impedance triangle drawing and calculation from graph of the impedance and phase angle of a circuit.</li> <li>• Implementation of a reactance as filter</li> <li>• Voltage measurement at the terminals of the components and the current in the components</li> <li>• Measurement of the power                             <ul style="list-style-type: none"> <li>- Apparent power</li> <li>- Reactive power</li> <li>- Actual power</li> </ul> </li> </ul>	Study: Read corresponding chapters in the assigned material. Homework: Problems to solve.	22.2.15 22.2.16 22.2.22 22.2.27 22.2.41 22.2.45
	5. Check a faulty circuit using a multimeter.	The simple circuit is provided in the lab with a few elements mounted on the printed circuit board. The theoretical framework is provided to students who must then: <ul style="list-style-type: none"> <li>- Analyze the circuit</li> <li>- Record the values of the current and voltage for each element of the circuit</li> <li>- Troubleshoot the circuit</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework : Lab reports	22.2.15 22.2.42
#2. Inspect passive components AC operation	1. Use alternating current to check various passive components to determine their condition.	<ul style="list-style-type: none"> <li>• Use of a multimeter and an impedance bridge</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework : Lab reports	22.2.42 22.2.45
#3. Inspect AC electrical generation and distribution	1. Check the operation of a transformer.	<ul style="list-style-type: none"> <li>• Operation of a transformer</li> <li>• Applications of a transformer in aeronautics:                             <ul style="list-style-type: none"> <li>- Transformer rectifier unit (TRU)</li> <li>- Current transformer</li> <li>- AC system monitoring</li> </ul> </li> <li>• Inspection of the performances of a TRU</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework : Lab reports	22.2.19 22.2.28 22.3.20 22.3.23 22.3.11

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.



Element of the Ministerial Objective	Learning Objective	Content	Personal Study Activities	Transport Canada Reference
#3. Inspect the alternating-current electrical generating and distribution systems on an aircraft.	2. Check the operation of an AC generator	<ul style="list-style-type: none"> <li>Principle of producing alternating electrical current and identification of components of an AC generator</li> <li>Examine the elements of the brushless alternator and analyse its operating principle</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework : Lab reports	22.2.1 22.2.7 22.2.8 22.2.25 22.2.29 22.2.30 22.2.31 22.3.18 22.3.22
	3. Check the operation of an AC electric motor	<ul style="list-style-type: none"> <li>Operation of AC electric motors</li> <li>Motor losses</li> <li>Comparison of AC and DC motors</li> </ul>		22.2.6, 22.2.10 22.2.34, 22.2.35 22.2.36, 22.2.37 22.2.38, 22.2.48 22.3.25, 22.3.44 22.3.45
	4. Check operation of special electrical machines.	<ul style="list-style-type: none"> <li>Principle of the production of AC from DC and identifying components of an inverter                             <ul style="list-style-type: none"> <li>Rotary inverters</li> <li>Static inverters</li> </ul> </li> <li>Position sensors (synchro, LVDT, RVDT)</li> </ul>		22.2.32 22.3.24  22.2.9 22.3.26
	5. Check AC generation system of an aircraft whose primary generation is DC.	<ul style="list-style-type: none"> <li>Secondary AC generation : rotary or semiconductors invertors that convert primary DC power into AC power</li> </ul>		22.3.9 22.3.27 22.3.41 22.3.42 22.3.45
#3. Inspect the alternating-current electrical generation and distribution systems on an aircraft.	6. Check the AC generation system on aircraft whose primary generation is AC	<ul style="list-style-type: none"> <li>Primary AC generation</li> <li>Description of the following elements :                             <ul style="list-style-type: none"> <li>Aircraft power supplied by Ground Power Unit or Auxiliary Power Unit APU</li> <li>Power from left or right alternator</li> <li>Operation in case of loss of an alternator</li> <li>Primary AC generation</li> <li>Paralleling alternators</li> <li>Balancing actual alternator loads procedure</li> <li>GCU controlled alternator parameters</li> <li>System monitoring</li> <li>Simulation of power failure by modifying GCU controlled alternator parameters</li> </ul> </li> </ul>	Study: Read corresponding chapters in the assigned material. Homework : Lab reports	22.2.33 22.3.9 22.3.27 22.3.41 22.3.42 22.3.45

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

Element of the Ministerial Objective	Learning Objective	Content	Personal Study Activities	Transport Canada Reference
#8. Make an Electric load analysis of an aircraft.	1. Identify the information relevant to the analysis of AC electrical charge generation for aircraft with primary DC generation <ul style="list-style-type: none"> <li>- FAR 23</li> <li>- AC 43.13</li> <li>- JAR 23</li> <li>- Manufacturer's Manuals</li> </ul>	<ul style="list-style-type: none"> <li>• Capacity of the electrical generation system</li> <li>• Calculation of the maximum allowable electric load</li> <li>• Calculation of the actual electrical load of an aircraft</li> <li>• Measurement of actual electrical load of an aircraft</li> <li>• Conclusions regarding the electrical load analysis of the aircraft</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework : Lab reports	22.2.47
	2. Identify information relevant to the analysis of AC electrical load generation for aircraft with primary AC generation <ul style="list-style-type: none"> <li>- FAR 25</li> <li>- AC 43.13</li> <li>- JAR 25</li> <li>- Manufacturer's manuals</li> </ul> 3. Identify regulations that require a mandatory new electrical load analysis	<ul style="list-style-type: none"> <li>• Type of monitoring</li> <li>• Capacity of the electrical generation system</li> <li>• Calculating the maximum allowable electrical load in normal flight and in case of loss of single or multiple sources</li> <li>• Calculating the actual electrical load of an aircraft</li> <li>• Assessment of the actual electrical load of an aircraft</li> <li>• Conclusions regarding the electrical load analysis of the aircraft</li> </ul>	Study: Read corresponding chapters in the assigned material. Homework : Lab reports	

This course outline is the translation of "Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif". In case of any contradictions, the French version, which is the original, prevails.

**Session Calendar:**

**Theory:**

Periods	Content	Personal Study	Objectives	
Week 1	3 per Semiconductor circuits	<ul style="list-style-type: none"> <li>▪ Presentation of Course Outline</li> <li>▪ Diode and Zener diode</li> <li>▪ Bipolar transistors</li> <li>▪ Transistor – switching operation</li> <li>▪ Applications : DIM circuits, dome light (Bell 206) ; H mount of the trim control (Hughes 300)</li> </ul>	Study: <ul style="list-style-type: none"> <li>• Chapters in the corresponding reference manual and course notes</li> <li>• Circuit analysis</li> </ul>	#2.5 (025T)
Week s 2 and 3	4 per. Operation of control circuits for DC electrical generation and distribution for twin-engine piston aircrafts	<ul style="list-style-type: none"> <li>▪ Battery circuit and external power</li> <li>▪ Starter circuit</li> <li>▪ Ignition circuits</li> <li>▪ Control circuits for generators and DC output alternators</li> <li>▪ Types of monitoring</li> <li>▪ Generators and DC output alternators Paralleling</li> <li>▪ Electrical Load Analysis</li> </ul> <p>Use the diagrams of the Piper Aztek, of the Cessna 337 and of the Aerocommander as examples of applications</p>	Study: <ul style="list-style-type: none"> <li>• Chapters in the corresponding reference manual and course notes</li> <li>• Circuit analysis</li> </ul>	#3.5 and #3.6, #3.8 and #3.9, #7 (025T), #8.1 and #8.3 (0263)
Week s 4 and 5	3 per. Operation of control circuits for DC electrical generation and distribution for twin-engine turbine aircrafts	<ul style="list-style-type: none"> <li>▪ Battery circuit and external power</li> <li>▪ Starter circuit</li> <li>▪ Ignition circuits</li> <li>▪ Control circuit for generators and DC output alternators</li> <li>▪ Types of monitoring</li> <li>▪ Generators and DC output alternators Paralleling</li> <li>▪ Electrical Load Analysis</li> </ul> <p>Use the diagrams of the King Air and of the BK 117 as examples of applications</p>	Study: <ul style="list-style-type: none"> <li>• Chapters in the corresponding reference manual and course notes</li> </ul> Homework : <ul style="list-style-type: none"> <li>• Questions on the operation of circuits</li> </ul>	#3.7 to #3.9, #7 (025T), #8.1 and #8.3 (0263)
Week 6	2 per Capacitors and coils in a DC circuit	<ul style="list-style-type: none"> <li>▪ Description of the physical characteristics that influence the value of the capacity of a capacitor</li> <li>▪ Charge and discharge phenomena description</li> <li>▪ Capacitors association</li> <li>▪ Application - fuel gauge capacitive circuits</li> <li>▪ Description of the physical characteristics that influence the value of the inductance of a coil</li> <li>▪ Description of the field produced by a single coil</li> <li>▪ Coils association</li> </ul>	Study: <ul style="list-style-type: none"> <li>• Chapters in the corresponding reference manual and course notes</li> </ul>	#2.1 to #2.4 (025T)
Week. 7	2 per Test 1 (20 points) Semi-conductors; electrical circuits of twin-engine piston and turbine aircrafts; capacitors and coils in DC circuits			#2, #3.5 to #3.9, #7 (025T)

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

Periods		Content	Personal Study	Objectives	
Week 8	2 per.	Sinusoidal wave (sine wave) Application of Ohm's and Kirchhoff's Laws on a resistive AC circuit	<ul style="list-style-type: none"> <li>▪ Characteristics of the sine wave (period, frequency, special values, pulse, phase angle, phase shift)</li> <li>▪ AC voltages and frequencies used in aeronautics</li> <li>▪ Simple circuits with a single loop</li> </ul>	Study: <ul style="list-style-type: none"> <li>• Chapters in the corresponding reference manual and course notes</li> </ul> Homework: <ul style="list-style-type: none"> <li>• Problems selected by the instructor</li> </ul>	#1.1 and #1.2 (0263)
Week 9	2 per.	Coils and capacitors in AC-circuits	<ul style="list-style-type: none"> <li>▪ Capacitive reactance</li> <li>▪ Voltage current phase shift through a capacitor</li> <li>▪ Inductive reactance</li> <li>▪ Voltage current phase shift in an inductor</li> <li>▪ Impedance triangle</li> <li>▪ Active, reactive and apparent power</li> </ul>	Study: <ul style="list-style-type: none"> <li>• Chapters in the corresponding reference manual and course notes</li> </ul> Homework: <ul style="list-style-type: none"> <li>• Problems selected by the instructor</li> </ul>	#1.3 and #1.4 (0263)
Week 10	2 per.	Transformers and rectifiers	<ul style="list-style-type: none"> <li>▪ The ideal transformer</li> <li>▪ Transformer ratio</li> <li>▪ Center-tap transformer</li> <li>▪ Multi-tap transformer</li> <li>▪ Autotransformer</li> <li>▪ Magneto</li> <li>▪ Diode rectifier circuits</li> </ul> Applications : turbine ignition circuit; Ignition with magneto.	Study: <ul style="list-style-type: none"> <li>• Chapters in the corresponding reference manual and course notes</li> </ul> Homework: <ul style="list-style-type: none"> <li>• Problems selected by the instructor</li> <li>• Circuit analysis</li> </ul>	#3.1 (0263)
Week 11	2 per.	AC electrical machines	<ul style="list-style-type: none"> <li>▪ Three-phase systems in Y or delta</li> <li>▪ Three-phase rectifier</li> <li>▪ The TRU (transformer-rectifier unit)</li> <li>▪ Rotary inverter</li> <li>▪ Three-phase induction motor</li> </ul>	Study: <ul style="list-style-type: none"> <li>• Chapters in the corresponding reference manual and course notes</li> </ul>	#3.2 to #3.5 (0263)
Weeks 12 to 14	6 per.	AC generation and utilities systems	<ul style="list-style-type: none"> <li>▪ Primary AC generation</li> <li>▪ Aircraft power supplied by Ground Power Unit (GPU) or Auxiliary Power Unit (APU)</li> <li>▪ Paralleling alternators, load balancing</li> <li>▪ Operation in case of loss of an alternator</li> <li>▪ GCU control circuits</li> <li>▪ Generation system monitoring</li> </ul> Using the Challenger 601 documentation study the brushless alternators. Use documentation of the AC generation system for the Boeing 747 to study paralleling generators. Study the AC generation system of the Challenger 601. <ul style="list-style-type: none"> <li>▪ Examples of AC utilities (hydraulic pump drives, flap motor of the Challenger 601).</li> </ul>	Study: <ul style="list-style-type: none"> <li>• Chapters in the corresponding reference manual and course notes</li> </ul> Homework : <ul style="list-style-type: none"> <li>• Questions on the operation of circuits</li> </ul>	#3.6 (025T), #8.2 and #8.3 (0263)
Week 15	2 per.	Final Comprehensive Evaluation (30 points) Semi-conductors; electrical circuits for twin-engine piston and turbine aircrafts; DC capacitors and coils; sinusoidal waves; AC capacitors and coils; transformers and rectifiers; AC electric machines , AC generation systems		#2, #3.5 to #3.9, #7 (025T) #1.1 to #1.4, AC#3 and #8 (0263)	

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

**Practical Work:**

Periods		Content	Personal Study	Objectives	
Week 1	2 per.	Introduction to the course  Simulator for twin-engine electrical generation system	<ul style="list-style-type: none"> <li>• Course Outline</li> <li>• Safety concepts</li> <li>• Introduction to diagrams reading</li> <li>• Introduction to the simulator for twin-engine electrical generation system (operator mode)</li> </ul>	#3.5, #3.6 (025)	
Week 2	2 per.	Presenting and inspecting a DC generation system of a twin-engine piston aircraft. Troubleshooting methods review	<ul style="list-style-type: none"> <li>• Using a DC electrical system simulator of a twin-engine piston aircraft</li> <li>• Identifying system components</li> <li>• Measuring nominal values of the voltages for components in normal operation</li> <li>• Analysing obtained nominal values</li> <li>• Troubleshooting of short-circuits and open circuits</li> </ul>	<u>Laboratory Preparation :</u> Define the nominal theoretical values of voltages (battery, external power, and alternator) in the circuits.	#3.5, #3.6, #3.8 (025T)
Weeks 3 to 5	6 per.	Troubleshooting a DC generation system of a twin-engine piston aircraft	<ul style="list-style-type: none"> <li>• Using the DC electrical system simulator of a twin-engine piston aircraft</li> <li>• Detecting abnormal operation and identifying defective components by measuring voltage and comparing them with the nominal values</li> <li>• Adjustment of voltage regulators on simulator – parallel operation</li> </ul>		#3.9 (025T)
Weeks 6 and 7	4 per.	A. Test : Individual exam on troubleshooting using the simulator. 2 periods per student. The power failures are open circuit or short-circuit types. Each student must have a failure on the generation circuit of a piston twin-engine and a failure in the distribution system.  B. Inspecting semi-conductors: Individually 2 periods. <ul style="list-style-type: none"> <li>• Inspecting transistor types TO-3, TO-220 and TO-92 with the multimeter</li> <li>• Checking the family of 1N4000 diodes</li> <li>• Checking a diode bridge</li> <li>• Checking diodes of a DC output alternator</li> </ul>		#3.5, #3.6, #3.8 and #3.9 (025T) #2.5 (025T)	
Weeks 8	4 per.	Static inspection of an alternator, a starter or a starter-generator	Static inspection of the alternator, starter and starter-generator parts according to the manufacturer's standards.	<u>Laboratory Report :</u> Report measurements taken. Comment on the results.	#3.5, #3.6 and #3.8 (025T)
Week 9	2 per.	King Air AC distribution and inverters inspection	<ul style="list-style-type: none"> <li>• Inspection of the inverters on an aircraft, King Air, Learjet</li> </ul>	Questionnaire on inspection procedures. And troubleshooting	#3.4, #3.5, #3.6 (0263)
Week 10	2 per.	Introduction to measuring AC voltage	<ul style="list-style-type: none"> <li>• Demonstration by the teacher of a sine and the phase shift between two sines.</li> <li>• RMS Voltage measurement (AC 1phase 60Hz) with a digital voltmeter. (on LabVolt)</li> <li>• AC three-phase : Measurement of the voltage between lines, the phase voltage with a digital voltmeter.</li> </ul>	<u>Laboratory Report :</u> Report measurements and compare them with theoretical values. Comment on the results.	#1.1, #1.5, #2.1 (0263)

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

Periods		Content		Personal Study	Objectives
Week 11	2 per	Power-up of an aircraft with AC primary generation system Components visualisation (Challenger 601)	<ul style="list-style-type: none"> <li>• Planning the power-up of the aircraft using the AC ground power unit</li> <li>• Planning the power-up of the aircraft using the DC ground power unit</li> <li>• DC buses power-up</li> <li>• Localize Challenger 601 generation system components (TRU, IDG, GLAC, GTC, GCU etc)</li> </ul>	Preparation : <u>Components position on aircraft; components purpose on aircraft</u> Questionnaire on aircraft localization of components; aircraft electrical distribution system and power-up.	#3.6 (0263)
Week 12, 13, 14	6 per.	Become familiar with and troubleshooting performing exercises using simulation software for AC primary electrical generation systems.	<ul style="list-style-type: none"> <li>• Become familiar with the simulator operation.</li> <li>• Become familiar with the operation of the involved systems.</li> <li>• Check proper operation of the circuits and systems on the simulator.</li> <li>• Determine a diagnosis of the operational status of the systems..</li> <li>• Troubleshooting DC system</li> </ul>	Review primary AC generation on board an aircraft and its distribution. Use of manufacturer's technical documentation. ATA100 System.	#1.5, #2.1, #3.6 (0263)  #3.8 (025T)
Week 15	2 per.	Exam on malfunction detection on AC primary electrical generation systems and DC system troubleshooting using simulation software.	<ul style="list-style-type: none"> <li>• Check proper operation of the circuits and systems on the simulator.</li> <li>• Determine a diagnosis of the operational status of the systems</li> <li>• Troubleshooting of DC system.</li> <li>• DURATION: 100 minutes per student</li> </ul>	Review primary AC generation on board an aircraft and its distribution. Use of manufacturer's technical documentation. ATA100 System.	#1.5, #2.1, #3.6 (0263)  #3.8 (025T)

This course outline is the translation of "Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif". In case of any contradictions, the French version, which is the original, prevails.

SYNTHESIS OF SUMMATIVE EVALUATION METHODS

Theory

Description of Evaluation Activity	Context	Learning Objective(s)	Due Date (date assignment is due or exam given)	Weighting (%)
Homework	Individual Work -	Complies with weekly objectives	Weeks 4, 6, 9, 13	8% (2% each)
Complementary exercises selected by the instructor.	Individual work Answers at the back of study guide	Complies with weekly objectives	Weeks 4, 6, 9, 13	2% (0.5% each)
Test 1	Duration : 2 periods Without documentation	#2, #3.5 to #3.9, #7 (025T)	Week 7	20%
FINAL ÉVALUATION OF THE COURSE	Duration: 2 periods Page of notes (letter format, recto-verso, handwritten)	All	Week 15	30%

Sub-total : 60%

Practical Work

Description of Evaluation Activity	Context	Learning Objective(s)	Due Date (date assignment is due or exam given)	Weighting (%)
Week 2 – Laboratory preparation. Report on the inspection on the simulator of the DC generation system of a piston twin-engine aircraft.	Laboratory preparation with nominal theoretical values of the voltages (battery, external power, alternator) (50%). In teams of two. Compilation and analysis of the data. <u>Individual evaluation of the laboratory work (25%)</u> : Measurements, manipulations, interpretation of the information <u>Evaluation of the team report (25%)</u> .	#3.5, #3.6 et #3.8 (025T)	Laboratory Week 4.	3%
Weeks 6 and 7 – Troubleshooting test	Individual on the simulator (see the laboratory description). 50% of the mark will be for the troubleshooting procedure, 50% for finding the cause.	#3.5, #3.6, #3.8 et #3.9 (025T)	Week 6 or 7. 2 periods per student	12%
Report on the inspection of semi-conductors	Individual. Compilation and analysis of the data.	#2.5 (025T)	Week 7 or 8 2 periods per student	3%
Weeks 8 Static inspection of an alternator, a starter or a starter-generator	In teams of two. Compilation and analysis of the data gathered. <u>Individual evaluation of the laboratory work (50%)</u> : Measurements, manipulations, interpretation of information. <u>Evaluation of the team report (50%)</u>	#3.2, #3.3 (0263)	Laboratory Week 9	3%
Week 9 – King Air Distribution and Inverters inspection	Individual questionnaire on troubleshooting (100%)	#1.1, #1.5, #2.1 (0263)	At the end of the lab	3%
Week 10 - Introduction to AC voltage measuring	Individual questionnaire on the lab demonstration	#1.1, #1.5, #2.1 (0263)	At the end of the lab	2%

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

**Course outline 280-4A4-EM :AC Avionics Systems**

Week 11 Preparation on the role of components – Preparation on the localization of components Mini test on electrical distribution and power-up Questionnaire on the location of the components 2	Preparation on the role of components – 30% Preparation on the localization of components 25% Mini test 20% Individual Questionnaire on the location and the role of the components 25%	#1.1, #3.1a #3.3 et #3.6 (0263)	Preparation at the start of Laboratory  Questionnaire during laboratory week 12	4%%
Week 15 – Exam on AC and DC systems check-up for an aircraft with AC primary system	DC troubleshooting -50% AC and DC systems check-up 50%	#1.5, #2.1, #3.6 (0263)  #3.8 (025T)	Laboratory Week 15.	10%

Sub-total: 40%

**TOTAL: 100%**

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.



## REQUIREMENTS TO PASS THE COURSE

### (1) Passing Mark

The passing mark is 60%.

### (2) Summative evaluations Attendance

Summative evaluations attendance is mandatory.

### (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 work day it is late. On the sixth day after the due date, the assignment will receive a zero (0).

For a report to be corrected, students must have been present for the corresponding activities. If a student is absent for an activity or part of an activity, he or she will receive a zero (0) for the report corresponding to this activity or the proportionate amount of the part of an activity missed.

### (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**.

### (5) Quality of the English language

The Instructor supports the use of the exact English terminology.

The formative evaluation also relates to the quality of oral and written English. If need be, the instructor recommends to the students to register for an English course.

When a given homework is considered to be unacceptable because of the quality of written English, the correction of this work will be delayed until work is returned in the standards set by the instructor. In this case, the homework handing-over delays penalties apply.

The professor can allocate 10% of the mark for a work to the quality of oral or written English.

## CLASS PARTICIPATION EXPECTATIONS

### Laboratory safety and use of the premises:

Students must be under the supervision of an instructor or a technician whenever they are in the laboratory or using the equipment, unless otherwise indicated.

Any student whose conduct in the laboratory poses a risk to others will receive a warning from the instructor and then be excluded from the laboratory until the case can be reviewed by the instructor and the coordinator of the Avionics Department.

This course outline is the translation of “Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif”. In case of any contradictions, the French version, which is the original, prevails.

## REQUIRED MATERIAL

All material required for this course is provided by the college. Students must bring the required texts listed below to the theory and laboratory classes.


## MEDIAGRAPHY

### Required Text

- EISMIN, THOMAS K. – Aircraft Electricity & Electronics, Fifth Edition, Glencoe, 2002.
- Course Notebook (collection of diagrams) (COOP).

### Manual available on loan at the library:

BYGATE, J.E. - Aircraft Electrical Systems, Single and Twin Engine. IAP Inc., 1990.

 Additional documents are available on the internet and the college's network (as indicated by the instructor).

## 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/avionique/reglements](http://www.college-em.qc.ca/ena/avionique/reglements)

This course outline is the translation of "Plan de cours – 280-404-EM – Systèmes avioniques à courant alternatif". In case of any contradictions, the French version, which is the original, prevails.