ÉCOLE NATIONALE D'AÉROTECHNIQUE
UN CAMPUS DU CÉGEP ÉDOUARD-MONTPETIT

280-4A4-EM
WINTER 2014
Avionics

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**
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OFFICE HOURS

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning					
Afternoon					

Coordinator(s)	**Office**	**☎ extension**	**✉ e-mail or website**
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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.

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 ».

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:

	3rd session	280-3D4-EM : Direct-Current Avionics Systems	55 periods out of 100
►	4th session	280-4A4-EM : Alternate-Current Avionics Systems	30 periods out of100
	6th session	280-6A3-EM : Avionics Maintenance	15 periods out of100
	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:

	3rd session	280-3D4-EM : Alternate-Current Avionics Systems	5 periods out of 70
►	4th session	280-4A4-EM : Direct-Current Avionics Systems	30 periods out of 70
	4th session	280-4C5-EM : Aircraft Instrumentation	5 periods out of 70
	6th 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.

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COURSE PLAN

025T Maintain direct-current circuits on an aircraft.

Element of the Ministerial Objective	Learning Objective	Transport Canada Reference
#2 Inspect the direct current operation of passive components	1. Describe the characteristics of a capacitor.	
	2. Analyze circuits formed by a DC voltage source, a resistor and capacitors.	
	3. Describe the basic characteristics of a coil.	
	4. Analyze a circuit formed by a DC voltage source, a resistor and coils	
	5. Interpret blueprints and diagrams that include semi-conductor elements.	
#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.	
	2. Describe the general theory of electromagnetism and analyze the principles.	
	3. Check the operation of a DC generator.	
	4. Check the operation of a DC electric motor.	
	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.	
	7. Check a DC generation system of a turbine twin-engine aircraft	
	8. Check the DC distribution system in a pistons twin-engine aircraft and a turbine twin-engine aircraft while respecting safety procedures.	
	9. Diagnose the malfunctions of the DC power and distribution systems of a pistons twin-engine aircraft and a turbine twin-engine aircraft	
#7. Perform the Electrical-Load Analysis of a direct-current circuit in an aircraft.	1. Identify relevant information for Electrical-Load Analysis for a twin-engine : - AC 43 13 - FAR 23 - JAR 23 - Manufacturer's Manuals	
	2. Identify the regulations concerning requirements to create a new Electrical-Load Analysis	

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

Element of the Ministerial Objective	Learning Objective	Transport Canada Reference
#1. Inspect alternating-current circuits on an aircraft.	1. Identify a sinusoidal wave form and its characteristics	
	2. Use Ohm's Law and Kirchhoff's Laws to calculate the parameters of a resistive circuit powered by an alternative source.	
	3. Define the characteristics of AC-powered passive components: coils, capacitors, etc.	
	4. Analyze AC-powered circuits containing resistors, capacitors and coils.	
	5. Check a faulty circuit using a multimeter.	
#2. Inspect passive components AC operation	1. Use alternating current to check various passive components to determine their condition.	
#3. Inspect AC electrical generation and distribution on an aircraft.	1. Check the operation of a transformer.	
	2. Check the operation of an AC generator	
	3. Check the operation of an AC electric motor	
	4. Check operation of special electrical machines.	
	5. Check AC generation system of an aircraft whose primary generation is DC.	
	6. Check the AC generation system on aircraft whose primary generation is AC	
#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 - FAR 23 - AC 43.13 - JAR 23 - Manufacturer's Manuals	
	2. Identify information relevant to the analysis of AC electrical load generation for aircraft with primary AC generation - FAR 25 - AC 43.13 - JAR 25 - Manufacturer's manuals	
	3. Identify regulations that require a mandatory new electrical load analysis	

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Session Calendar:

Theory:

Periods		Content		Personal Study	Objectives
Week 1	2 per	Semiconductor circuits	▪ Presentation of Course Outline ▪ Diode and Zener diode ▪ Bipolar transistors ▪ Transistor – switching operation ▪ Applications : DIM circuits, dome light (Bell 206) ; H mount of the trim control (Hughes 300)	Study: • Chapters in the corresponding reference manual and course notes • Circuit analysis	#2.5 (025T)
Weeks 2 and 3	4 per.	Operation of control circuits for DC electrical generation and distribution for twin-engine piston aircrafts	▪ Battery circuit and external power ▪ Starter circuit ▪ Ignition circuits ▪ Control circuits for generators and DC output alternators ▪ Types of monitoring ▪ Generators and DC output alternators Paralleling ▪ Electrical Load Analysis Use the diagrams of the Piper Aztek, of the Cessna 337 and of the Aerocommander as examples of applications	Study: • Chapters in the corresponding reference manual and course notes • Circuit analysis	#3.5 and #3.6, #3.8 and #3.9, #7 (025T), #8.1 and #8.3 (0263)
Weeks 4 and 5	3 per.	Operation of control circuits for DC electrical generation and distribution for twin-engine turbine aircrafts	▪ Battery circuit and external power ▪ Starter circuit ▪ Ignition circuits ▪ Control circuit for generators and DC output alternators ▪ Types of monitoring ▪ Generators and DC output alternators Paralleling ▪ Electrical Load Analysis Use the diagrams of the King Air and of the BK 117 as examples of applications	Study: • Chapters in the corresponding reference manual and course notes Homework : • Questions on the operation of circuits	#3.7 to #3.9, #7 (025T), #8.1 and #8.3 (0263)
Week 6	2 per	Capacitors and coils in a DC circuit	▪ Description of the physical characteristics that influence the value of the capacity of a capacitor ▪ Charge and discharge phenomena description ▪ Capacitors association ▪ Application - fuel gauge capacitive circuits ▪ Description of the physical characteristics that influence the value of the inductance of a coil ▪ Description of the field produced by a single coil ▪ Coils association	Study: • Chapters in the corresponding reference manual and course notes	#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)

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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	▪ Characteristics of the sine wave (period, frequency, special values, pulse, phase angle, phase shift) ▪ AC voltages and frequencies used in aeronautics ▪ Simple circuits with a single loop	Study: • Chapters in the corresponding reference manual and course notes Homework: • Problems selected by the instructor	#1.1 and #1.2 (0263)
Week 9	2 per.	Transformers and rectifiers	▪ The ideal transformer ▪ Transformer ratio ▪ Center-tap transformer ▪ Multi-tap transformer ▪ Autotransformer ▪ Magneto ▪ Diode rectifier circuits Applications : turbine ignition circuit; Ignition with magneto.	Study: • Chapters in the corresponding reference manual and course notes Homework: • Problems selected by the instructor Circuit analysis	#3.1 (0263)
Week 10	2 per.	AC electrical machines	▪ Three-phase systems in Y or delta ▪ Three-phase rectifier ▪ The TRU (transformer-rectifier unit) ▪ Rotary inverter ▪ Three-phase induction motor	Study: • Chapters in the corresponding reference manual and course notes	#3.2 to #3.5 (0263)
Week 11	2 per.	Coils and capacitors in AC-circuits	▪ Capacitive reactance ▪ Voltage current phase shift through a capacitor ▪ Inductive reactance ▪ Voltage current phase shift in an inductor ▪ Impedance triangle ▪ Active, reactive and apparent power	Study: • Chapters in the corresponding reference manual and course notes Homework: • Problems selected by the instructor	#1.3 and #1.4 (0263)
Weeks 12 to 14	6 per.	AC generation and utilities systems	▪ Primary AC generation ▪ Aircraft power supplied by Ground Power Unit (GPU) or Auxiliary Power Unit (APU) ▪ Paralleling alternators, load balancing ▪ Operation in case of loss of an alternator ▪ GCU control circuits ▪ Generation system monitoring 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. ▪ Examples of AC utilities (hydraulic pump drives, flap motor of the Challenger 601).	Study: • Chapters in the corresponding reference manual and course notes Homework : • Questions on the operation of circuits	#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)

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Practical Work:

Periods		Content		Personal Study	Objectives
Week 1	4 per.	Introduction to the course Simulator for twin-engine electrical generation system.	• Course Outline • Safety concepts • Introduction to diagrams reading • Introduction to the simulator for twin-engine electrical generation system (operator mode) •	Laboratory Preparation : Define the nominal theoretical values of voltages (battery, external power, and alternator) in the circuits.	#3.5, #3.6 , #3.8 (025T)
Week 2		Simulator for twin-engine electrical generation system. Troubleshooting methods review	• Identifying system components • Using the DC electrical system simulator for twin-engine piston aircraft • Measuring nominal values of the voltages for components in normal operation (marking the measured values on the diagram and in the troubleshooting log) • Analysing obtained values • Adjustment of voltage regulators on simulator – separate operation		
Weeks 3 to 5	6 per.	Troubleshooting a DC generation system of a twin-engine piston aircraft	• Using the DC electrical system simulator of a twin-engine piston aircraft • Adjustment of voltage regulators on simulator – parallel operation • Detecting abnormal operation and identifying defective components by measuring voltage and comparing them with the nominal values (regulators separate and parallel operation)		#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 and short-circuit types. Each student shall have a failure on the generation circuit of a piston twin-engine and a failure in the distribution system (regulators parallel operation). B. Inspecting semi-conductors: Individually 2 periods. • Inspecting transistor types TO-3, TO-220 and TO-92 with the multimeter • Checking the family of 1N4000 diodes • Checking a diode bridge • Checking diodes of a DC output alternator			#3.5, #3.6, #3.8 and #3.9 (025T) #2.5 (025T)
Week 8	2 per.	Static inspection of an alternator.	Static inspection of the alternator parts according to the manufacturer's standards.	Laboratory Report : Report measurements taken. Comment on the results.	#3.5, #3.6 and #3.8 (025T)
Week 9	2 per.	Introduction to measuring AC voltage	• Demonstration by the teacher of a sine and the phase shift between two sines. • RMS Voltage measurement (AC 1phase 60Hz) with a digital voltmeter. (on LabVolt) • AC three-phase : Measurement of the voltage between lines, the phase voltage with a digital voltmeter on Labvolt and a transformer	Questionnaire on AC following the demonstration	#1.1, #1.5, #2.1 (0263)
Week 10	2 per.	King Air AC distribution and inverters inspection	• Inspection of the inverters on an aircraft, King Air, Learjet	Questionnaire on inspection procedures. Lab report on troubleshooting	#3.4, #3.5, #3.6 (0263)

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Periods		Content		Personal Study	Objectives
Week 11	2 per	Power-up of an aircraft with AC primary generation system Components visualisation (Challenger 601)	• Planning the power-up of the aircraft using the AC ground power unit • Planning the power-up of the aircraft using the DC ground power unit • DC buses power-up • Localize Challenger 601 generation system components (TRU, IDG, GLAC, GTC, GCU etc)	Preparation : Components position on aircraft; components purpose on aircraft 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.	• Become familiar with the simulator operation. • Become familiar with the operation of the involved systems. • Check proper operation of the circuits and systems on the simulator. • Determine a diagnosis of the operational status of the systems.. • Troubleshooting DC system	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.	• Check proper operation of the circuits and systems on the simulator. • Determine a diagnosis of the operational status of the systems • Troubleshooting of DC system. • DURATION: 100 minutes per student	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)

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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 -	#2, #3.5 à #3.9, #7 (025T) #1.1 à #1.4, #3 et #8 (0263)	Weeks 4, 6	3% Total
			Weeks 9, 12, 14	5% Total
Complementary exercises selected by the instructor.	Individual work Answers at the back of study guide	#2, #3.5 à #3.9, #7 (025T) #1.1 à #1.4, #3 et #8 (0263)	Weeks 4, 6	1% (0.5% each)
			Weeks 9, 13	1% (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. Individual evaluation of the laboratory work (25%) : Measurements, manipulations, interpretation of the information Evaluation of the team report (25%).	#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). 33% of the mark will be for the troubleshooting procedure, 67% for finding the cause.	#3.5, #3.6, #3.8 et #3.9 (025T)	Week 6 or 7. 2 periods per student	4% 8% mark received at the end of the test
Report on the inspection of semi-conductors	Individual. Compilation and analysis of the data.	#2.5 (025T)	Week 7 or 6 2 periods per student	3%
Week 8 Static inspection of an alternator, a starter or a starter-generator	In teams of two. Compilation and analysis of the data gathered. Measurements, manipulations, interpretation of information. Evaluation of the team report (100%	#3.2, #3.3 (0263)	Laboratory Week 9	3%
Week 9 - 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%

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Week 10 – King Air Distribution and Inverters inspection	Individual questionnaire check-up procedures(50%) Individual report on troubleshooting (50%)	#1.1, #1.5, #2.1 (0263)	At the end of the lab Week 10	3%
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, #3.1à #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%**

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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://www.cegepmontpetit.ca/biblio) under the heading « ***Aide ».***

(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.

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MANDATORY REQUIRED MATERIAL

Safety clothing and equipment as per ENA rules.

MEDIAGRAPHY

Required Text

- EISMIN, THOMAS K. – Aircraft Electricity & Electronics, Fifth Edition, Glencoe, 2002.

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 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 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: http://www.cegepmontpetit.ca/campus-de-longueuil/le-college/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 the specific regulations for this course:
http://ena.cegepmontpetit.ca/
http://ena.cegepmontpetit.ca/etudiants-actuels/programmes-d-etudes/departements-d-enseignement#a4.

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