ÉCOLE NATIONALE D'AÉROTECHNIQUE

UNE ÉCOLE AFFILIÉE AU CÉGEP ÉDOUARD-MONTPETIT

280-4A4-EM

WINTER 2020

Avionics Department

COURSE OUTLINE

COURSE: **Alternate current avionics**

PROGRAM: 280.C0 Aircraft Maintenance Technology

DISCIPLINE: 280 Aeronautics

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

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OFFICE HOURS

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning					
Afternoon					

Coordinator(s)	Office	☎ extension	✉ email
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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 in the fourth term of the program. It is assumed that students who enrol in the course have passed the course in their preceding term, 280-3D4 DC Avionics. Students who do not meet this condition may still enrol in the course, the Avionics Department believes that these students will find it more difficult to pass the course.

By the end of this 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.

Transports 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 (280.03) and Avionics (280.04) 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)

Student will be able to perform repairs, maintenance and troubleshooting on simple electrical systems on aircraft.

MINISTERIAL OBJECTIVE(S) AND COMPETENCIES

025T To maintain direct-current circuits on an aircraft.

(training duration: 100 course periods)

Distribution of the 025T competence in the program:

3rd term	280-3D4-EM:	DC Avionics	55 periods out of 100
4th term	280-4A4-EM:	AC Avionics	30 periods out of 100
► 6th term	280-6A3-EM:	Avionics Maintenance	15 periods out of 100
Total:			100 periods

0263 To check the operation of simple alternating-current currents on an aircraft.

(training duration: 70 course periods)

Distribution of the 0263 competence in the program:

3rd term	280-3D4-EM:	DC Avionics	5 periods out of 70
4th term	280-4A4-EM:	AC Avionics	30 periods out of 70
4th term	280-605-EM:	Aircraft Instrumentation	5 periods out of 70
► 6th term	280-6A3-EM:	Avionics Maintenance	30 periods out of 70
Total:			70 periods

TERMINAL OBJECTIVE OF THE COURSE (FINAL COURSE OBJECTIVE)

At the end of this course, the student will be able to troubleshoot basic aircraft electrical systems.

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.

COURSE PLAN

025T Maintain direct-current circuits on an aircraft.

Element of the Ministry Objective	Learning Objectives
#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

0263 Inspect simple alternating-current circuits on an aircraft.

Element of the Ministerial Objective	Learning Objective
#1. Inspect AC 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

Term Calendar

Theory:

Periods		Content		Personal study	Objectives
Week 1	2 per.	Review of fundamental electric principals.	▪ Presentation of the course outline ▪ Summary exercises on simple aircraft electrical circuits	Readings and exercises: • Corresponding chapters in the reference manual and in the course notes. • Circuit analysis.	#2.5 (025T)
Weeks 2 and 3	4 per.	Study of electrical generation and distribution control circuits of twin-engine pistons and turbine aircraft.	▪ Battery and GPU circuits ▪ Starting circuit ▪ Ignition circuits ▪ Control circuit of DC generators and alternators. ▪ Monitoring ▪ Paralleling of DC generators and alternators ▪ Regulator-alternator relationship in twin-engine aircraft ▪ Piper Aztec, Cessna 337 and Aerocommander will be used as examples.	Readings and exercises: • Corresponding chapters in the reference manual and in the course notes. • Circuit analysis	#3.5 et #3.6, #3,7, #3.8 et #3.9, #7 (025T), #8.1 et #8.3 (0263)
Week 4		Semi-conductors circuit analysis.	▪ Zener diode ▪ Bipolar transistor ▪ Transistor used in commutation.		
Week 5	4 per.	Sinusoidal wave (sine wave) Application of Ohm's Law 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 ▪ Y and Delta configuration of tree-phase electric power systems	Readings and exercises: • Corresponding chapters in the reference manual and in the course notes.	#2.1 à #2.4 (025T)
Week 6	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.	Readings and exercises: • Corresponding chapters in the reference manual and in the course notes.	#3.1 (0263)
Week 7	2 per.	Test 1 (20 points) Semi-conductors; electrical circuits of twin-engine piston and turbine aircrafts; AC			#2, #3.5 à #3.9, #7 (025T)

Periods		Content		Personal study	Objectives
Week 8	2 per.	AC electrical machines	▪ Three-phase rectifier ▪ The TRU (transformer-rectifier-unit_ ▪ Rotating inverter ▪ Tree-phase induction motor (IDG)	Readings and exercises: • Corresponding chapters in the reference manual and in the course notes.	#3.2 à #3.5 (0263)
Weeks 9 to 11	6 per.	AC generation and utilities systems	▪ Primary AC generation ▪ Aircraft power supplied by Ground Power Unit (GPU) or Auxiliary Power Unit (APU) ▪ Alternators paralleling with balanced load ▪ Operation in case of loss of an alternator ▪ GCU control circuits ▪ Generation system monitoring ▪ Using the Challenger 601 documentation, study of the brushless alternators. ▪ Study of aircraft with AC electric generation. ▪ Examples of AC utilities (hydraulic pump drives, flap motor of the Challenger 601).	Readings and exercises: • Corresponding chapters in the reference manual and in the course notes. Homework: Questionnaire on the Challenger circuits, the transformers and the electrical machines.	#3.6 (025T), #8.2 et #8.3 (0263)
Week 12 and 13	4 per.	Capacitors and coils in direct current and in AC circuits	▪ Description of the physical characteristics that influence the capacity of a capacitor and the inductance of a coil ▪ Description of the charging and discharging process ▪ Grouping capacitors and coils ▪ Capacitive fuel level gauge. ▪ Description of the magnetic field produced by a basic coil. ▪ Capacitive and inductive reactance ▪ Voltage current phase shift through a capacitor and inductor ▪ Impedance triangle ▪ Active, reactive and apparent power	Readings and exercises: Corresponding chapters in the reference manual and in the course notes.	#1.3 et #1.4 (0263)
Week 14	2 per.	AC generation and utilities systems	▪ Introduction to A220 electrical generation system		
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 à #3.9, #7 (025T) #1.1 à #1.4, #3 et #8 (0263)

Practical Work:

Periods		Content		Personal Study	Objectives
Week 1 and 2	4 per.	Introduction to the course Simulator for twin-engine electrical generation system.	• Course Outline • Review of the safety rules • Introduction to the simulator for twin-engine electrical generation system (operator mode) • Measurements of voltages on different components in normal operation. • Analysis of the normal values obtained • Regulator adjustment on the simulator in parallel 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)
Weeks 3 to 5	6 per.	Troubleshooting a DC generation system of a twin-engine piston aircraft	• Detection of abnormal operation and identification of the defective component by continuity measurements and comparison with the nominal valued - open circuit and short circuit.	Review of the electrical schematics and troubleshooting techniques.	#3.9 (025T)
Weeks 6 and 7	4	A) Test: Individual exam on troubleshooting using the simulator (2 periods per student). Failures are open circuit and short-circuit types. B) Static inspection of an alternator – Individually 2 periods. • According the manufacturer's standards and procedures • Laboratory report: report and comment the results of the manipulations.			#3.5, #3.6, #3.8 and #3.9 (025T) #2.5 (025T)
Week 8	2 per	King Air AC distribution and inverters inspection	• Inspection of the inverters on an aircraft, King Air, Learjet	Review of theory course notes	#3.4, #3.5, #3.6 (0263)

Periods		Content		Personal Study	Objectives
Week 9 to 11 and 13	6 per.	Become familiar with and troubleshooting performing exercises using a simulation software for AC primary electrical generation systems.	• Become familiar with the simulator operation. • Become familiar with the systems in normal condition. • Check proper operation of the circuits and systems on the simulator. • Make a diagnosis of the operational status of the systems. • Troubleshooting of 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 12	2 per	Power-up of an aircraft with AC primary generation system Components visualisation (Challenger 601)	Activities on aircrafts in rotation: • Power-up of the aircraft using the AC and DC ground power unit • Localize Challenger 601 generation system components (TRU, IDG, GLAC, GTC, GCU etc.) • Engine starting and power up the IDGs on the cockpit trainer • Deployment ant retraction of the RAT	Review of theory course notes	#3.6 (0263)
Week 14	2 per	Exam on fault detection on AC primary electrical generation systems and DC system troubleshooting using a simulation software.	• Check the operation of the simulator circuits and systems. • Make a diagnosis on the status of the systems • Troubleshooting of DC system. • DURATION: 100 minutes per student	Review of 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.	Power-up of an aircraft with AC primary generation system Components visualisation (A220)	Activities on aircraft: • Power-up of the aircraft using the AC ground power unit • Localize Challenger 601 generation system components • Familiarisation with onboard equipment and electrical system monitoring and control		

SYNTHESIS OF SUMMATIVE EVALUATION METHODS

Theory

Description of Evaluation Activity	Context and method of evaluation	Learning Objective(s)	Evaluation Criteria	Due Date (date assignment is due or exam given)	Weighting (%)
Quiz On the content of the homework performed in the corresponding weeks.	5 individual quiz Without documentation	#2, #3.5 à #3.9, #7 (025T) #1.1 à #1.4, #3 et #8 (0263)	*Accuracy of calculations, diagnosis and applied methodology*	Weeks 4, 6	4% Total (2 points each)
				Weeks 10, 12, 14	6% Total (2 points each)
Test 1 Verification, calculation and analysis of control circuits, of semi-conductor circuit and DC circuits with coils and capacitors.	Duration: 2 periods Without documentation	#2, #3.5 to #3.9, #7 (025T)		Week 7	20%
FINAL EVALUATION OF THE COURSE Calculation of parameters, verification of operation and diagnosis of anomalies on AC and DC electrical generation and distribution systems.	Duration: 2 periods Page of notes (letter format, double sided, handwritten)	All		Week 15	30%

Sub-total: 60%

Practical Work

Description of Evaluation Activity	Context and method of evaluation	Learning Objective(s)	Evaluation Criteria	Due Date (date assignment is due, or exam is held)	Weighting (%)
Weeks 6 or 7 – Troubleshooting test	Individual on the simulator (see the laboratory description). 50% of the mark will be for the troubleshooting procedure; 50% for the diagnostic	#3.5, #3.6, #3.8 et #3.9 (025T)	*Correct methodology* *Correct measurements and diagnostic*	Week 6 or 7. 2 periods per student	9% 9%
Week 6 or 7 – Static inspection of an alternator, a starter or a starter-generator	Individual. Compilation and analysis of the data obtained. Measurements, manipulations, interpretation of the information.	#3.2, #3.3 (0263)	*Correct measurements and diagnostic*	At the end of laboratory, Week 6 or 7	3%
Week 8 – King Air Distribution and Inverters inspection	Individual report on troubleshooting of the aircraft	#1.1, #1.5, #2.1 (0263)		At the end of the laboratory, week 8	3%
Week 12 Maintenance activities on the generation and distribution systems of the CL-601	Activities in the hangar, in rotation on the CL-601 and on the cockpit trainer. One laboratory report to complete for each activity.	#1.1, #3.1à #3.3 et #3.6 (0263)	*Correct explanations, accurate measurements, accurate location of identified components*	Lab report due at the end of the laboratory, week 12	4%
Week 14 – Exam on AC and DC systems check-up for an aircraft with AC primary system	DC troubleshooting AC or DC systems operational check	#1.5, #2.1, #3.6 (0263) #3.8 (025T)	*Correct methodology* *Correct measurements and diagnostic*	Laboratory Week 14.	12%

Sub-total: 40%
TOTAL: **100%**

If a student is absent for an activity or a part of an activity, he or she will receive the mark of zero for the report that corresponds to this activity or part of the activity during which he or she was absent. If the absence is for a serious and documented reason, the student will not be penalized.

REQUIRED MATERIAL

- Work clothes and accessories required by the college to work in the hangar (safety shoes, safety glasses)
- Theory and Workshop documents and presentations (available on LEA)
- Manufacturers documents (manuals and catalogues)

MANDATORY MANUAL

EISMIN, THOMAS K. – Aircraft Electricity & Electronics, 7th Edition, Glencoe, 2019.

MEDIAGRAPHY

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 teacher).

REQUIREMENTS TO PASS THE COURSE

(1) Passing Mark

The passing mark for this course is 60% (PIEA, article 5.1m).

(2) Course Attendance for Summative Evaluations

Attendance at summative evaluation activities is mandatory. (PIEA, article 5.2.5.1).

(3) Submitting Assignments

Homework required by the teacher must be handed in at the established date, place and time. The penalties associated with delays are established according to departmental rules (PIEA, article 5.2.5.2).
In case of delay the penalties are:

- See section « Règles des départements » at the follwing website link: http://guideena-en.cegepmontpetit.ca/department-rules/

(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/normes.) under the heading **« Méthodologie ».**

The **departmental penalties** for non-compliance with Written Work Standard Presentation (PIEA, article 5.3.2) are:

- See section « Règles des départements » at the following link: http://guideena-en.cegepmontpetit.ca/department-rules/

(5) Quality of the English language

The Teacher expects the use of proper English terminology. The formative evaluation also relates to the quality of oral and written English. If need be, the teacher will recommend that students 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 the work is returned in the standards set by the teacher. In this case, penalties apply to any delay in submitting homework assignments. The teacher may allocate 10% of the mark for any assignment to the quality of oral or written English.

METHODS FO COURSE PARTICIPATION

Laboratory safety and use of the premises:

Students must be under the supervision of a teacher 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 teacher and then be excluded from the laboratory until the case can be reviewed by the teacher and the coordinator of the Avionics Department.

OTHER DEPARTMENTAL REGULATIONS

Students are encouraged to consult the website for the specific regulations for this course:
http://guideena-en.cegepmontpetit.ca/department-rules/

INSTITUTIONAL POLICIES AND REGULATIONS

All students enrolled in the École nationale d'aérotechnique of Édouard-Montpetit CEGEP must be aware of and comply with the contents of institutional policies and regulations. In particular, the *Politique institutionnelle de la langue française (PILF), the Politique pour un milieu d'études et de travail exempt de harcèlement et de violence (PPMÉTEHV),), the conditions of admission and academic progress, the procedure dealing with student complaints within educational relations.*

The complete version of these policies and regulations is available on the CEGEP website at the following address: http://www.cegepmontpetit.ca/ena/a-propos-de-l-ecole/reglements-et-politiques. In case of discrepancy between the version appearing elsewhere and the complete version, the complete version will be applied and will be considered the official version for legal purposes.

APPENDIX

None.