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

280-4B5-EM
WINTER 2019
Pre-Flight department

COURSE OUTLINE

COURSE: **Hydraulic and Pneumatic Systems (Power and Control)**

PROGRAM: 280.C0 Aircraft Maintenance Technology

DISCIPLINE: 280 Aéronautics

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

Instructor(s)	**Office**	**☎ extension**	**✉ email or web site**
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OFFICE HOURS

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning					
Afternoon					

Coordinator(s)	**Office**	**☎ extension**	**✉ e-mail or web site**
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INTRODUCTION AND CONTEXT OF THIS COURSE IN THE PROGRAM

This course is offered during the fourth session of the program. The use of hydraulics and pneumatics has progressed so much that there are very few industrial products that have not been influenced in one way or another. In aviation, especially for wide-bodied aircraft, maneuvering landing gear, leading and trailing edge devices, flight controls, cargo doors, thrust reversers, some engine cowlings, and one could add other elements to the list, all rely on hydraulic or pneumatic energy to operate.

In order for students enrolled in the aircraft maintenance program to achieve the ministry objective—to check for proper operation (power and control) of the hydraulic and pneumatic systems—the course has two types of activities: theoretical and practical.

The theoretical part (2 periods per week): In this part of the course students study a complete analysis of the fundamental laws of physics applied to fluids and the principles of operation for each component; this analysis must be completely understood before proceeding to troubleshooting or checking the operation of a hydraulic or pneumatic system.

The practical part (3 periods per week): In this part of the course, students will be asked to apply their theoretical knowledge. By assembling circuits and handling components of hydraulic and pneumatic systems as well as equipment needing maintenance, the course aims to ensure that students develop:

- manual dexterity
- an ability to troubleshoot and resolve the problem
- familiarity with the graphic symbols specific to the subject in order to use them in a schematic diagram
- knowledge of the necessary security measures to take while working with hydraulic and pneumatic 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 ».

COMPETENCIES OF THE EXIT PROFILE (STUDENT SKILL PROFILES)

Carrying out maintenance of aircraft systems

MINISTERIAL OBJECTIVE(S) AND COMPETENCIES

025U To check the operation (power and control components) of hydraulic and pneumatic systems

TERMINAL OBJECTIVE OF THE COURSE (FINAL COURSE OBJECTIVE)

By means of a diagram, verify the state of a hydraulic system

TEACHING AND LEARNING STRATEGIES

Theory: In general, formal lectures and the software program Hydropneu® are used to develop hydraulic systems, to simulate failures and calculate the performance of components. Additionally, students may work in discussion groups to reinforce the material presented.

Practical Work: students form teams in the laboratory to work on practical activities that include:

- developing a diagram that represents a hydraulic or pneumatic circuit and build this circuit according to the proposed exercise.
- performing necessary calculations to determine the parameters (pressure, force, flow, work, power and pressure loss) of the operation of the circuit that was built.
- comparing the theoretical values with the practical observations and justify the difference
- choosing the necessary elements, depending on the activity, to allow proper operation of the circuit
- proposing necessary modifications to make the system more efficient
- analyzing the hydraulic systems of the Falcon 20 and Astar during the last two weeks of the course.

COURSE PLAN – THEORY

Week	Learning Objective	Content	Personal Study Activity
W1	#1 Compare, distinguish and identify different systems and their components. #2 Analyze the data for the problem. #3 Record the results. #4 Identify various types of energy in a hydraulic system : potential, kinetic and thermal (simplified examples).	▪ Review exercises on basic concepts of physics applied to hydraulics and pneumatics. ▪ Ref: aerodynamics, basic electricity, controls and flight control surfaces, introduction to aeronautics ▪ Hydraulic or pneumatic.	▪ Read Course Outline ▪ Read Course Notes and/or the relevant chapter in a reference book.
W2 W3		▪ Identify and explain some phenomena particular to fluids ▪ Compressibility of fluids ▪ Legal units of measurement ▪ Force, work, torque, moment, power, efficiency, speed (linear and angular)	
		▪ Study various laws applied to hydrostatics.	
W4		▪ Hydraulic and pneumatic circuit design: closed circuit.	▪ Read Course Notes and/or the relevant chapter in a reference book. ▪ Practice calculation exercises.
W5	#5 Observe the system operation.	▪ Determine the impact of installing active elements on a hytraulic circuit. ▪ The various graphic symbols that make up the construction of a complete and functional basic circuit.	▪ Read Course Notes and/or the relevant chapter in a reference book. ▪ Practice calculation exercises. ▪ Complete practical simple circuit design exercises using graphic symbols.

Week	Learning Objective	Content	Personal Study Activity
W7 W8 W9	#6 Establish connections between system operation and the manufacturer's specifications. #7 Interpret system operation sequences #8 Check the operation of the systems #9 Measure the operation parameters. #10 Analyze the history of a system.	▪ Classification and operation of cylinders. ▪ Profiles of the hydraulic variables according to the chosen assembly. ▪ Study the various hydraulic and pneumatic receivers. ▪ Motor and pump in closed circuit. ▪ Complete and functional circuits.	▪ Read Course Notes and/or the relevant chapter in a reference book. ▪ Complete practical exercises on circuit design. ▪ Automation Studio software.
W11 W12 W13 W14	#11 Choose a problem-solving approach. #12 Diagnose problems. #13 Present the analyzed information.	▪ Hydraulic or pneumatic control. ▪ Controlling hydraulically or pneumatically. ▪ Study the different types of enslavement.	▪ Read Course Notes and/or the relevant chapter in a reference book. ▪ Exercises to develop circuits.
		▪ Study flow and pressure control. ▪ Size and function of large families of valves and servo valves.	
		▪ Study ancillary components. ➢ Tanks. ➢ Cooler. ➢ The exchangers. ➢ Position sensors, level control and various types of protection. ➢ The cockpit indications.	▪ Read Course Notes and/or the relevant chapter in a reference book ▪ Circuit analysis exercises for an aircraft.
		▪ Analyze the operation of a hydraulic and pneumatic system. ▪ Hydraulic circuits of a hydraulic and pneumatic generation type system of a large aircraft.	▪ Read Course Notes and/or the relevant chapter in a reference book ▪ Circuit analysis exercises for a wide-bodied aircraft.

COURSE PLAN – PRACTICAL WORK (LABORATORY)

Week	Learning Objective	Content	Personal Study Activity
W1 W2 W3 W4	#14 Consult technical documents in English and French related to the operation of hydraulic and pneumatic systems. #15 Interpret the sequences of systems operation. #16 Use auxiliary power groups, ground equipment and onboard systems.	▪ Description of equipment in the room. ▪ Determine the hazards associated with the handling of hydraulic oils and those related to the operation of the components of a hydraulic or pneumatic system. ▪ Check the operation of the hydraulic cylinder and measure pressure variations in various arrangements: series connection and parallel connection of several cylinders. ▪ Determine safety measures to take in the workshop when using hydraulic or pneumatic systems.	▪ Read course outline. ▪ Study hydraulic and pneumatic circuits for test benches. ▪ Read texts about various types of oil used.
		▪ Calculate various parameters (forces, pressure, flow, velocity, work, power and load losses) generated in a hydraulic or pneumatic circuit. ▪ Apply basic hydrostatic principles. ▪ Apply basic hydrodynamic principles. ▪ Study the nature and state of the fluid lines which conduct fluid in a system	▪ Review of physical concepts applicable to hydraulics and pneumatics Ref: aerodynamics, basic electricity, controls and flight controls, onboard instruments, introduction to aviation. ▪ Review units of measurement systems (metric and imperial) ▪ Read texts on fluid properties (viscosity, etc.)
		▪ Actuator	▪ Read ATA Chapter 29
		▪ Distributor	
W6 W7 W8 W9	#17 Consult technical documents in English and French related to the operation of hydraulic and pneumatic systems. #18 Interpret the sequences of systems operation #19 Use auxiliary power groups, ground equipment and onboard systems.	▪ Determine the number of active elements to incorporate in a basic hydraulic circuit: building a circuit. ▪ Check description and operation of distributors, valves (non-return valve, overpressure valve), flow restrictors, pressure regulators.	▪ Read ATA Chapter 29, the part on the description and operation of a hydraulic circuit on an aircraft
		▪ Check the operation of hydraulic cylinder and measure pressure variations in different arrangements: series connection and parallel connection of several cylinders. ▪ Review classification and operation of cylinders ▪ Study profiles of hydraulic variables depending on the installation selected	▪ Exercises to better understand simple circuits.
		▪ Study the change in volume of a gas as a function of pressure. ▪ Maintain an accumulator and determine its capacity necessary for proper operation of a hydraulic circuit. ▪ Servo-commands and command control by cable.	▪ Exercises to determine the load pressure of an accumulator and the hydraulic volume necessary for the emergency operation
		▪ Check operation of a hydraulic engine. ▪ Classify and operate hydraulic motors, rotary actuators and pumps.	
W11 W12 W13	#20 Use auxiliary power groups, ground equipment and onboard systems. #21 Observe systems operation #22 Check systems operation		

Week	Learning Objective	Content	Personal Study Activity
W14	#23 Measure operating parameters #24 Use auxiliary power groups, ground equipment and onboard systems. #25 Identify and carry out operation check #26 Check fluid level #27 Analyze parameters #28 Locate and identify defects (snags) #29 Determine the source of the problem #30 Provide recommendations		
		▪ Check filters, circuit sealing, condition of metal detectors, heat exchangers and presence of contaminants. ▪ Bleed hydraulic system ▪ Check operational aspects of a hydraulic circuit: feeding, cooling, pollution, problems related to air in the hydraulic system ▪ Check solenoid valves	▪ Operational analysis of an aircraft hydraulic circuit.
		▪ Integrate electric and electronic elements in a hydraulic system: remote control indicators (pressure, flow, quantity, temperature, calculators). ▪ Check electric and electronic elements in a hydraulic system.	▪ Study of an aircraft electric and electronic diagram.
		▪ Turn on Falcon 20 hydraulic system. ▪ Turn on ASTAR 350 hydraulic system. ▪ Note defects (snags) ▪ ATA 29 for Falcon 20. ▪ ATA 29 for ASTAR 350. (visit hangar)	▪ Detailed study of diagrams for these two aircraft.
		▪ Determine a defect and suggest a solution following a malfunction of the hydraulic system. ▪ Check ÉNA's Falcon 20 and Lear Jet hydraulic systems.	▪ Detailed study of troubleshooting procedures in maintenance manuals.

Terms of Summative Evaluation

THEORY

Description of Evaluation Activity	Context	Learning Objective(s)	Evaluation criteria	Due Date (assignment or evaluation given)	Weighting (%)
▪ calculation of operating parameters; ▪ precautions to be taken when starting a hydraulic or pneumatic equipment or system; ▪ analysis of the characteristics of the components studied.	▪ Duration of 2 periods. ▪ Individual Written examination: the answers to the examination questions could be: ➢ development; ➢ multiple choices; ➢ combination of the two ways cited.	#1 to #5 of the first 5 weeks.	❶	Week 6	15%
▪ construction of hydraulic circuits using graphic symbols and calculation of operating parameters ▪ explanation of the function and roles of the hydraulic components; ▪ classification and characteristics of hydraulic or pneumatic components; ▪ parameters determining the choice of a hydraulic or pneumatic component.	▪ Duration of 2 periods. ▪ Individual Written examination: the answers to the examination questions could be: ➢ development; ➢ multiple choices; ➢ combination of the two ways cited.	#6 to #10 for Weeks 7 to 9	❷	Week 10	15%
▪ calculation of operating parameters; ▪ means used for the protection and routine maintenance of a hydraulic or pneumatic system; ▪ troubleshooting and solutions; ▪ precautions to be taken when working on a hydraulic system.	▪ Duration of 2 periods. ▪ Individual Written examination: the answers to the examination questions could be: ➢ development; ➢ multiple choices; ➢ combination of the two ways cited.	#11 to #13 for Weeks 11 to 14	❸	Week 15	20%

❶: The whole approach (calculus development), precise answers to a decimal point, complete and functional drawing, precision of the technical terms and the vocabulary used. The calculations must necessarily include the development and the answer will be to one decimal point, drawing of graphic circuit analysis into a complete and functional graphic symbol, hydraulic and pneumatic calculations, general question on components of a hydraulic circuit.

❷ : Precision of the fault found, steps of a functional circuit, precise interpretation of the sequences of operation of the control part of a system. Analysis of a complete functional circuit using Animation Studio software.

❸: Precision of identified breakdowns (causes, identification of the circuit involved, steps in repair, compliance with the troubleshooting logic, inspection procedure, health and safety rules). Identification of a complete circuit, diagnosis of faults and circuit analysis, general questions about the components of a circuit, all the components of a complex circuit.

Total : 50%

Practical Work (Laboratory)

Description of Evaluation Activity	Context	Learning Objective(s)	Evaluation criteria	Due Date (approximate date assignment due or exam given)	Weighting (%)
▪ calculation of operating parameters; ▪ precautions to be taken when starting a hydraulic or pneumatic equipment or system; ▪ verification of the characteristics of the components studied.	▪ Duration of 3 periods. ▪ Individual In two parts: the first, on a test bench timed 30 minutes. the second, written exam: the answers to the examination questions could be: ➢ development; ➢ multiple choices; ➢ combination of the two ways cited.	#14 to #16 of the first 4 weeks	❹	Week 5	15%
▪ explanation of the function and roles of the hydraulic components; ▪ classification and characteristics of hydraulic or pneumatic components; ▪ Parameters determining the choice of a hydraulic or pneumatic component.	▪ Duration of 3 periods. ▪ Individual. Written examination: the answers to the examination questions could be: ➢ development; ➢ multiple choices; ➢ combination of the two ways cited. Note: the questions asked concern the manipulation, calculation, troubleshooting of the laboratories seen in class.	#17 to #19 for Weeks 6 to 9	❺	Week 10	15%
▪ complete hydraulic systems ▪ means used for the protection and routine maintenance of a hydraulic or pneumatic system; ▪ troubleshooting and solutions; ▪ Precautions to be taken when working on a hydraulic system	▪ A written examination: the answers to the examination questions could be: ➢ development; ➢ multiple choices; ➢ combination of the two ways cited.	#20 to #30 for Weeks 11 to 14	❻	Week 15	20%

❹ : compliance with health and safety standards (protective equipment, use of tools), overall approach (calculation development), accurate answers to one decimal point, complete and functional design, precise and functional assembly, Precise measurement of the various parameters, accurate determination of the expected and actual performance of the systems. Pressure and flow variations: calculations of pressure, surface, stroke, volume, power and work (for hydraulic cylinders), assembly (within 30 minutes) of a functional circuit with distributor and flow control.

❺ : Precision of the technical terms used. Different parts in section: physical identification of components, explanation of its function, description of its operating mechanism.

❻ : Adherence to procedures, thorough and rigorous analysis of system history and all parameters, accurate interpretation of schemes and expected system performance, appropriate choice and logical resolution of the failure, accurate diagnosis of problems Precision of the faults identified (causes, identification of the circuit involved, steps of the repair), accuracy and clarity of the recommendations (steps to bypass the failure in flight), accuracy of the technical terms used Identification of the AS350 and F20 circuits Breakdowns and circuit analysis, general questions about the components of a circuit.

Total: 50%

REQUIRED MATERIAL

Course coop handbook, (the number will be provided during the first course). Must have prior week 2 class.

MEDIAGRAPHY

- Conception des circuits hydrauliques par Rejean Labonville.
- Technologie de l'hydraulique par J.P De GROOTE.
- Hydraulique simplifié par L.S. McNICHLE, Jr.

REQUIREMENTS TO PASS THE COURSE

(1) Passing Mark

The passing mark for this course is 60% (PIEA, article 5.1m), which is calculated by adding the marks for the theoretical and the practical parts of the course. However, the TCM (Training Control Manual) has other requirements. Students should inform themselves about the Ministry of Transport's policy (see CAR 566, Part IV). .

(2) Attendance for Summative Evaluations

Attendance is mandatory for summative evaluation activities (PIEA, article 5.2.5.1). Students must comply with the requirements to carry out the evaluation activity as provided by the teacher and written in the course outline.

Students who arrive late to a summative evaluation activity without justification may be refused the right to participate in the activity.

Students who are absent without a serious justification (illness, death in the family, serious incident, etc.) from a summative evaluation may receive a mark of zero (0) for the activity.

It is the student's responsibility to meet with the teacher before an evaluation activity or immediately upon his or her return to ÉNA to explain the reasons for the absence and provide supporting documentation. If the reasons are serious and recognized as such by the teacher, the conditions for a postponed evaluation activity will be arranged between the teacher and the student.

(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 day it is late up to a week. After one week, the assignment will be graded a zero (0).
- These rules are as per «**règle départementales**» (PEIA, article 5.2.5.2) http://guideena.cegepmontpetit.ca/regles-des-departements/

(4) Presentation of Written Work

The student must comply with the (*Normes de présentation matérielle des travaux écrits*) adopted by the Cegep. Failure to comply with these standards may delay the acceptance of work or affect the grade awarded. These standards are available in (**Liens éclair**, **Bibliothèques**) under the (**Méthodologie**) section of the Cegep's Documentation Centers, at:www.cegepmontpetit.ca/normes.

The departmental penalties for non-compliance with the (*Normes de présentation matérielle des travaux écrits*) (PIEA, Article 5.3.2) are:

- The teacher provides students with information and guidelines for orderly presentation and orderly composition of the work. When a work submitted is deemed unacceptable due to presentation, the correction of this work will be delayed until the work is done in the standards set by the teacher. In this case, penalties for delays in the delivery of work apply.

(5) Quality of English

The evaluation of the quality of the language (PIEA, Article 5.3.1) must respect the criteria and values established by the department.

The departmental procedure for assessing the quality of English is:

- A teacher who considers a work presented in an incorrect English refuses or delays acceptance. In the case of refusal, the "0" mark is assigned to the job. If the teacher delays acceptance, the work is then subject to the penalties provided for in the rule (Remise des travaux). http://guideena.cegepmontpetit.ca/regles-des-departements/

METHODS OF COURSE PARTICIPATION

From the first class, students must wear their glasses, authorized work clothes and safety shoes.

Students are required to comply with the rules taught when using the equipment and to comply with the safety rules for operating tests of systems on aircraft and workbench. A non-conforming and dangerous use or attitude will result in a suspension of the student during the course. It is forbidden to wear open shoes during laboratory work. Safety glasses must be worn when required.

OTHER DEPARTMENTAL REGULATIONS

Students are encouraged to consult the website for specific regulations related to this course: http://guideena.cegepmontpetit.ca/regles-des-departements/

INSTITUTIONAL POLICIES AND REGULATIONS

All students enrolled to the National Institute of Aeronautics, of the 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.