ÉCOLE NATIONALE D'AÉROTECHNIQUE
Un campus du collège Édouard-Montpetit

280-4B5-EM
WINTER 2013
Pre-Flight

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.

MINISTERIAL OBJECTIVE(S) AND COMPETENCIES

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

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 W2 W3	#1 Compare, distinguish and identify different systems and their components. #2 Analyze the data for the problem. l #3 Record the results	▪ Review exercises on basic concepts of physics applied to hydraulics and pneumatics. ▪ Ref: aerodynamics, basic electricity, controls and flight control surfaces, introduction to aeronautics ▪ Legal units of measurement ▪ Force, work, torque, moment, power, efficiency, speed (linear and angular) ▪ Hydraulic or pneumatic ▪ Identify and explain some phenomena particular to fluids ▪ Compressibility of fluids ▪ Viscosity ▪ Flow types ▪ Study various laws applied to hydrostatics.	▪ Read Course Outline ▪ Read Course Notes and/or the relevant chapter in a reference book. ▪ Practice calculation exercises.
W4	#4 Identify various types of energy in a hydraulic system : potential, kinetic and thermal (simplified examples).	▪ Static and dynamic parameters of a hydraulic circui : forces, pressure, flow, work, power. ▪ Circuit design: closed.	▪ Read Course Notes and/or the relevant chapter in a reference book. .
W5	#5 Observe the system operation.	▪ Calculate loss of energy ▪ Determine influence of lines ▪ Water hammer ▪ Determine the impact of installing active elements on a hytraulic circuit.	▪ Read Course Notes and/or the relevant chapter in a reference book. ▪ Complete practical simple circuit design exercises using graphic symbols.
W6	Summative evaluation	▪ Content of previous weeks (weeks 1 to 5)	▪ Review previous content and personal notes
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.	▪ Study classification and operation of actuators ▪ Profiles of hydraulic variables depending on the selected installation. ▪ Study various hydraulic and pneumatic receivers. ▪ Study hydrostatic transmissions. ▪ Study engine and pump in a closed circuit. ▪ Study complete and operational circuits.	▪ Read Course Notes and/or the relevant chapter in a reference book. ▪ Complete practical exercises on circuit design.
W10	▪ Summative evaluation	▪ Content of the three previous weeks (Weeks 7 to 9)	▪ Review previous content and personal notes.

Week	Learning Objective	Content	Personal Study Activity
W11 W12 W13 W14	#11 Choose a problem-solving approach. #12 Diagnose problems. #13 Present the analyzed information.	▪ Cable control ▪ Hydraulic or pneumatic control ▪ Hydraulic or pneumatic servo-actuator ▪ Study various types of servo-control	▪ Read Course Notes and/or the relevant chapter in a reference book. ▪ Exercises to develop circuits.
		▪ Study regulating flow and pressure ▪ Learn about size and function of large families of valves and servo-valves.	
		▪ Study additional components: o Tanks o Coolers o Heat exchangers o Position sensors, control levels and types of protection.	▪ 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 circuit. ▪ Study hydraulic circuits of a hydraulic and pneumatic generation of a wide bodied aircraft.	▪ Read Course Notes and/or the relevant chapter in a reference book ▪ Circuit analysis exercises for a wide-bodied aircraft.
W15	Summative exam and comprehensive exam for the session	▪ Study course content (Weeks 1 to 14)	▪ Review course content and personal notes.

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	
W5	▪ Summative Evaluation	▪ Review content from the preceding weeks	▪ Review previous content and personal notes.
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 a battery and determine the capacity necessary for proper operation of a hydraulic circuit.	▪ 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.	

Week	Learning Objective	Content	Personal Study Activity
W10	Summative Evaluation	▪ Study content of the last 4 weeks	▪ Review previous content and personal notes.
W11 W12 W13 W14	#20 Use auxiliary power groups, ground equipment and onboard systems. #21 Observe systems operation #22 Check systems operation #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.
W15	▪ Summative evaluation and comprehensive exam for the session	▪ Course content	▪ Review course content and personal notes.

SYNTHESIS OF SUMMATIVE EVALUATION METHODS

THEORY

Description of Evaluation Activity	Context	Learning Objective(s)	Due Date (approximate date assignment due or exam given)	Weighting (%)
Written exam: answers to exam questions could be: ▪ Short or long answers ▪ multiple choice ▪ combination of the two	▪ Duration: 2 periods ▪ Individual ▪ Calculate operating parameters ▪ Explain precautions to take when operating equipment or a hydraulic or pneumatic system ▪ Analyze the characteristics of the components studied	#1 to #5 of the first 5 weeks.	Week 6	15%
Written exam: answers to exam questions could be: ▪ Short or long answers ▪ multiple choice ▪ combination of the two	▪ Duration: 2 periods ▪ Individual ▪ Draw hydraulic schematic using graphic symbols and calculations of operating parameters ▪ Explain operation and the roles of hydraulic components. ▪ Classify and explain characteristics of hydraulic or pneumatic components ▪ Determine parameters for choosing a hydraulic or pneumatic component	#6 to #10 for Weeks 7 to 9	Week 10	15%
Written exam: answers to exam questions could be: ▪ Short or long answers ▪ multiple choice ▪ combination of the two	▪ Duration: 2 periods ▪ Individual ▪ Calculate operating parameters ▪ Determine how to assure protection and maintenance of a hydraulic or pneumatic system ▪ Troubleshoot and provide solutions ▪ Explain precautions to take when working on a hydraulic system	#11 to #13 for Weeks 11 to 14	Week 15	20%

Total : 50%

Practical Work (Laboratory)

Description of Evaluation Activity	Context	Learning Objective(s)	Due Date (approximate date assignment due or exam given)	Weighting (%)
Written exam: answers to exam questions could be: ▪ Short or long answers ▪ multiple choice ▪ combination of the two	▪ Duration: 3 periods ▪ Individual ▪ Calculate operating parameters ▪ Explain precautions to take when operating equipment or a hydraulic or pneumatic system ▪ Check characteristics of the components studied	#14 to #16 of the first 4 weeks	Week 5	15%
Written exam: answers to exam questions could be: ▪ Short or long answers ▪ multiple choice ▪ combination of the two Note: the questions refer to handling, calculations and troubleshooting of the laboratories seen in class.	▪ Duration: 3 periods ▪ Individual ▪ Calculate operating parameters ▪ Explain operation and the roles of hydraulic components. ▪ Classify and explain characteristics of hydraulic or pneumatic components ▪ Determine parameters for choosing a hydraulic or pneumatic component	#17 to #19 for Weeks 6 to 9	Week 10	15%
Written exam: answers to exam questions could be: ▪ Short or long answers ▪ multiple choice ▪ combination of the two	▪ Calculate operating parameters ▪ Determine how to assure protection and maintenance of a hydraulic or pneumatic system ▪ Troubleshoot and provide solutions ▪ Explain precautions to take when operating a hydraulic system	#20 to #30 for Weeks 11 to 14	Week 15	20%

Total: 50%

REQUIREMENTS TO PASS THE COURSE

(1) Passing Mark

The passing mark for this course is 60%, 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. 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) Course Attendance: Transport Canada Standard

The Department applies the Transport Canada standard which tolerates a 5% absence rate (for both theory and practical courses). The Department compiles student absences listed in the Aircraft Maintenance Program (280.C0) and Avionics Technology (180.D0) as required by Transport Canada. The application of Transport Canada's policy on absences is available on the College website and in the student agenda under the heading "Privilèges accordés par Transports Canada" (Privileges granted by Transport Canada)

(4) 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).

(5) Presentation of Written Work

The teacher will provide students with information and guidelines for methodical and orderly presentation of work. When the presentation of work that has been submitted is judged to be unacceptable, correction of this work will be delayed until the work meets the standards set by the teacher. In this case, penalties for delays in submitting work will apply.

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.***

(6) Quality of English

A teacher may refuse or delay acceptance of any submitted work if the level of English is considered unacceptable. If the work is refused, it will receive a mark of "0." If the teacher delays acceptance, the work is subject to the same penalties listed under "Submitting Assignments."

CONDITIONS FOR PARTICIPATION IN CLASS

Students are required to comply with the rules they have been taught regarding the use of equipment and to respect safety rules regarding system operation tests on aircraft and models. Any non-compliant and dangerous usage or attitude will result in the student being suspended from the course. Students are forbidden to wear open shoes in the laboratories. Safety glasses must be worn when required.

REQUIRED MATERIAL

Course notes, (the number will be provided by the instructor during the first course)

MEDIAGRAPHY

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

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. If there is a disparity between shortened versions of the text and the full text, the full text will be applied and will be considered the official version for legal purposes.

OTHER DEPARTMENTAL REGULATIONS

Students are encouraged to consult the website for specific regulations related to this course:
http://ena.college-em.qc.ca/
http://ena.college-em.qc.ca/etudiants-actuels/programmes-d-etudes/departements-d-enseignement#a2

NOTE: This Course Outline is a translation of the *Plan de cours* for 280-415-EM: *Systèmes hydraulique et pneumatique (puissance et commande)*. If there is a disparity, then the original French version will be considered the official version for legal purposes.