



## COURSE OUTLINE

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

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

**DISCIPLINE:** 280 Aeronautics

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

<b>Instructor(s)</b>	<b>Office</b>	<b>☎ extension</b>	<b>✉ email or web site</b>
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### OFFICE HOURS

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning					
Afternoon					

<b>Coordinator(s)</b>	<b>Office</b>	<b>☎ extension</b>	<b>✉ e-mail or web site</b>
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## **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 covers, 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 verify the 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 mounting 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 repair defects;
- To become familiar with the graphic symbols specific to the subject matter;
- Take necessary security measures while working with hydraulic and pneumatic systems.

## **MINISTERIAL OBJECTIVE(S) AND COMPETENCIES**

**025 U** To inspect the operation of power and control components of hydraulic and pneumatic systems

## **TEACHING AND LEARNING STRATEGIES**

**Theory:** In general, formal lectures and the software program Hydro-pneu are used to develop hydraulic circuits, 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:

- To develop a diagram that represents a hydraulic or pneumatic circuit and build this circuit according to the proposed exercise.
- To perform necessary calculations to determine the parameters (pressure, force, flow, work, power and charge loss) of the operation of the circuit that was built.
- To compare the theoretical values with the practical observations and justify the difference.
- To choose the necessary elements, depending on the activity, to allow proper operation of the circuit.
- To propose necessary modifications to make the system more efficient.
- To analyze 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	<ul style="list-style-type: none"> <li>Review the basic concepts of physics applied to hydraulics and pneumatics. Ref : aerodynamics, basic electricity, controls and control surfaces, onboard instruments, introduction to aeronautics.</li> </ul>	<ul style="list-style-type: none"> <li>Course Outline.</li> <li>Legal units of measure.</li> <li>Force, work, torque, moment, power, efficiency, velocity (linear and angular).</li> <li>Hydraulic or pneumatic.</li> </ul>	<ul style="list-style-type: none"> <li>Read Course Outline.</li> <li>Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>Practice calculation exercises.</li> </ul>
W2	<ul style="list-style-type: none"> <li>Identify and explain some characteristics specific to fluids.</li> </ul>	<ul style="list-style-type: none"> <li>Compressibility of fluids.</li> <li>Fluidity of liquids.</li> <li>State of flow.</li> </ul>	<ul style="list-style-type: none"> <li>Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>Practice calculation exercises.</li> </ul>
W3	<ul style="list-style-type: none"> <li>Study the various laws applied to hydrostatics.</li> </ul>	<ul style="list-style-type: none"> <li>Change in apparent weight of a body immersed in a liquid.</li> <li>Action forces on a solid immersed in a liquid.</li> <li>Measurement of atmospheric pressure.</li> <li>Interpretation of absolute and relative pressure.</li> </ul>	<ul style="list-style-type: none"> <li>Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>Practice calculation exercises.</li> </ul>
W4	<ul style="list-style-type: none"> <li>Identify the different types of energy in a hydraulic circuit : potential, kinetic and thermal (simplified examples).</li> </ul>	<ul style="list-style-type: none"> <li>The static and dynamic parameters of a hydraulic circuit: forces, pressure, flow, work, power.</li> <li>Circuit design: open and closed.</li> <li>Hydraulic pumps.</li> </ul>	<ul style="list-style-type: none"> <li>Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>Simple circuit design exercises using graphical symbols.</li> </ul>
W5	<ul style="list-style-type: none"> <li>Summative evaluation.</li> </ul>	<ul style="list-style-type: none"> <li>Content of previous weeks.</li> </ul>	<ul style="list-style-type: none"> <li>Review previous material and personal notes.</li> </ul>
W6	<ul style="list-style-type: none"> <li>Determine the impact of installation of active elements in a hydraulic circuit.</li> </ul>	<ul style="list-style-type: none"> <li>Charge loss calculation.</li> <li>Lines / influence.</li> <li>Hydraulic surge.</li> </ul>	<ul style="list-style-type: none"> <li>Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>Practice calculation exercises.</li> </ul>
W7	<ul style="list-style-type: none"> <li>Study various hydraulic and pneumatic receivers.</li> </ul>	<ul style="list-style-type: none"> <li>Classification and operation of actuators.</li> <li>Profiles of hydraulic variables depending on installation choice.</li> </ul>	<ul style="list-style-type: none"> <li>Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>Practical exercises on circuit design.</li> </ul>
W8	<ul style="list-style-type: none"> <li>Study the different emergency generators.</li> </ul>	<ul style="list-style-type: none"> <li>Different types of accumulators. Ref. RAC 566 Appendix C – Part 2 - 1.0.4 – 14.0.1 – 14.0.4 to 14.0.6 – 15.0.2</li> <li>Transfer cylinders.</li> <li>Pressure amplifying means.</li> </ul>	<ul style="list-style-type: none"> <li>Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>Practical exercises on circuit design.</li> </ul>

*Course Outline 280-4B5-EM: Hydraulic and Pneumatic Systems (Power and Control)*

<b>Week</b>	<b>Learning Objective</b>	<b>Content</b>	<b>Personal Study Activity</b>
<b>W9</b>	<ul style="list-style-type: none"> <li>▪ Study hydrostatic transmissions.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Motors in a closed circuit.</li> <li>▪ Motors in an open circuit.</li> <li>▪ Transmission torque and formulas related to power.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>▪ Practical exercises on cylinder, torque and power calculations.</li> </ul>
<b>W10</b>	<ul style="list-style-type: none"> <li>▪ Study different types of servo-mechanisms.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Control cable.</li> <li>▪ Hydraulic or pneumatic control.</li> <li>▪ Hydraulic or pneumatic pilot valves.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>▪ Practical exercises on circuit design.</li> </ul>
<b>W11</b>	<ul style="list-style-type: none"> <li>▪ Summative evaluation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Content of the preceding 5 weeks.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Review previous material and personal notes.</li> </ul>
<b>W12</b>	<ul style="list-style-type: none"> <li>▪ Study pressure and flow control.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Size and function of the major families of valves and servo valves.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>▪ Practical exercises on circuit design.</li> </ul>
<b>W13</b>	<ul style="list-style-type: none"> <li>▪ Study additional components.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Coolers.</li> <li>▪ Heat exchangers.</li> <li>▪ Position and level control sensors and various types of protections.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>▪ Wide-bodied aircraft circuit analysis exercises.</li> </ul>
<b>W14</b>	<ul style="list-style-type: none"> <li>▪ Analyze the operation of a hydraulic and pneumatic circuit.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hydraulic and pneumatic generation systems of a wide-bodied aircraft.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Read Course Notes and/or the relevant chapter in the reference manual.</li> <li>▪ Wide-bodied aircraft circuit analysis exercises.</li> </ul>
<b>W15</b>	<ul style="list-style-type: none"> <li>▪ Summative evaluation and comprehensive exam.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Course content.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Review all course material and personal notes.</li> </ul>

## COURSE PLAN – PRACTICAL WORK (LABORATORY)

Week	Learning Objective	Content	Personal Study Activity
W1	<ul style="list-style-type: none"> <li>Become familiar with the course outline and the safety measures to take in the workshop when using hydraulic and pneumatic systems.</li> </ul>	<ul style="list-style-type: none"> <li>Various points of the lesson plan</li> <li>Description of the equipment in the laboratory.</li> <li>Hazards related to handling hydraulic oils and those related to the operation of components of a hydraulic or pneumatic system.</li> </ul>	<ul style="list-style-type: none"> <li>Read Course Outline.</li> <li>Study hydraulic and pneumatic test benches.</li> <li>Read texts dealing with the variety of oils used.</li> </ul>
W2	<ul style="list-style-type: none"> <li>Calculate the different parameters (forces, pressures, flows, velocities, work, power and charge losses) generated in a hydraulic or pneumatic circuit.</li> </ul>	<ul style="list-style-type: none"> <li>Application of the basic principles of hydrostatics.</li> <li>Application of the basic principles of hydrodynamics.</li> <li>The nature and condition of the lines that carry fluid in a circuit.</li> </ul>	<ul style="list-style-type: none"> <li>Review concepts of physics that apply to hydraulics and pneumatics. Ref : aerodynamics, basic electricity, controls and control surfaces, onboard instruments, introduction to aeronautics.</li> <li>Review measurement systems (International and English).</li> <li>Read texts dealing with properties of fluids (viscosity, lubricity, wear resistance).</li> </ul>
W3	<ul style="list-style-type: none"> <li>Do maintenance on a hydraulic reservoir.</li> </ul>	<ul style="list-style-type: none"> <li>Description of several types of reservoirs for various aircraft.</li> <li>Pneumatic pressurization sources used and reservoirs protection means.</li> <li>Factors that determine the location and volume of a reservoir.</li> <li>Contamination of a reservoir.</li> </ul>	<ul style="list-style-type: none"> <li>Read Chapters ATA 29, sections relevant to reservoirs of two different types of aircraft: comparison of reservoirs for pressurized and unpressurized aircraft.</li> </ul>
W4	<ul style="list-style-type: none"> <li>Evaluate the flow and displacement of a pump.</li> <li>Differentiate between a volumetric and non-volumetric pump.</li> <li>Visualize several types of pumps: gear, lobe, vane, piston (rotary and axial).</li> </ul>	<ul style="list-style-type: none"> <li>Hydraulic pumps classification and operating Precautions to take when starting a hydraulic pump.</li> <li>Hydraulic pump drive.</li> </ul>	<ul style="list-style-type: none"> <li>Read Chapter ATA29, the part reserved for pumps, circuit of a wide-bodied aircraft.</li> </ul>
W5	<ul style="list-style-type: none"> <li>Summative evaluation.</li> </ul>	<ul style="list-style-type: none"> <li>Content of previous weeks.</li> </ul>	<ul style="list-style-type: none"> <li>Review content of previous weeks and personal notes.</li> </ul>
W6	<ul style="list-style-type: none"> <li>Determine the number of active elements to be incorporated in a basic hydraulic circuit: build a circuit.</li> </ul>	<ul style="list-style-type: none"> <li>Description and operation of distributors, valves (check valves, pressure relief valves), flow restrictors, and pressure regulators.</li> </ul>	<ul style="list-style-type: none"> <li>Read Chapter ATA 29, sections relevant to description and operation of the hydraulic system of a large aircraft.</li> </ul>

*Course Outline 280-4B5-EM: Hydraulic and Pneumatic Systems (Power and Control)*

<b>Week</b>	<b>Learning Objective</b>	<b>Content</b>	<b>Personal Study Activity</b>
<b>W7</b>	<ul style="list-style-type: none"> <li>▪ Check the operation of hydraulic actuators and evaluate the pressure variations in different configurations: series connection and parallel connection of several cylinders.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Classification and operation of actuators.</li> <li>▪ Profiles of hydraulic variables depending on the connection chosen.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Further exercises on simple circuits.</li> </ul>
<b>W8</b>	<ul style="list-style-type: none"> <li>▪ Do maintenance on an accumulator and determine the necessary capacity for proper operation of a hydraulic system</li> </ul>	<ul style="list-style-type: none"> <li>▪ Variation of the volume of a gas as a function of pressure</li> <li>▪ Secondary roles attributed to an accumulator.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Exercises to determine the load pressure of an accumulator and the hydraulic volume necessary for the planned back-up operation.</li> </ul>
<b>W9</b>	<ul style="list-style-type: none"> <li>▪ Check the operation of a hydraulic motor.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hydraulic motors and rotary actuators classification and operating principle</li> </ul>	<ul style="list-style-type: none"> <li>▪ Exercises to determine the displacement and engine torque developed.</li> </ul>
<b>W10</b>	<ul style="list-style-type: none"> <li>▪ Inspect the filters, the chip detectors condition, check for leaks and presence of contaminants in the system.</li> <li>▪ Bleed air from hydraulic system.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Functional aspects of a hydraulic circuit: boosting, cooling, pollution, problems related to the presence of air in a hydraulic system.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Functional analysis of a wide-bodied aircraft's hydraulic system.</li> </ul>
<b>W11</b>	<ul style="list-style-type: none"> <li>▪ Summative exam.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Content of previous 5 weeks.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Review previous content and personal notes.</li> </ul>
<b>W12</b>	<ul style="list-style-type: none"> <li>▪ Integrate the electrical and electronic components in a hydraulic system: remote control, indicators (pressure, flow, quantity, temperature, calculators).</li> </ul>	<ul style="list-style-type: none"> <li>▪ Electrical and electronic components in a hydraulic system.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Study an electric and electronic diagram for a wide-bodied aircraft.</li> </ul>
<b>W13</b>	<ul style="list-style-type: none"> <li>▪ Turn on the hydraulic system for the Falcon 20.</li> <li>▪ Turn on the hydraulic system for the ASTAR 320.</li> <li>▪ Note defects.</li> </ul>	<ul style="list-style-type: none"> <li>▪ ATA 29 for the Falcon 20.</li> <li>▪ ATA 29 for the ASTAR 320. (Visit to the hangar).</li> </ul>	<ul style="list-style-type: none"> <li>▪ Make a detailed study of the diagrams of these two aircraft.</li> </ul>
<b>W14</b>	<ul style="list-style-type: none"> <li>▪ Troubleshoot and propose solutions following a malfunction of a hydraulic system.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hydraulic circuits for the Falcon 20 and Lear jet at ENA.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Make a detailed study of the troubleshooting procedures described in maintenance manuals.</li> </ul>
<b>W15</b>	<ul style="list-style-type: none"> <li>▪ Summative evaluation and comprehensive exam.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Course content.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Review course content and personal notes.</li> </ul>

**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: <ul style="list-style-type: none"> <li>▪ Essay (long answer).</li> <li>▪ Multiple choice.</li> <li>▪ A combination of the two.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Duration of 2 class periods.</li> <li>▪ Individual.</li> </ul>	See the objectives for the first 4 weeks : <ul style="list-style-type: none"> <li>▪ Calculation of the operating parameters.</li> <li>▪ Precautions to take when starting hydraulic or pneumatic systems equipment.</li> <li>▪ Analyzing characteristics of the components studied.</li> </ul>	Week 5	15%
Written exam: answers to exam questions could be: <ul style="list-style-type: none"> <li>▪ Essay (long answer).</li> <li>▪ Multiple choice.</li> <li>▪ A combination of the two.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Duration of 2 class periods.</li> <li>▪ Individual.</li> </ul>	See the objectives for the last 5 weeks : <ul style="list-style-type: none"> <li>▪ Building hydraulic circuits using graphic symbols and calculations of operating parameters.</li> <li>▪ Explaining the operation and roles of hydraulic components.</li> <li>▪ Classifying and identifying characteristics of hydraulic or pneumatic components.</li> <li>▪ Factors determining the choice of a hydraulic or pneumatic component.</li> </ul>	Week 11	15%
Written exam: answers to exam questions could be: <ul style="list-style-type: none"> <li>▪ Essay (long answer).</li> <li>▪ Multiple choice.</li> <li>▪ A combination of the two.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Duration of 2 class periods.</li> <li>▪ Individual.</li> </ul>	See course objectives : <ul style="list-style-type: none"> <li>▪ Calculation of the operating parameters.</li> <li>▪ Methods used to ensure the protection of ongoing maintenance of a hydraulic or pneumatic system.</li> <li>▪ Troubleshooting and finding solutions.</li> <li>▪ Taking precautions when working on a hydraulic system.</li> </ul>	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 (%)
<p>Written exam: answers to exam questions could be:</p> <ul style="list-style-type: none"> <li>▪ Essay (long answer).</li> <li>▪ Multiple choice.</li> <li>▪ A combination of the two.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Duration of 3 class periods.</li> <li>▪ Individual.</li> </ul>	<p>See the objectives for the first 4 weeks :</p> <ul style="list-style-type: none"> <li>▪ Calculation of the operating parameters.</li> <li>▪ Precautions to take when starting equipment or a hydraulic or pneumatic system.</li> <li>▪ Verification of the characteristics of the components studied.</li> </ul>	<p>Week 5</p>	<p>15%</p>
<p>Written exam: answers to exam questions could be:</p> <ul style="list-style-type: none"> <li>▪ Essay (long answer).</li> <li>▪ Multiple choice.</li> <li>▪ A combination of the two.</li> </ul> <p>Note: the questions relate to the labs seen in class on handling, calculating, troubleshooting.</p>	<ul style="list-style-type: none"> <li>▪ Duration of 3 class periods.</li> <li>▪ Individual.</li> </ul>	<p>See the objectives for the last 5 weeks:</p> <ul style="list-style-type: none"> <li>▪ Calculation of the operating parameters.</li> <li>▪ Explanation of the operation of the hydraulic components.</li> <li>▪ Classification and characteristics of the hydraulic or pneumatic components.</li> <li>▪ Parameters determining the choice of a hydraulic or pneumatic component.</li> </ul>	<p>Week 11</p>	<p>15%</p>
<p>Written exam: answers to exam questions could be:</p> <ul style="list-style-type: none"> <li>▪ Essay (long answer).</li> <li>▪ Multiple choice.</li> <li>▪ A combination of the two.</li> </ul>		<p>See the course objectives :</p> <ul style="list-style-type: none"> <li>▪ Calculation of the operating parameters.</li> <li>▪ Means used to ensure the protection and ongoing maintenance of a hydraulic or pneumatic system.</li> <li>▪ Troubleshooting and solutions.</li> <li>▪ Precautions to take when working on a hydraulic system.</li> </ul>	<p>Week 15</p>	<p>20%</p>

**Total : 50%**



## REQUIREMENTS TO PASS THE COURSE

### (1) Passing Mark

The sum of the two marks for theory and practical work must be greater than or equal to 60% to obtain the DEC. However, the MCF has other requirements. Students are advised to inform themselves regarding the policies of the Ministry of Transportation (see CAR 566, Part IV)

### (2) Attendance for Summative Evaluations

Attendance is mandatory. However, for certain situations, Department policies will apply (see the student agenda and/or the ÉNA website).

### (3) Submitting Assignments

The teacher will establish the conditions for submitting assignments beforehand and students must respect these conditions.

### (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 recherché** ».

## 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](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 specific regulations related to this course:

<http://www.college-em.qc.ca/>  
[www.college-em.qc.ca/ena/preenvol/reglements](http://www.college-em.qc.ca/ena/preenvol/reglements)