I. INTRODUCTION

A. Modern aircraft have several different mechanical systems that utilize the movement of fluid to transmit a force. The most common examples are the hydraulic and pneumatic systems. This course provides instruction on servicing, inspecting and maintaining aircraft fluid systems including hydraulic, pneumatics and fuel. An in-depth study of aircraft fuel systems from types of fuel to comprehensive troubleshooting and fuel system repair procedures. Safety will be addressed in each topic.

B. This is a required course of study for the Associate Degree of Applied Science in Aviation Maintenance Technology.

C. This course is occupationally related and serves as preparation for a career in the field of Aviation Maintenance.

D. Prerequisite: Successful completion of the general (G) aviation maintenance courses.

II. LEARNING OUTCOMES

Upon successful completion of this course, Aircraft Hydraulic, Pneumatic and Fuel Systems, the student will:

Demonstrate the ability to identify the various FAA-approved hydraulic fluids and their identification marks. Demonstrate competency in troubleshooting, inspection, servicing and repair of hydraulic and pneumatic systems. Demonstrate the ability to identify aircraft fuel, inspect and analyze malfunctions and repair leaks. Use correct safety procedures when working with hydraulic and pneumatic systems.

(C18,F1,F4,F5,F10,F12)

III. INSTRUCTIONAL MATERIALS
A. The instructional materials identified for this course are viewable through www.ctcd.edu/books

B. Supplemental Reading: None


IV. COURSE REQUIREMENTS

The following will be required of each student for successful completion of this course:

A. Reading Assignment: Students are required to complete all reading assignments prior to the class in which the materials will be discussed. Students are subject to announced and unannounced written and oral examinations on assigned reading material.

B. Projects: The following ten projects will be completed by students only after coverage of the subjects by course material. Students are required to demonstrate proficiency and knowledge in each area. (Projects are to be assigned based on instructor discretion and availability of resources). Each project will carry a weight of 20 points.

1. Charge an accumulator with the correct amount of air or nitrogen.

2. Remove and replace an actuating cylinder in an aircraft system. Purge the air from the system after the cylinder is reinstalled.

3. Identify the type of hydraulic fluid by its color. Explain the appearance of contaminated fluid.

4. Inspect the fuel selector valves of an aircraft and determine whether or not there is positive indication of the valve being fully on and fully off.

5. Explain the symptom of an aircraft hydraulic system when the accumulator has no air preload.
6. Explain the correct method to check a bladder-type fuel cell for leakage and the correct way to repair this leakage.

7. Locate and identify the fuel tank probes, the amplifier, and the indicator of an electronic fuel quantity system. Explain the correct method to calibrate a fuel quantity system.

8. Drain all of the sumps of an aircraft fuel system and check for the presence of water.

9. Explain the correct procedures to follow if a reciprocating engine-powered aircraft has been fueled with turbine fuel, and the engine has been run.

10. Properly identify the fuel in the tank of a reciprocating-engine-powered aircraft by its color.

C. Class performance: Students are required to attend all classes and to be in the classroom on time. The instructor can lower a student’s grade because of excessive tardiness. When absent from class for any reason, it is the student’s responsibility to arrange for and make up assignments missed during the absence.

D. Class Participation: Students will earn a satisfactory grade in the course by attending and regularly participating in class, giving complete attention to class activities, completion of all assigned work and successfully completing the examinations. Students are required to maintain a minimum GPA of 2.0 to receive a passing grade for the class and are encouraged to compute and monitor their GPA as the class progresses.

V. EXAMINATIONS

A. There will be two written examinations for this course covering all lecture notes and reading material.

B. Practicum: Projects will be assigned based on instructor’s discretion and availability of resources

VI. SEMESTER GRADE COMPUTATION

<table>
<thead>
<tr>
<th>EXAMINATIONS</th>
<th>POINTS</th>
<th>POINT TO GRADE RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXAM 1</td>
<td>400</td>
<td>900- 1000 = A</td>
</tr>
<tr>
<td>EXAM 2</td>
<td>400</td>
<td>800- 899 = B</td>
</tr>
<tr>
<td>Projects (20 pts/per)</td>
<td>200</td>
<td>700- 799 = C</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1000</td>
<td>600- 699 = D</td>
</tr>
</tbody>
</table>
VII. NOTES AND ADDITIONAL INSTRUCTIONS FROM COURSE INSTRUCTOR

A. **Course Withdrawal**: It is the student’s responsibility to officially drop a class if circumstances prevent attendance. In order to be officially withdrawn from the course, a student must obtain, complete and file an Application for Withdrawal form with the College. The student’s transcript will show “W” or “F”, depending on whether the student was passing or failing at the time of withdrawal.

B. **Administrative Withdrawal**: Students not meeting course objectives or not making satisfactory progress may be withdrawn from the course at the discretion of the instructor.

C. **Cellular Phones and Beepers**: Cellular phones and beepers will be turned off while the student is in the classroom or laboratory.

D. **American’s with Disabilities Act (ADA)**: Disability Support Services provide services to students who have appropriate documentation of a disability. Students requiring accommodations for class are responsible for contacting the Office of Disability Support Services (DSS) located on the central campus. This service is available to all students, regardless of location. Explore the website at [www.ctcd.edu/disability-support](http://www.ctcd.edu/disability-support) for further information. Reasonable accommodations will be given in accordance with the federal and state laws through the DSS office.

E. **Instructor Discretion**: The instructor reserves the right of final decision in course requirements.

F. **Civility**: Individuals are expected to be cognizant of what a constructive educational experience is and respectful of those participating in a learning environment. Failure to do so can result in disciplinary action up to and including expulsion.

VIII. COURSE OUTLINE

A. **Module One**: Introduction to hydraulic principles

   1. **Learning Outcomes**: upon successful completion of this module, the Student will:

       Apply fundamental hydraulic principles in the performance of inspections, services and repairs.
2. **Learning Activities:** Introduction to fluid power systems

Successfully complete examination 1 covering material presented in this Module. (F1,F4,F5,F10,F12)

3. **Equipment and Materials:**

   a. Serviceable or unserviceable airframe with operable brakes, landing gear retraction system with wheels and tires, shock absorbers or Oleo struts and a completely operable hydraulic system in which all components are fully functional. Provide a service manual for hydraulic systems on the airframe above.

   b. Aircraft jacks suitable for use with the above airframe.

   c. Ground powered hydraulic cart or APU to power hydraulic systems without aircraft engine power.

4. **Module Outline One:** Introduction to fluid power systems

   a. Historical overview

   b. Basic laws of physics

      1. Area
      2. Distance
      3. Volume
      4. Work
      5. Power
      6. Relationship between force, pressure and area
      7. Relationship between volume, area, and distance
      8. The law of conservation of energy
      9. Relationship between height and pressure

   c. Pascal’s Law

   d. Mechanical advantage

   e. Bernoulli’s Principle

      1. Pressure drop in moving fluid
      2. Advantages and disadvantages of fluid power systems

   f. Basic aircraft hydraulic systems

      1. Sealed brake systems
      2. Reservoir-Type brake system
      3. Single-Acting actuator system
      4. Double-Acting actuator system
      5. Power Pump systems

         a) Manual pump control valve system
         b) Power control valve system
B. **Module Two: Hydraulic system components**

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
   
   a. Differentiate between the different types of hydraulic fluids by color.
   
   b. Service hydraulic reservoirs according to manufacture specifications and visually recognize hydraulic fluid contamination.
   
   c. Identify different types of hydraulic pumps.
   
   d. Explain the purpose and operation of various types of hydraulic valves, fuses, and pressure regulators.
   
   e. Explain the function of a hydraulic accumulator and properly service the accumulator according to manufacture specifications.
   
   f. Explain the function of hydraulic actuators, remove, install and bleed air from the system after installation and perform function checks.
   
   g. Identify hydraulic seals and wipers and comply with proper installation techniques.

2. **Learning Activities:**
   
   a. Successfully complete examination 1 covering material presented in this Module. (F1,F5,F10)
   
   b. Complete projects 1-3 and 5. (C18-C20,F1,F4,F5,F10,F12)

3. **Equipment and Materials:**
   
   
   b. safety goggles, basic hand tools and shop towels
c. An assortment of serviceable or unserviceable hydraulic pumps, valves, hydraulic fuses, pressure control valves, filters, actuators, and seals for identification purposes.

d. Serviceable or unserviceable airframe with operable brakes, landing gear retraction system with wheels and tires, shock absorbers or Oleo struts and a completely operable hydraulic system in which all components are fully functional. Provide a service manual for hydraulic systems on the airframe above.

e. Ground powered hydraulic cart or APU to power hydraulic systems without aircraft engine power.

f. Nitrogen or air servicing cart with pressure gages and regulator and adapter fittings compatible with accumulators and struts to be serviced.

4. Module Outline Two: Hydraulic system components

a. Hydraulic fluids
   1. Vegetable-base hydraulic fluids
   2. Mineral-base hydraulic fluid
   3. Synthetic-base hydraulic fluid
   4. Phosphate Ester hydraulic fluid

b. Contamination and protection of hydraulic fluids

c. Hydraulic reservoirs
   1. Nonpressurized reservoirs
   2. Pressurized reservoirs

d. Hydraulic pumps
   1. Hand pumps
   2. Power pumps
      Constant-displacement pumps
      1) Vane-type pumps
      2) Gear-type pumps
      3) Gearotor pumps
      4) Piston pumps
   3. Variable-Displacement pumps

e. Hydraulic valves
   1. Flow control valves
      a) Check valves
         Orifice check valves
      b) Selector valves
         1) Plug-type closed-center selector valves
         2) Poppet-type closed-center selector valves
3) Poppet-type Open-center selector valves
4) Spool-type closed-center selector valve
c) Sequence valves
d) Priority valves
e) Flap Overload valves
f) Flow equalizer valves
g) Landing gear Crossflow valves
h) Pressure control valves
  1) Relief valves
      Thermal Relief valves
  2) Automatic Pressure Regulators or Unloading valves
  3) Pressure reducer
f. Hydraulic Accumulators
g. Hydraulic filters
h. Hydraulic Actuators
  1. Linear Actuators
  2. Rotary Actuators
  3. Servo Actuators
i. High-Pressure seals
  1. Chevron seals
  2. O-ring seals
  3. T-seals
j. Seal identification
k. Seal installation
l. Wipers

C. **Module Three:** Hydraulic lines and fittings, pneumatic systems, large aircraft hydraulic systems and troubleshooting

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
   a. Differentiate between the types of fittings and lines, inspect, manufacture, test and install lines and fittings
   b. Explain types and functions of pneumatic systems commonly used in aircraft and service, test and repair malfunctioning systems.
   c. Maintain large aircraft hydraulic systems.
   d. Perform hydraulic system troubleshooting procedures, diagnose faults and repair or replace defective components.
2. **Learning Activities:**

   Successfully complete examination 1, covering material presented in this Module. (C18-C20,F1,F4,F5,F10)

3. **Equipment and Materials:**

   a. Samples of pipe fittings, AN and AC flare fittings, MS Flareless fittings, quick-disconnect fittings, rigid aluminum or stainless steel tubing and rubber or Teflon hose material

   b. Serviceable or unserviceable airframe with operable brakes, landing gear retraction system with wheels and tires, shock absorbers or Oleo struts and a completely operable hydraulic system in which all components are fully functional. Provide a service manual for hydraulic systems on the airframe.

   c. Ground powered hydraulic cart or APU to power hydraulic systems without aircraft engine power.

   d. Wheel type tubing cutter, roller-type flaring tool, hand operated tubing bender up to ¾” tubing. Safety goggles, O-ring installation/removal tools, basic hand tools, bench mounted vice and shop towels, and a 4x6x10 power magnifying glass for inspecting lines, hoses and fittings for defects.

4. **Module Outline Three:** Hydraulic lines and fittings, pneumatic systems, large aircraft hydraulic systems and troubleshooting

   a. Fluid power system lines and fittings
      1. Fluid lines
         a) Rigid tubing
            1) Preparation for flared-tube fittings
            2) Preparation for Flareless Fittings
            3) Bending rigid tubing
         b) Flexible fluid lines
            1) Low-pressure hose
            2) Medium-pressure hose
            3) High-pressure hose
            4) Teflon hose
      2. Fluid line fittings
         a) Pipe fittings
b) AN and AC flare fittings
c) Universal or bulkhead fittings
d) MS Flareless fittings
e) Quick-Disconnect fittings

3. Fluid line installation
a) Rigid lines
b) Flexible lines

c. Pneumatic Systems
   a) Engine-driven air pumps
   b) Pneumatic Deicer systems
   c) Pneumatic Gyro power systems
   b) Backup high-pressure pneumatic systems
   c) Full pneumatic systems

c. Large aircraft fluid power systems
   1. Sources of hydraulic power
   2. Jet transport airplane hydraulic system
      a) System A
      b) System B
      c) Standby system
      d) Reservoir servicing

d. Hydraulic system maintenance and troubleshooting
   1. Hydraulic system troubleshooting
   2. Troubleshooting tips and procedures

D. **Module Four: Types of aircraft fuels, fuel system requirements and tanks**

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
   a. Identity different types of aircraft fuels and fuel characteristics.
   b. Identify fuel system requirements for different types of aircraft fuel systems.
   c. Identify and repair different types of fuel tanks.

2. **Learning Activities:*
   a. Successfully complete examination 2 covering material presented in this module. (F1-F4,F10)
   b. Complete projects 4,8 and 10. (F1,F5,F10)
3. **Equipment and Materials:**

Multimeters, general hand tools, goggles, fuel proof gloves, explosion proof flashlights, safety wire, fuel sample tools, samples of each grade of aviation gasoline and jet/turbine engine “Jet-A”.

4. **Module Outline Four:** Types of aircraft fuels and fuel system requirements and tanks

a. Aircraft fuel types
   1. Aviation Gasoline fuel
   2. Aviation gasoline Characteristics
      a) Purity
      b) Volatility
      c) Antidetonation Qualities
   3. Fuel Additives

b. Turbine engine fuels
   1. Turbine engine fuel volatility
   2. Turbine engine fuel viscosity
   3. Microbiological growth in turbine fuel tanks
   4. Fuel anti-icing

c. Fuel system requirements
   1. Gravity-feed fuel systems for a float carburetor
   2. Gravity-feed system for a fuel-injected engine
   3. Low-wing, single-engine fuel system for a float carburetor
   4. Low-wing, twin-engine fuel system for fuel injected engines
   5. Twin-engine cross-feed fuel system
   6. Four-engine manifold cross-feed fuel system
   7. Helicopter fuel system
   8. Large turbine-engine transport fuel system
   9. Fueling and Defueling
   10. Fuel dumping
   11. Instruments and controls
      a) Refueling panel
      b) Flight Engineer’s panel

d. Fuel Tanks
   1. Built-up fuel tanks
   2. Integral fuel tanks
   3. Bladder-type fuel tanks
   4. Fuel tank filler-caps

E. **Module Five:** Fuel pumps, filters, strainers, valves and heaters
1. **Learning Outcomes:** upon successful completion of this module, the Student will:
   
a. Describe aircraft fuel pump types, diagnose and replace faulty components
b. Describe different types of fuel filters, strainers and common contaminants
c. Identify and explain typical valves used in aircraft fuel systems and test for proper operation
d. Describe different types of fuel heaters and purpose.

2. **Learning Activities:**
   Successfully complete examination 2 covering material presented in this module. (F1,F5,F10)

3. **Equipment and Materials:**
   
a. Serviceable or unserviceable fuel pump types available for visual inspection and recognition
b. Filter elements and strainers for display
c. Fuel valves to demonstrate proper operation and serve as display for recognition.

4. **Module Outline Five:** Types of aircraft fuels pumps, filters, strainers, valves, and heaters
   
a. Fuel pumps
   1. Electrical Auxiliary pumps
   2. Plunger-type pumps
   3. Centrifugal boost pumps
   4. Ejector pump systems
   5. Engine-driven fuel
      a) Diaphragm-type fuel pumps
      b) Vane-type fuel pumps
   6. Turbine-engine fuel pump
b. Fuel filters and strainers
   1. Types of contaminants
   2. Required fuel strainers
c. Fuel valves
1. Plug-type valves
2. Poppet-type selector valve
3. Electric motor-operated sliding gate valve
4. Solenoid-operated poppet-type fuel shutoff valve
d. Fuel heaters

F. Module Six: Fuel Systems subcomponents, servicing and fuel quality systems

1. Learning Outcomes: upon successful completion of this module, the Student will:
   a. Identify, install and calibrate various types of fuel quantity measuring components.
   b. Inspect and correctly install fuel lines ensuring proper bonding.
   c. Inspect and service fuel jettisoning systems.
   d. Safely service aircraft using methods of refueling/defueling appropriate for the aircraft system.
   e. Identify different types of fuel contamination and take corrective action.
   f. Conduct logical fuel system troubleshooting using schematic diagrams, flow charts and service manuals.

2. Learning Activities:
   a. Successfully complete examination 2 covering material presented in this module. (F1,F5,F10)
   b. Complete projects: 4, 6, 7, and 9. (C18,F1,F5,F10)

3. Equipment and Materials:
   a. Sample fuel pumps, strainers, valves, and fuel quantity transmitters and indicators for identification purposes.
   b. Multimeters, fuel pressure gage with adapter fittings, fuel sampling containers, waste fuel receptacles
c. Serviceable or unserviceable air frame with functioning fuel system components.

d. Service manuals for the equipment stated above with fuel system schematics and diagrams.

e. Ground power unit to provide external power to the airframe or subsystems above.


a. Fuel system instruments
   1. Fuel quantity measuring systems
      a) Direct-reading fuel gage
      b) Electric resistance-type fuel quantity indicating system
      c) Capacitance-type electronic fuel quantity measuring system
      d) Drip gage and sight gage
   2. Fuel Flowmeters
      a) Flowmeters for large reciprocating engines
      b) Flowmeters for fuel-injected horizontally opposed reciprocating engines
      c) Flowmeters for turbine engines
   3. Computerized fuel system
   4. Fuel pressure warning system
   5. Fuel temperature indicators

b. Fuel system plumbing
   1. Fuel line routing
   2. Fuel line alignment
   3. Bonding
   4. Support of fuel system components

c. Fuel jettisoning system

d. Fueling and Defueling

e. Fuel system contamination control

f. Fuel system troubleshooting