CENTRAL TEXAS COLLEGE
AERM 2371
AIRCRAFT AIRFRAME COURSE-A

Semester Hours Credit: 3

INSTRUCTOR: _______________________
OFFICE HOURS: _______________________

I. INTRODUCTION


B. This is an optional 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 careers in the field of Aviation Maintenance.

D. Prerequisite: Successful completion of all required (G) general aviation maintenance courses or at least 18 months practical experience with the procedures, practices, materials, tools and equipment generally used in constructing, maintaining or altering airframes.

II. LEARNING OUTCOMES

Upon successful completion of this course, Aircraft Airframe Course, the student will:

A. Perform inspections, adjustments, repairs, services and troubleshooting procedures on airframe structures and airframe systems. (C18-C20,F1, F6,F10,)

August 1, 2008
B. Successfully complete the Federal Aviation Administration (FAA) Aviation Mechanic-Airframe examination. (F1-F5,F10)


II. INSTRUCTIONAL MATERIALS

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

B. Supplemental Reading: None


III. 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 examination on assigned reading material.

B. Projects: None

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 examination. 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.

IV. EXAMINATION
A. There will be five written examinations for this course covering all the lecture notes and reading material with a weight of 200 points each totaling 1000 points.

B. Practicum: None

V. SEMESTER GRADE COMPUTATION

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<thead>
<tr>
<th>EXAMINATION</th>
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<td>900-1000 = A</td>
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<td>EXAMINATION 5</td>
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TOTAL 1000

VI. 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 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 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.

VII. **COURSE OUTLINE**

A. **Module One: Basic Aerodynamics**

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

   a. Explain Fixed Wing Aerodynamic principles and define the dynamic forces acting on aircraft and control surfaces used to stabilize and change flight attitudes.

   b. Explain High-Speed Aerodynamics at subsonic, Transonic, and supersonic speeds.

   c. Explain complex aerodynamic principles associated with Rotor-Wing Aerodynamics and the function of helicopter flight controls.

2. **Learning Activities:**

   Complete examination 1 covering material presented in this module. (F1-F6,F10,F12)

3. **Equipment and Materials:**

   Static model aircraft to serve as a visual aid in explaining aerodynamic principles and flight attitudes.

4. **Module Outline One: Basic Fixed-Wing Aerodynamics**

   a. **Fixed-Wing Aerodynamics**

      1. **The Beginning of Flight**
      2. **Two Types of Lift**
         a) Aerostatic Lift
         b) Aerodynamic Lift
      3. **Properties of the Atmosphere**
         Standard Atmospheric Conditions
      4. **Bernoulli’s Principle**
      5. **Axes of an Aircraft**
      6. **Forces Acting on an Aircraft in Flight**
a) Thrust  
b) Lift  
c) Weight  
d) Drag  

b. Development of the Aerodynamic Forces  
1. Airfoil Sections  
2. Aerodynamic Lift  
3. Induced Drag  
4. Parasite Drag  

c. Flight at High-Lift Conditions  
1. Ground Effect  
2. Effect of High-Lift Devices  
3. Boundary Layer Control  
4. Vortex Generators  
5. Effect of Wing Planform  
6. Slots and Stall Strips  
7. Wing-Tip Vortices  

d. Stability Control  
1. Static Stability  
2. Dynamic Stability  
3. Longitudinal Stability  
4. Longitudinal Control: Rotation about the Lateral Axis  
5. Lateral Stability  
6. Lateral Control: Rotation about the Longitudinal Axis  
7. Turning Flight  
8. Directional stability  
9. Dutch Roll  
10. Directional Control: Rotation about the vertical axis  

e. Basic High-Speed Aerodynamics  
1. Compressibility  
   a) Compressible and Incompressible Flow  
   b) The Speed of Sound  
2. Flight Speed Ranges  
   a) Subsonic Flight  
   b) Transonic Flight  
      1) Effect of Sweepback  
      2) Forward-Swept Wing  
3. Supersonic Airflow  
   a) Normal Shock Waves  
   b) Oblique Shock Waves  
   c) Expansion Waves  

f. Basic Rotor-Wing Aerodynamics
1. Aerodynamic Principles
   a) Lift or Thrust
   b) Dissymmetry of Lift
   c) Torque
   d) Autorotation
   e) Retreating Blade Stall
   f) Ground Effect
   g) Translational Lift
   h) Gyroscopic Precession
   i) Transverse Flow Effect
   j) Coriolis Effect
   k) Settling With Power

g. Helicopter Flight Controls
   a) Collective Pitch Control
   b) Cyclic Pitch Control
   c) Horizontal Stabilizer
   d) Antitorque Pedals
   e) Stabilization System
      1) Stabilizer Bar
      2) Offset Flapping Hinge
      3) Electronic Stability Augmentation System

B. Module Two: Metallic aircraft structural methods

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

   a. Identify types of metallic aircraft structures.

   b. Examine stresses acting on aircraft structures.

   c. Examine nonferrous metals and heat treating methods.

   d. Examine ferrous metals and strength measuring methods.

2. Learning Activities:
   Successfully complete examination 1 covering material presented in this module. (F1-F6, F10)

3. Module Outline Two: Introduction to Metallic Aircraft Structures

   a. Identify types of metallic aircraft structures
      1. Monocoque structures
      2. Semimonocoque structures
      3. Reinforced Shell structures
b. Analyze stresses on aircraft structures
   1. Tension
   2. Compression
   3. Torsion
   4. Bending
   5. Shear

c. Examine nonferrous metals
   1. Aluminum alloys, designation and characteristics
   2. Heat treatable alloys
   3. Solution heat treatment
   4. Precipitation heat treatment
   5. Alloy numbers and Brinell hardness number
   6. Tensile strength of alloy and temper
   7. Annealing
   8. Nonheat-treatable alloys
   9. Corrosion protection of aluminum alloys
      a) Cladding
      b) Oxide film protection, anodizing and alodine
      c) Enamel or lacquer coating
   10. Magnesium alloys
   11. Titanium

d. Ferrous Metals
   1. Alloy steal and corrosion resistant steel
   2. Strength of metal structural materials
      a) Rockwell C-scale hardness numbers
      b) Tensile strength
      c) Bearing strength
      d) Shear strength

C. Module Three: Aircraft structural fasteners

1. Learning Outcomes: upon successful completion of this module, the Student will:
   a. Explain the installation of various types of aircraft structural fasteners.
   d. Explain the use of tools available for sheet metal assembly, repair and fabrication.
   c. Discuss the laying-out procedures used to form sheet metal before bends are made.
   d. Explain the installation or repair sheet metal with various rivets.
e. Inspect, remove and replace a defective or failed rivet.

2. **Learning Activities:**

   Successfully complete examination 1 covering material presented in this module. (F1,F5,F6,F10)

3. **Equipment and Materials:**

   a. Tools listing: Eye and hearing protection, compressed air source with multiple quick disconnect couplings and air hoses, complete sheet metal mechanics tool kits, Conic brake or leaf brake, box brake, Slip Roll former, Sandbags, Squaring sheer, throatless sheer, Scroll sheer, Band saw, Hack saw, Files, chisels and Compression Rivet Squeezer

   b. Expendable supplies: Rivets Universal, countersunk, round head, and flat head, assortment of blind rivets, sheet metal aluminum 2024 grade 0.025”, 0.032”, and 0.040” thick, sheet metal aluminum 6061 grade 0.025”, 0.032”, and 0.040” thick.

   c. For exhibit only: friction lock cherry rivets, mechanical lock cherry rivets, threaded rivets, high-strength pin rivets

4. **Module Outline Three: Aircraft structural fasteners**

   a. Identify solid rivets
      1. Universal, countersunk, round head, and flat head
      2. Head making identification
      3. Rivet dimensions
      4. Icebox rivets
   b. Identify special fasteners
      1. Friction lock cherry Rivets
      2. Mechanical lock cherry rivets
      3. Threaded rivets
      4. High-Strength pin rivets
   c. Identify tools for sheet metal assembly, fabrication and repair
   d. Identify layout tools
      1. Combination set
      2. Steal scale
      3. Dividers
   e. Marking Tools
      1. Guide lines for making on steal and aluminum
2. Punches, prick punch, center punch, transfer punch, and pin punch

f. Cutting Tools
   1. Squaring sheer
   2. Throatless sheer
   3. Scroll sheer
   4. Band saw
   5. Hack saw
   6. Files
   7. Chisels

g. Deburring Tools

h. Drills, numbers, letters, fractions and decimal equivalent
   1. Drill motors
   2. Special drills
   3. Special attachments

i. Forming Tools
   1. Conic brake or leaf brake
   2. Box brake
   3. Slip Roll Former
   4. Sandbag

j. Riveting Tools
   1. Rivet Gun
   2. Rivet Sets
   3. Bucking Bars
   4. Compression Rivet Squeezer

k. Sheet Metal Assembly Tools
   1. Cleco fasteners
   2. Whole finder
   3. Chip Chaser

l. Layout and Forming
   1. Grain of Metal
   2. Bend Radius
   3. Setback, Degree/K-Factor
   4. Bend Allowance, Thickness/Radius of Bend
   5. Flat Pattern Layout
      a) Sight Lines
      b) Bend tangent line
   6. Folding a Box
   7. Forming Small Compound Curves in the maintenance shop
   8. Flanging Lightening Holes
   9. Joggling
   10. Sheet-Metal Joints Using Solid Rivets
       a) Rivet selection
       b) Rivet Layout
c) Rivet Pitch
d) Transverse Pitch
e) Edge distance

m. Layout Practice
1. Find the strength needed by the joint
2. Select the rivet
3. Layout the rivet pattern

n. Hole preparation for protruding head rivets
1. Drilling the holes
2. Hole preparation
3. Countersinking
4. Dimpling, Dimple Radius and Coin Dimpling

o. Rivet Installation
1. Compression Riveting
2. Gun Riveting
   a) Correct rivet Set
   b) Hitting force adjustments
   c) Rivet installation and rivet set position
   d) Bucking bar selection and positioning
   e) Driving the Rivet
   f) Evaluate the Rivet
   g) Rivet Removal
   h) NACA method of flush riveting
   i) Team Riveting

D. Module Four: Structural repairs, gas and electric aircraft welding

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

b. Determine Damage Classification.

c. Explain repair of Cracks in Noncritical areas.

d. Explain repair procedures for stressed skin surfaces.

e. Discuss the process of fabricating a flush patch.

f. Explain stringer repair.

g. Explain the process of repairing pressure vessels, Floats and Seaplane Hulls.

h. Discuss the process of installing a section of aircraft skin.
i. Read Advisory Circular 43.13-1B and complete FAA form 337 Major Repair and Alteration (Airframe, Powerplant, Propeller, or Appliance) for repair approval.

j. Explain methods of gas and electric welding techniques.

2. **Learning Activities:**

   Successfully complete examination 1 covering material presented in this module. (C18,F1,F5,F10)

3. **Equipment and Materials:**

   a. Welding booths (Facilities must meet OSHA standards)

   b. Oxygen/Acetylene Gas welding equipment including gloves, helmet or goggles, and jackets

   c. Electrical welding equipment: Shielded Metal Arc Welder (SMAW), Gas Metal Arc Welding (GMAW), Gas Tungsten Arc Welding (GTAW) or Tungsten Inert Gas Welding (TIG) and Spot Welding equipment.

   d. Consumable materials: Metal filler rod for each type of welding equipment, Flux for brazing, Steal and Aluminum plates for practice welds.

   e. Tools listing: Eye and hearing protection, compressed air source with multiple quick disconnect couplings and air hoses, and complete sheet metal mechanics tool kits

   f. Expendable supplies: Rivets Universal, countersunk, round head, and flat head, assortment of blind rivets, sheet metal aluminum 2024 grade 0.025”, 0.032”, and 0.040” thick, sheet metal aluminum 6061 grade 0.025”, 0.032”, and 0.040” thick and sealing compound for pressurized vessel repairs.

4. **Module Outline Four:** Structural repairs, gas and electric aircraft welding

   a. Repair of Sheet Metal Structure
      1. Appraisal of Damage
      2. Classification of Damage
3. Repair of Cracks in Noncritical Areas
4. Surface Patch for stressed skin
5. Flush Patch
6. Stringer Repair
7. Repairs to Pressure Vessels
8. Repairs to Floats and Seaplane Hulls
9. Aircraft Skin section replacement
10. Approval of the Repair

b. Aircraft Welding
1. Gas Welding
   a) Fuel Gases
   b) Gas storage cylinders
   c) Pressure Regulators
   d) Oxygen Regulator
   e) Acetylene Regulator
   f) Hoses
   g) Torches types and tips, lighters and goggles
   h) Filler Rod
   i) Equipment set-up, safety, adjustments and shutdown

c. Gas Welding Techniques
1. Holding the Torch, forehand and backhand methods
2. Welding Positions, flat, horizontal, vertical, and overhead

d. Control of Expansion and Contraction

e. Good Weld Characteristics

f. Oxyacetylene Cutting

g. Gas welding of Aluminum

h. Brazing

i. Soldering
   1. Silver Soldering
   2. Soft Soldering

j. Electric Welding
   1) Arc Welding
   2) Shielded Metal Arc Welding
      a) Gas Shielded Arc Welding, MIG
      b) Gas Tungsten Arc Welding
         (1) Shielding Gases
         (2) Regulator and Flowmeter
         (3) Power Unit, reverse polarity welding and straight polarity welding
   3) Hand Held Torches
      a) Electrodes
      b) Welding Techniques and Procedures
      c) Inspection of the weld
4) Electrical Resistance Welding
   a) Spot Welding
   b) Seam Welding
5) Repair of Aircraft Structure by Welding
   a) Specific Weld Repairs and FAA Approval
   b) Welded patch Repair
   c) Longeron Dented at a Cluster
   d) Tubing Spliced by the Inner-Sleeve Method
   e) Tubing Spliced by the Outer-Sleeve Method

E. Module Five: Wood structures and fabric covering

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
   a. Examine and identify types of wood used in aircraft structures and perform repairs.
   b. Identify and apply different types of glue used in aircraft wood structures.
   c. Identify, select and apply different types of fabric covering material.
   d. Test, analyze, inspect and perform repairs on fabric covered aircraft structures using various methods and systems.

2. **Learning Activities:**

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

3. **Equipment and Materials:**
   a. Selection of aircraft grade woods and aircraft plywood
   b. Powered wood planner, jointer, fine toothed saws, rulers, pencils, safety goggles, adjustable compressed air source with moisture removal system, air spray gun, disposable gloves, dust masks, and respirator system.
   c. Fabric sewing materials, 320-400 and 600 grit wet/dry sandpaper, reinforcing and surface tape, fabric covering material, distilled water, nitrate and butyrate dope, thinner
for each type of dope, animal bristle brushes, iron capable of 200-400 °F, plastic resin or resorcinol glue, mock-up off wing or control surface to apply fabric covering, MSDS sheets.


a. Aircraft Wood Structures
   1. Types of wood
   2. Evaluating wood for aircraft use
b. Glues and Gluing
   1. Types of Glue
   2. Surface Preparation for Gluing
   3. Proper Gluing Procedures
c. Construction and Repair of Wood Structures
   1. Wing Spar Repair
   2. Rib Repairs
   3. Repair to Damaged Plywood Aircraft Structures
d. Aircraft Fabric Covering Systems
   1. Organic Fabrics
   2. Inorganic Fabrics
   3. Covering Systems Approval
      a) Original Equipment Manufacturer
      b) Supplemental Type Certificates
      c) FAA Field Approval
e. Aircraft Re-Covering
   1. Determining the need to Re-Cover
   2. Fabric Testing
   3. Preparation for Re-Covering
      a) Fabric removal
      b) Inspect the Structure
      c) Prepare the Structure
      d) Re-Covering
   4. Cotton Fabric Covering
      a) Textiles
      b) Chemicals
      c) Installing the Fabric
   5. Removing Wrinkles
   6. The First Coat of Dope
   7. Attaching the Fabric
   8. Drain Grommets and Inspection Rings
   9. Application of the Finish System
  10. Inorganic Fabric Covering Systems
  11. Poly-Fiber System
      a) Materials used
      b) Installing and shrinking the fabric
c) Attaching the fabric
d) Application of Surface Tape and Hole Reinforcements
e) The Finish

12. Superflite System
   a) Superflite System I
   b) Superflite System II

13. The Ceconite 7600 System
   a) Materials used
   b) Installing the Fabric
   c) Shrinking the Fabric
   d) Attaching the Fabric
   e) The Finish

14. Repair of Aircraft Fabric
   a) Tear in the Fabric
   b) Dope-on Patch

F. Module Six: Aircraft Painting and Finishing

1. Learning Outcomes: upon successful completion of this module, the Student will:
   a. Demonstrate paint removal, surface preparation and corrosion treatment methods.
   b. Apply finishing systems.
   c. Select and apply fabric finishing systems.
   d. Apply paint and dope.
   e. Practice safety measures and employ safety equipment associated with the application of finishing system equipment.

2. Learning Activities:

   Successfully complete examination 1 covering material presented in this module. (C18,F1,F5,F10)

3. Equipment and Materials:

   a. safety goggles, adjustable compressed air source with moisture removal system and multiple outlets, paint spray guns, disposable gloves, dust masks, and respirator system.
b. Plastic media blasting equipment, or chemical paint removers; (choose the method most acceptable or practical to your location after considering local EPA requirements)

c. Primers, Alodine, zinc chromate, finishing system (paint) and thinning solvents compatible with paint used, and MSDS sheets; 400 and 600 grit wet/dry sand paper, masking tape, and craft paper

4. Module Outline Six: Aircraft painting and finishing

a. Metal Finishing
   1. Paint Removal
      a) Chemical Stripping
      b) Dry Stripping

b. Preparation for Painting
   1. Corrosion Detection
   2. Conversion Coating
   3. Primers
      a) Zinc Chromate
      b) Wash Primer
      c) Epoxy Primer

c. Finishing Systems
   1. Acrylic Lacquer
   2. Synthetic Enamel
   3. Polyurethane

d. Fabric Finishing
   1. Organic Fabric Finishes
      a) The Fill coat
      b) The Ultraviolet-Blocking Coat
      c) The Finish Coat
   2. Inorganic Fabric Finishes
      a) Finish Problems
      b) Poor Adhesion
      c) Blushing
      d) Pinholes
      e) Orange Peel
      f) Fisheyes
      g) Runs and Sags
      h) Dope Roping
      i) Ringworms and Rejuvenation

e. Paint and Dope Application
   1. Finishing Equipment
      a) Spray Area
      b) Air Supply
      c) Spray Equipment
1) Air-Atomized Spray Equipment

2. Safety Equipment
   a) Fire Safety
   b) Respiratory Systems
   c) Toxicity Safety

3. Application of the finish
   a) Spraying on the Finish
   b) Adjusting the Spray Pattern
   c) Sequence of Painting

4. Paint Gun Problems
   a) Distorted Spray Pattern
   b) Spray Gun Spitting
   c) Cleaning the Spray Equipment

5. Application of Trim and Registration Numbers

G. Module Seven: Composite structures and transparent plastics

1. Learning Outcomes: upon successful completion of this module, the Student will:
   a. Differentiate between the types of composite materials and apply these materials in repairs.
   b. Explain types of manufacturing methods of fabricating composite structures.
   c. Install, repair, and manipulate transparent plastics.

2. Learning Activities:

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

3. Equipment and Materials:
   a. Samples of fiberglass, Kevlar and graphite and hybrid cloth.
   b. Disposable gloves (recommend protective hand gel), respirators, fiberglass cloth, resin (either polyester or epoxy), 320, 400 and 600 grit wet/dry sandpaper, Micro-Mesh polishing kit, MSDS sheets for all hazardous materials.
c. Vacuum bag system with perforated parting film, bleeder material, sealing tape, vacuum bag, vacuum line and vacuum gage and pump.

d. Transparent acrylic plastics 0.125” thick, acrylic cement (methylene chloride or ethylene dichloride)

4. **Module Outline Seven:** Composite structures and transparent plastics

a. Composite Structures
1. Composite Materials
   a) Reinforcing Materials
   b) Fiberglass
   c) Kevlar
   d) Graphite
   e) Hybrids
      1) Fiber Orientation
         (a) Unidirectional Fabric
         (b) Bidirectional Fabric

2. Matrix Materials
   a) Polyester Resins
   b) Epoxy Resins

3. Preimpregnated Materials

4. Adhesives

5. Core Materials
   a) Foam
   b) Honeycomb
   c) Fillers

6. Manufacturing Methods
   1. Matched Dies
   2. Vacuum Bag
   3. Autoclaves
   4. Filament winding

7. Composite Structure Inspection and Repair
   a) Inspection
   b) Repair
      1) Room-Temperature Cure
      2) Hot-Bond Repair

Curing the Repair

8. Cutting and Sanding Composite Materials

9. Safety around composites
   a) Skin Care
   b) Eye Care
   c) Respiratory Care

b. Transparent Plastics
1. Storing and Handling Transparent Plastic Materials
2. Working with Transparent Plastic Materials
   a) Cutting
   b) Drilling
   c) Forming Acrylic Plastics
   d) Cementing Transparent Plastic Materials
   e) Curing Transparent Plastic Materials
3. Cleaning Transparent Plastic Materials
   Polishing and Protecting
4. Installing Plastic Windshields and Windows
5. Repairing Transparent Plastic Materials
   a) Crazing
   b) Holes
   c) Cracks

H. Module Eight: Assembly and Rigging
1. Learning Outcomes: upon successful completion of this module, the Student will:
   a. Distinguish between the different primary and secondary flight control functions and rig airplane flight controls according to manufacture procedures and adjust cable tension, check travel limitations for correctness.
   b. Assemble, align and level aircraft empennages.
   c. Install and rig helicopter flight control components following manufacture instructions.

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

3. Equipment and Materials:
   a. Airframe with functional flight control systems.
   b. Control Surface Balancing Fixture, Tensiometer, Control Surface Protractor, Propeller Protractor, rigging pins and service manual for above airframe.
   c. General mechanic hand tools

4. Module Outline Eight: Assembly and Rigging
a. Airplane Controls
   1. Airplane Primary Flight Controls
      a) Controls for Roll
         1) Ailerons
         2) Elevons
      b) Controls for Pitch
         1) Elevator
         2) Stabilator
         3) Ruddervator
         4) Canard
      c) Controls for Yaw
   b. Airplane Secondary Flight Controls
      1. Surfaces that Modify the Lift
         a) Flaps
            1) Plain Flaps
            2) Split Flaps
            3) Slotted Flaps
            4) Fowler Flaps
            5) Triple-Slotted Flaps
            6) Leading Edge Flaps
         b) Slats
         c) Spoilers
      2. Devices that Change the Operating Forces
         a) Balance surfaces
         b) Tabs
            1) Trim Tabs
            2) Balance Tabs
            3) Servo Tabs
            4) Spring Tabs
            5) Antiservo Tabs
         c) Adjustable Stabilizer
            1) Balance Panel
            2) Bungee Spring
            3) Elevator Downspring
         d) Control System Operating Methods
            1) Cable Operated Systems
               (a) Control Cables
               (b) Fairleads and Pulleys
            2) Push-Pull Rod Systems
               Rod-End Fittings
            3) Torque Tube Systems
            4) Fly-by-Wire Systems
            5) Fly-By-Light Systems
e) Control Actuation Systems for Large Airplanes
   1) Roll Control
   2) Pitch Control
   3) Yaw Control
   4) Wing Flaps

c. Airplane Assembly and Rigging
   1. Airplane Assembly
      a) Installing the Wings and Landing Gear
      b) Leveling the Airplane
      c) Aligning the Wings
         1) Dihedral
         2) Angle of Incidence
         3) Wash in and Wash Out
      d) Installing and Aligning the Empennage
      e) Symmetry Check
      f) Control Surface Installation and Rigging
         1) Control Surface Balancing
         2) Rigging the Ailerons
            (a) Adjusting Cable Tension
            (b) Checking Control Travel
            (c) Checking and Safeguarding the System
         3) Rigging the Elevator
         4) Rigging the Rudder
         5) Control Movement Check

d. Helicopter Assembly and Rigging
   1. Helicopter Controls
      a) The Swashplate
      b) The Collective Pitch Control
      c) The Cyclic Pitch Control
      d) Horizontal Stabilizers
      e) Torque Compensation
      f) Stabilizer Systems
   2. Rotor System
      a) Fully articulated Rotor
      b) Semirigid Rotor
      c) Rigid Rotor
   3. Helicopter Powerplants
      a) Reciprocating Engines
      b) Turbine Engines
      c) Transmission
      d) Clutch
      e) Freewheeling Unit
      f) Helicopter Vibrations
I. **Module Nine: 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 2 covering material presented in this module. (F1-F6,F10)

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 Nine: 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
      c) Automatic unloading valve system
      d) Open-Center system
   6. Power pack system

J. Module Ten: 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:

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

**K. Module Eleven:** 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 2 covering material presented in this module. (F1,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 above.

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 Eleven: 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

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

L. Module Twelve: Aircraft Landing Gear Systems

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

   a. Service, repair and adjust landing gear systems.

   b. Test, service and repair landing gear retraction systems.

   c. Inspect, service and repair aircraft brake systems.

   d. Inspect, and service aircraft wheels.

   e. Inspect aircraft tires and tubes for serviceability and service tires according to service manual requirements.
2. **Learning Activities:**

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

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

   c. Pressure bleeding pot, wheel alignment straightedge, carpenter square, air or nitrogen tire servicing kit, exerciser jack (wheel jack), bubble protractor, dye penetrant kit, 4x6x10 magnifying glass and a tire cage.

   d. Safety goggles, disposable gloves, basic hand tools, shop rags, cleaning solvent (varsol or naphtha), soft bristle brushes, bearing grease and slippage marking paint.

4. **Module Outline Twelve:** Aircraft Landing Gear Systems

   a. Landing gear types
      1. Operating from water
      2. Operating from snow and ice
      3. Operating from hard surfaces

   b. Shock Absorbers
      1. Servicing Oleo shock struts
      2. Nonshock-Absorbing landing gear
      3. Wheel alignment
         a) Toe-In or Toe-Out
         b) Camber
         c) Wheel alignment for spring steel landing gears
         d) Wheel alignment for landing gears with Oleo Struts
      4. Ground steering with a Tail Wheel
      5. Ground steering with a Nose Wheel
      6. Shimmy dampers

   c. Landing gear retraction systems
      1. Power pack system
a) Lowering the landing gear
b) Raising the landing gear

2. Typical landing gear retraction system
   Emergency extension of the landing gear

d. Aircraft Brakes
1. Brake actuating units
   a) Energizing brakes
   b) Nonenergizing brakes
      1) Expander tube brakes
      2) Single-Disk brakes
      3) Dual-Disk brakes
      4) Multiple-Disk brakes
         a) Thin-Disk Multiple-Disk brakes
         b) Segmented-Rotor Multi-Disk brakes
         c) Carbon Disk brakes

2. Brake actuation systems
   a) Independent brake master cylinders
   b) Boosted brakes
   c) Power brakes
      1) System Operation
      2) Power brake control valves
   d) Antiskid system
      1) Antiskid system components
         a) Wheel-Speed sensors
         b) Antiskid control valves
         c) Antiskid control box
      2) System tests
         a) Preflight test
         b) Prelanding check
         c) Disabling the system
         d) Maintenance checks
      3) Wheel-Speed sensors
      4) Control Box
      5) Anti-skid control valve
   e) Deboosters
   f) Emergency brake system
   g) Dual power brake actuating system
   h) Auto brake system
   i) Brake maintenance
      1) Installation of the brake on the aircraft
      2) Bleeding the brakes
         a) Gravity bleeding
(b) Pressure bleeding

e. Aircraft wheels
   1. Wheel nomenclature
      a) Inboard wheel half
      b) Outboard wheel half
      c) Bead seat area
   2. Wheel maintenance
      a) Wheel removal
      b) Tire removal
      c) Wheel inspection
   3. Bearing maintenance
   4. Tire installation
   5. Wheel installation

f. Aircraft tires and tubes
   1. Evolution of aircraft tires
   2. Tire construction
      a) The bead
      b) The carcass
      c) The tread
      d) The sidewall
      e) The inner liner
   3. Tire inspection
      a) Inflation
      b) Tread condition
      c) Sidewall condition
   4. Tire maintenance
      a) Inspection
      b) Retreading
      c) Storage
      d) Mounting
         (1) Tubeless tires
         (2) Tube-Type tires
      e) Balancing
   5. Aircraft Tubes
   6. A summary of aircraft tires

M. Module Thirteen: An introduction to aircraft electrical systems

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

   a. Describe aircraft electrical systems including a review of terms, general knowledge of electrical components, direct current power sources.
b. Identify series, parallel and complex circuits.

c. Discuss aircraft power circuits in detail, including battery, DC alternator, DC generator circuits, and turbine engine starter generators.

2. Learning Activities:

Successfully complete examination 3 covering material presented in this module. (F1,F5,F10)

3. Equipment and Materials:

a. Multimeters

b. Soldiering pens (27-40 watt), solder, electrical soldiering paste, wire striping pliers, de-soldering braid and safety goggles.

c. Assortment of electrical components: resistors, capacitors, diodes, transistors, SCRs, TRIACs, transformers, relays, circuit breakers and circuit boards

d. Variable DC power supply and bread board

4. Module Outline Thirteen: Introduction to aircraft electrical systems

a. Electrical system requirements.

b. Electrical terms.

c. Direct current and alternating current flow.

d. Electrical system components.

e. DC power sources, electrical load, basic electrical circuits

f. Study circuit control devices, switches, semiconductor components, relays, solenoids, and bipolar transistors.

g. Series, parallel and complex circuits.

h. Battery powered circuits, protection devices and induced current protection

i. Ground power circuit design and function

j. Power generating systems

k. Direct current alternator circuits

l. Twin engine alternator systems using a shared voltage regulator

m. Twin engine alternator systems using individual voltage regulators

n. Direct current generator circuits
N. Module Fourteen: Aircraft electrical load circuits and large aircraft electrical power systems

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

   a. Describe starter circuits, navigation, landing and taxi lighting systems.
   b. Identify landing gear actuation, indicating circuits and antiskid brake systems.
   c. Identify propeller deicing systems, turbine engine auto ignition circuits, reciprocating engine starting and ignition circuits.
   d. Describe split-bus circuits for avionics protection.

2. Learning Activities:

   Successfully complete examination 3 covering material presented in this module. (F1,F5,F10)

3. Equipment and Materials:

   a. Sample electrical schematic diagrams of electrical subsystems discussed in this lesson.
   b. Oscilloscope, continuity lights, Multimeters, clamp on ammeters.
   c. Serviceable or unserviceable Air frame with electrical systems or subsystems accessible for hands on applications.
   d. Service manuals for the equipment stated above.
   e. Ground power unit to provide external power to the airframe or subsystems above.
4. **Module Outline Fourteen**: Aircraft Electrical Load Circuits

   a. Engine starter circuits  
   b. Navigation light circuits  
   c. Landing and taxi light circuits  
   d. Landing gear actuation and indicating circuits  
   e. Antiskid brake systems  
   f. Electrical propeller deicing systems  
   g. Turbine engine auto ignition circuits  
   h. Reciprocating engine starting and ignition circuits  
   i. Split-bus circuits for avionics protection  
   j. Large aircraft electrical power systems auxiliary power units

O. **Lesson Fifteen**: Electrical system installation, troubleshooting, flowcharts and electrical component schematic symbols

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

   a. Select correct wire gage for a given amperage and distance required for typical electrical component installation.

   b. Install wire terminals, splices; quick disconnect connectors, junction boxes, switches and circuit control devices.

   c. Apply wire bundle number codes to wire harnesses

   d. Perform systematic troubleshooting procedures

   e. Identify electrical components in schematic diagrams by electronic symbols.

2. **Learning Activities**:

   Successfully complete examination 3 covering material presented in this module. (F1,F5,F10)

3. **Equipment and Materials**:

   a. Sample electrical schematic diagrams of electrical subsystems discussed in this lesson.
b. Serviceable or unserviceable Air frame with electrical systems or subsystems accessible for hands on applications; service manuals for the equipment stated above.

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

d. Multimeters, wire strippers, wire splices, wire, assorted connectors, pin insert and removal tools, crimping tools and wire terminals.

4. Module Outline Fifteen: Electrical system installation, troubleshooting, flowchart and schematic diagram reading
   a. Aircraft electrical system installation
   b. Electrical wire
   c. Selection of wire size
   d. Special types of wire
   e. Terminals and connectors installation
      1. Quick-Disconnect connectors
      2. Terminal strips
      3. Wire terminals
      4. Wire splices
   f. Wire identification
   g. Wire bundling
   h. Junction boxes
   i. Wire installation
   j. Circuit control and protection devices
      1. Switches
      2. Fuses and circuit breakers
   k. Rules for systematic troubleshooting
   l. An example of systematic troubleshooting
   m. Troubleshooting review
   n. Logic flowcharts for troubleshooting
   o. Troubleshooting tools:
      1. Continuity lights
      2. Analog multi-meters
      3. Digital multi-meters
      4. Clamp-on-ammeters
      5. Oscilloscopes
   p. Electronic symbols

P. Module Sixteen: 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:

   Successfully complete examination 3 covering material presented in this module. (F1,F5,F10)

3. Equipment and Materials:

   a. Multimeters, general hand tools
   
   b. Goggles, fuel proof gloves, explosion proof flashlights
   
   c. Safety wire, samples of each grade of aviation gasoline and jet/turbine engine “Jet-A”

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

   a. Aircraft fuels 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

Q. Module Seventeen: 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 3 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 Seventeen:** 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

R. **Module Eighteen:** Fuel Systems subcomponents, servicing and fuel quality

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

   a. Identify and install various types of fuel quantity measuring components and adjust them.

   b. Inspect and correctly install fuel lines ensuring proper bonding.

   c. Inspect and service fuel jettisoning systems.

   d. Safely service aircraft using methods of fueling/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:**

   Successfully complete examination 3 covering material presented in this module. (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 Airframe 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.

4. **Module Outline Eighteen**: Fuel Systems subcomponents, servicing and fuel quality

   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

   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  

S. **Module Nineteen:** Cabin Atmosphere Control and Oxygen Systems  

1. **Learning Outcomes:** Upon successful completion of this module, the Student will:  
   a. Identify human needs at various altitudes.  
   b. Identify physics of cabin atmosphere control in relation to heat and pressure.  
   c. Service and maintain aircraft oxygen systems.  
   d. Service and maintain aircraft cabin pressurization systems.  
   e. Service and maintain aircraft heaters and cooling systems.  

2. **Learning Activities:**  
   Successfully complete examination 4 covering material presented in this module. (F1,F5,F6)  

3. **Equipment and Materials:**  
   a. Airframe with serviceable oxygen and pressurization system  
   b. Oxygen servicing cart  

4. **Module Outline Nineteen:** Human needs in flight, cabin atmosphere control, and Oxygen systems  
   a. Human Needs in Flight  
      1. Pressure  
      2. Temperature  
      3. Humidity  
      4. Air Movement  
      5. The Atmosphere  
         a) Standard Conditions  
         b) The Characteristics of Oxygen  
            1) Oxygen Partial Pressure  
            2) The Function of Oxygen
c) The function of Carbon Dioxide  
d) The Threat of Carbon Monoxide

b. The Physics of Cabin Atmosphere Control
   1. Heat
      a) Units of Heat  
b) Types of Heat  
c) Movement of Heat  
   2. Temperature  
   3. Pressure
      Units of Pressure

c. Aircraft Supplemental Oxygen Systems
   1. Types of Oxygen Supply  
a) Gaseous Oxygen  
b) Liquid Oxygen  
c) Chemical Oxygen Candle  
d) Mechanically Separated Oxygen
   2. Two Types of Oxygen Systems
      a) Continuous-Flow Oxygen System  
         1) Continuous-flow Regulators  
         2) Continuous-Flow Masks  
      b) Demand-Type Oxygen Systems  
         1) Diluter-Demand-Type Regulator  
         2) Pressure-Demand Oxygen Regulator  
      c) Gaseous Oxygen Cylinders  
      d) Oxygen System Servicing  
         1) Oxygen System Filling  
         2) Purging  
         3) Leak Checking  
         4) System Discharge Indication  
         5) Special Precautions
    Fire Safety

T. Module Twenty: Aircraft Pressurization Systems, Heaters and Cooling Systems

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

   a. Describe aircraft Pressurization Systems and troubleshoot and identify faulty components.

   b. Identify and repair Exhaust and Combustion Heaters.
c. Identify and explain the operational process of different types of aircraft cooling systems and service and repair these systems.

2. **Learning Activities:**

   Successfully complete examination 4 covering material presented in this module. (C18,F1,F5,F10)

3. **Equipment and Materials:**

   a. Airframe with Pressurization, Heating and Refrigerant type cooling system

   b. Air conditioning charging stand and manifold gage set

   (Personnel operating this equipment must be certified to handle R-12 refrigerants if this refrigerant is used. Check local regulations regarding certification requirements)

   c. An electric oscillator-type refrigerant leak detector

4. **Module Outline Twenty: Aircraft Pressurization, Heating and Cooling Systems**

   a. Aircraft Pressurization Systems

   1. Principles of Pressurization

      Sources of Pressurization Air

      1) Reciprocating-Engine-Powered Aircraft

      2) Turbine-Engine-Powered Aircraft

   2. Modes of Pressurization

      a) The Unpressurized Mode

      b) The IsoBaric Mode

      c) The Constant-Differential Mode

   3. Pressurization Controls

   4. Pressurization Instruments

   5. Cabin Air Pressure Regulator

      a) IsoBaric Control

      b) Differential Control

      c) Cabin Rate of Climb

   6. Negative-Pressure Relief Valve

   7. Cabin Air Pressure Safety Valve

   8. Augmented Airflow

   b. Aircraft Heaters

   1. Exhaust System Heaters
2. Combustion Heaters

c. Aircraft Cooling Systems

1. Air-Cycle Cooling System
   Temperature Control

2. Vapor-Cycle Cooling System
   a) The Compressor
      1) The Compressor Drive System
   b) The Condenser
   c) The Receiver-Dryer
   d) Thermostatic Expansion Valves
   e) The Evaporator
   f) Service Valves

3. Air Conditioning System Servicing Equipment
   a) The Manifold Gage Set
   b) Charging Stand
   c) Vacuum Pumps
   d) Leak Detectors
   e) Refrigerant-12
   f) Refrigeration Oil

4. Air Conditioning System Checks
   a) Visual Inspection
   b) Operational Check

5. Air Conditioning System Servicing
   a) Discharging the System
   b) Replacing System Components
   c) Checking Compressor Oil
   d) Flushing the System
   e) Evacuating the System
   f) Charging the System

U. Module Twenty One: Aircraft Instruments

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

   Describe different classifications and purpose of aircraft instruments.

2. Learning Activities:

   Successfully complete examination 5 covering material presented in this module. (F1,F5,F10)

3. Equipment and Materials:
a. Static system checker

b. Airframe with operational static system

4. Module Outline Twenty One: An Overview of Aircraft Instruments

Classification of Aircraft Instruments

1. Principles of Pressurization

2. Pressure Measuring Instruments
   a) Absolute Pressure Instruments
   b) Gage Pressure Instruments
   c) Differential Pressure Instruments

3. Temperature Measuring Instruments
   a) Nonelectrical Temperature Measurements
   b) Electrical Temperature Measurements
      1) Resistance-Change Instruments
         (a) Wheatstone Bridge Circuits
         (b) Ratiometer Circuits
      2) Thermocouple Instruments

4. Mechanical Movement Measuring Instruments
   a) Position-Indicating Lights
   b) Synchro-Systems
      1) DC Selsyn System
      2) AC Magnesyn System
      3) AC Autosyn System
   c) Tachometers
      1) Mechanical Tachometer
      2) Electric Tachometer
   d) Synchrosopes
   e) Accelerometers
   f) Angle of Attack Indicating Systems

5. Direction-Indicating Instruments
   a) Compass Errors
      1) Variation
      2) Deviation
      3) Dip Errors
   b) Vertical-Card Magnetic Compass
   c) Flux Gate Compass System

6. Gyroscopic Instruments
   a) Attitude Indicator
   b) Heading Indicator

7. Rate Gyros
   a) Turn and Slip Indicator
   b) Turn Coordinator
V. Module Twenty Two: Aircraft Instrument Systems, Aural Warning Systems and Instrument Installation and Maintenance

1. Learning Outcomes: Upon successful completion of this module, the Student will:
   a. Describe different instruments associated with aircraft instrument systems.
   b. Describe automatic flight control systems.
   c. Describe aural warning systems.
   d. Demonstrate properly handling, mark, install and testing of aircraft instruments.

2. Learning Activities:
   Successfully complete examination 5 covering material presented in this module. (F1,F5,F10)

3. Equipment and Materials:
   a. Static system checker
   b. Airframe with operational static system

   a. Aircraft Instrument Systems
      1. Pitot-Static Systems
         a) Airspeed Indicators
            1) True Airspeed Indicator
            2) Maximum-Allowable Airspeed Indicator
         b) Machmeter
         c) Altimeters
            Encoding
         d) Vertical-Speed Indicators
            Instantaneous Vertical-Speed Indicator
      2. Gyro Instrument Power Systems
         Gyro Pneumatic Systems
         1) Suction Systems
            (a) Wet Vacuum Pump System
(b) Dry Air Pump Systems

2) Pressure Systems

3. Automatic Flight Control Systems
   a) Command Subsystem
   b) Error-Sensing Subsystem
   c) Correction Subsystem
   d) Follow-Up Subsystem
   e) Flight Director Indicator and Horizontal Situation Indicator

b. Aural Warning Systems
c. Instrument Installation and Maintenance
   1. Instrument Range Marking
   2. Instrument Installation
   3. Instrument Maintenance
   4. Static System Leak Checks
   5. Instrument Handling

W. Module Twenty Three: Aircraft Communication and Navigation Systems

1. Learning Outcomes: Upon successful completion of this module, the Student will:
   a. Explain basic radio theory for AM, FM, SSB modulation, radio waves and antenna.
   b. Describe aircraft interphone systems.
   c. Explain the different types of aircraft navigation equipment utilized to determine direction, distance, position and weather mapping systems.
   d. Point out the electronic instrument systems used on aircraft which aid crew in the performance of their system management duties.
   e. Perform electronic system installation and maintenance.

2. Learning Activities:
   Successfully complete examination 5 covering material presented in this module. (F1,F5,F10)

3. Equipment and Materials:
a. Soldering iron pencil type (20-40 watt), 60/40 solder, electrical soldering paste, wire stripper, general mechanic hand tools

b. Airframe with communication and navigational equipment properly installed.

4. **Module Outline Twenty Three: Communication and Navigation Systems**

a. Communication Systems
   
   1. Basic Radio Theory
      
      a) Modulation
         1) Amplitude Modulation (AM)
         2) Frequency Modulation (FM)
         3) Single-Sideband (SSB)
      
      b) Radio Waves
         1) Polarization
         2) Wavelength
         3) Frequency Allocation
         4) Radio Wave Propagation
      
      c) Antenna
         1) Transmission Lines
         2) Communication Radio Antenna
      
      d) Aircraft Communication Addressing and Reporting System (ACARS)
      
      e) Selective Calling (SELCAL)
      
      f) Audio Integrating System (AIS)
         1) Flight Interphone
         2) Cabin Interphone
         3) Service Interphone
         4) Passenger Address
         5) Passenger Entertainment
         6) Ground Crew Call
         7) Cockpit Voice Recorder
         8) Emergency Locator Transmitter (ELT)
      
   b. Electronic Navigation Systems
      
      1. Automatic Direction Finder (ADF)
      
      2. Very High Frequency Omnidirectional Range Navigation System (VOR)
         Radio Magnetic Indicator (RMI)
      
      3. Instrument Landing System
         a) Compass Locators
         b) Localizer
         c) Marker Beacons
d) Glide Slope
4. Radar Beacon Transponder
   Transponder Checks
5. Distance Measuring Equipment (DME)
6. Area Navigation (RNAV)
7. LORAN
8. Inertial Navigation System (INS)
9. Microwave Landing System (MLS)
10. Radar and Radio Altimeters
11. Ground Proximity Warning System (GPWS)
12. Traffic Alert Collision Avoidance System (TCAS)
13. Radar
   a) Doppler Navigation Radar
   b) Weather Radar
14. Stormscope Weather Mapping System
c. Electronic Instrument Systems
1. Microcomputers
2. Digital Indicating and Control Systems
   a) Electronic Flight Instrument Systems (EFIS)
   b) Engine Indicating and Crew Alerting System (EICAS)
   c) Electronic Centralized Aircraft Monitor System (ECAM)
3. Air Data Computer
4. Flight Management Computer System (FMCS)
d. Electronic Systems Installation and Maintenance
1. Approval for the Installation of Electronic Equipment
2. Electrical Considerations
   a) Load Limits
   b) Circuit Protection
   c) Wiring
      1) Bundling and Routing
      2) Transmission Lines
3. Protection from Electrostatic Discharge and Damage
4. Weight and Balance
5. Cooling
6. Shock Mounting
7. Static Protection
8. Antenna Installation
   a) Types of Antenna
      1) VHF Communication
      2) HF Communication
Module Twenty Four: Ice Control and Rain Removal Systems

1. **Learning Outcomes:** Upon successful completion of this module, the student will:
   a. Explain the dangers of In-Flight Icing.
   b. Describe different types of aircraft Ice Control Systems for all systems.
   c. Explain Ground Deicing and Anti-Icing methods.

2. **Learning Activities:**
   
   Successfully complete examination 5 covering material presented in this module. (F1,F5,F10)

3. **Equipment and Materials:**
   a. Multimeters, general mechanic hand tools
   b. Airframe with ice and rain removal systems
   c. Service manuals for the above airframe

4. **Module Outline Twenty Four:** Ice Control and Rain Removal Systems

   a. Ice Control Systems
   1. Basic Radio Theory
      a) Dangers of In-Flight Icing
      b) Types of Ice Control Systems
         1) Ice Detection Systems
         2) Anti-Icing Systems
         3) Deicing Systems
      c) Pitot-Static Systems Ice Protection
d) Windshield Ice Protection
e) Airfoil Ice Protection
  1) Pneumatic Deicer System
     (a) Single-Engine Airplane Deicing System
     (b) Multi-Engine Airplane Deicing System
  2) Thermal Ice Control Systems

2. Brake Deice Systems
3. Powerplant Ice Protection
   a) Reciprocating Engines
   b) Turbine Engines
   c) Propellers

4. Water Drain System Ice Protection
5. Ground Deicing and Anti-Icing
   b. Rain Removal Systems

Y. Module Twenty Five: Fire Protection Systems

1. Learning Outcomes: Upon successful completion of this module, the Student will:
   a. Describe the different types of Smoke and Fire Detection Systems used on aircraft.
   b. Describe the different types of hand-held and installed fire extinguishing systems.
   c. Perform maintenance and services on fire detection and extinguishing systems.

2. Learning Activities:

   Successfully complete examination 5 covering material presented in this module. (F1,F5,F10)

3. Equipment and Materials:
   a. Multimeters and general mechanic hand tools
   b. Airframe with fire protection system
   c. Service manuals for the above airframe

4. Module Outline Twenty Five: Fire Protection Systems
a. Fire Protection
b. Requirements for Fire
c. Fire Detection Systems
   1. Fire Detectors and Overheat Detection Systems
   2. Thermoswitch-Type Fire Detection System
   3. Rate-of-Temperature-Rise Detection System
   4. Continuous-Loop Detector System
      a) Thermistor-Type Continuous-Loop System
      b) Pneumatic-Type Continuous-Loop System
   5. Smoke and Flame Detectors
      a) Carbon Monoxide Detectors
      b) Photoelectric Smoke Detectors
      c) Ionization-Type Smoke Detectors
      d) Visual Smoke Detectors
d. Fire-Extinguishing Systems
   1. Fire-Extinguishing Agents
      a) Water
      b) Inert Cold Gas Agents
      c) Carbon Dioxide (CO₂)
      d) Liquid Nitrogen (N₂)
      e) Halogenated Hydrocarbons
   2. Hand-Held Fire Extinguishers
   3. Installed Fire-Extinguishing Systems
      a) Carbon Dioxide Extinguishing Systems
      b) High-Rate-Discharge (HRD) Extinguishing Systems
e. Complete Fire Protection System
f. Maintenance and Servicing of Fire-Detection Systems
g. Maintenance and Servicing of Fire-Extinguishing Systems

Z. Module Twenty Six: Inspections

1. **Learning Outcomes:** Upon successful completion of this module, the Student will:
   a. Identify required preflight, special, major and large aircraft inspections necessary to keep an aircraft airworthy.
   b. Determine the different methods of tracking and conducting 100-hour and annual inspections for private and commercial aircraft.

2. **Learning Activities:** Inspections

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Successfully complete examination 5 covering material presented in this module. (F1,F5,F10)

3. **Equipment and Materials:**
   a. Airworthy airframe with 100-hour and annual inspection checklist, appropriate service and maintenance manuals and maintenance records for same airframe, powerplant and subcomponents as required.
   b. Aircraft jacks suitable for use with the above airframe.
   c. Ground powered unit or APU to power electrical systems

4. **Module Outline Twenty Six: Inspections**
   Required Inspections
   1. Preflight Inspections
      Preflight inspection sequence
   2. Special Inspections
      a) Altimeters and Static Systems
      b) Static Systems check
      c) ATC Transponder
   3. Major Inspections
      a) Annual Inspection
      b) 100-Hour Inspection
      c) Progressive Inspection
   4. Large Aircraft Inspections

AA. **Module Twenty Seven: Conduct of Annual or 100-Hour Inspection.**

1. **Learning Outcomes:** Upon successful completion of this module, the Student will:
   a. Examine aircraft records, Airworthiness Directives and Airworthiness alerts to determine inspection requirements and compliance.
   b. Perform inspections on aircraft fuel, landing gear, airframe and control systems.
   c. Complete appropriate documentation indicating completion of inspection and findings.
2. **Learning Activities:**

   Successfully complete examination 5 covering material presented in this module. (F1,F5,F10)

3. **Equipment and Materials:**

   a. Airworthy airframe with 100-hour and annual inspection checklist, appropriate service and maintenance manuals and maintenance records for same airframe, powerplant and subcomponents as required.

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

   c. Ground powered unit or APU to power electrical systems

   d. Blank FAA Form 337, sample of an Airworthiness alert, sample of a Supplemental Type Certificate (STC), sample of a Type Certificate Data Sheet (TCDS), and a sample Airworthiness Directive (AD note)

4. **Module Outline Twenty Seven: Conduct of Annual or 100-Hour Inspections**

   a. Examination of the Aircraft Records
      Survey of Maintenance information

   b. Inspection of the Aircraft
      1. Fuel system
      2. Landing gear
      3. Airframe
      4. Control system

   c. Record of the Inspection

   d. Failed Inspection