I. INTRODUCTION

A. This course prepares experienced Aircraft Powerplant Mechanics to successfully complete the written examination administered by the Federal Aviation Administration (FAA) for certification as a Powerplant Maintenance Technician. This course will include coverage of proper techniques and procedures for maintaining, inspecting, servicing, and overhaul of reciprocating and turbine engines and related electrical, fuel, cooling and propeller systems.

B. This is a not 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 careers in the field of Aviation Maintenance.

D. Prerequisite: Students having 18 months or more of certifiable experience with aircraft engines may present certified documentation to the nearest FAA office requesting authorization to take the Aircraft Powerplant Technicians written exams.

II. LEARNING OUTCOMES

Upon successful completion of this course, Aircraft Powerplants and Systems, the student will:

A. Perform services, inspections, troubleshoot, repair and overhaul reciprocating and turbine engines, related systems and propeller systems. (C18,F1-F5,F10)

B. Successfully complete the Federal Aviation Administration (FAA) written Powerplant Maintenance Technician examination required for certification. (C18,F1-F6,F10)

C. This text, Aircraft Inspection, Repair and Alterations: Acceptable Methods, Techniques and Practices is located at the FAA website:

January 2007
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: There will be no graded projects; however, there will be many confidence building, hands on tasks assigned by the instructor providing exposure to a large variety of tools, techniques and procedures common to aviation powerplant maintenance.

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 four written examinations for this course covering all lecture notes and reading material.

B. Practicum: None
VI. SEMESTER GRADE COMPUTATION

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<th>EXAMINATIONS</th>
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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 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: Development of Aircraft Powerplants**

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
   
   Explain principles of heat engines including early attempts with steam powered engines and later reciprocating and turbine engines.

2. **Learning Activities:**

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

3. **Module Outline One: Development of Aircraft Powerplants**
   
   a. Principle of Heat Engines
   b. External-Combustion Engines
   c. Internal-Combustion Engines
   d. Aircraft Reciprocating engines
   e. Aircraft Turbine Engines

B. **Module Two: Reciprocating Engine Theory and Construction**

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

   b. Discuss constant-volume cycle of energy release in the four-stroke and two stroke reciprocating engines.

   c. Explain work-power considerations and the measurement of horsepower.

   d. Explain factors affecting engine power.

2. **Learning Activities:**

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

3. **Module Outline Two: Reciprocating Engine Theory**

   Energy Transformation
   1. The Constant-Volume Cycle of Energy Release
a) Four-Stroke, Five-Event Cycle
b) Two-Stroke Cycle

2. Work-Power Considerations
   a) Work
   b) Power
c) Horsepower of a Reciprocating Engine
   1) Indicated Horsepower
   2) Friction Horsepower
   3) Brake Horsepower
d) Factors Affecting Engine Power
   1) Thermal Efficiency
   2) Volumetric Efficiency
   3) Mechanical Efficiency
   4) Piston Displacement
   5) Compression Ratio
   6) Ignition Timing
e) Power Variations with Altitude
f) Engine Thrust
g) Specific Fuel Consumption

C. Module Three: Reciprocating Engine Requirements

1. Learning Outcomes: upon successful completion of this module, the Student will:
   a. Explain aircraft engine cylinder arrangements and numbering sequence and firing orders for each type of arrangement.
   b. Discuss engine cooling and lubricating systems.
   c. Explain typical engine identification lettering and numbering.

2. Learning Activities:

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

3. Module Outline Three: Reciprocating Engine Configurations

   a. Cylinder Arrangement
      1. In-line Engines
      2. V-Engines
      3. Radial Engines
      4. Horizontally Opposed Engines
   b. Cylinder Numbering
      1. Radial Engines
D. Module Four: Horizontally Opposed Engine Construction

1. Learning Outcomes: upon successful completion of this module, the Student will:
   
   a. Explain the current production configurations of cylinders.
   
   b. Explain cylinder head construction and assembly methods used in attaching the head to the cylinder.
   
   c. Explain the types of valves used in reciprocating engines and associated hardware incorporated into the cylinder head.
   
   d. Discuss construction of pistons, connecting rods and associated hardware.
   
   e. Explain the construction of crankshafts, counterweights, propeller shafts and propeller reduction gearing.
   
   f. Explain the typical crankcase construction, bearing surfaces, seals, camshafts and valve operating mechanisms.

2. Learning Activities:

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

3. Equipment and Materials:


   b. Hand tools and special tools (valve spring compressors, piston ring compressors, piston ring remover/installer, dial indicator, thickness gauges, micrometers, “T” gauges and torque
wrenches) required for removal/reinstallation of major components: cylinders, valves, crankshafts, camshafts and pistons and piston rods.

c. Shop towels and hand cleaner.

4. **Module Outline Four:** Horizontally Opposed Engine Construction

a. Cylinders
   1. Cylinder barrels
   2. Cylinder Heads

b. Valve Assemblies
   1. Valves
   2. Valve Guides
   3. Valve Seats
   4. Valve Springs and Retainers

c. Pistons
   1. Wrist Pins
   2. Piston Rings
      a) Compression Rings
      b) Oil Control Rings
      c) Oil Wiper or Scraper Rings
   3. Connecting Rods
   4. Crankshaft
      a) Propeller Attachment
      b) Dynamic Dampers

5. Propeller Reduction Gearing
   a) External Spur-Type Reduction Gearing
   b) Internal Spur-Type Reduction Gearing
   c) Planetary (Epicyclic) Reduction Gearing
      1) Bevel Planetary Gears
      2) Spur Planetary Gears

6. Crankcase
   a) Bearings
   b) Crankcase Oil Seals

7. Valve Operating Mechanism
   a) Camshaft
   b) Valve Lifters
      Hydraulic Valve Lifters
   c) Pushrods
   d) Rocker Arms

E. **Module Five:** Radial Engine Construction

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
1. Explain the properties of radial engine cylinders, crankcases, crankshafts, connecting rods and propeller reduction gearing.

b. Explain valve operating mechanisms.

c. Discuss supercharger function on radial engines.

2. Learning Activities:

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

3. Equipment and Materials:


b. Hand tools and special tools (valve spring compressors, piston ring compressors, piston ring remover/installer, dial indicator, thickness gauges, micrometers, “T” gauges and torque wrenches) required for removal/reinstallation of major components: cylinders, valves, crankshafts, cam shafts and pistons and piston rods.

c. Shop towels and hand cleaner.

5. Module Outline Five: Radial Engine Construction

a. Cylinders
b. Crankcase
c. Connecting Rods
d. Propeller Reduction Gearing
e. Bearings
f. Valve Operating Mechanisms
   1. Hot Valve Clearance
   2. Cold Valve Clearance
   3. Valve Adjustment: Engines with Floating Cam Rings
g. Supercharger

F. Module Six: Lubrication Systems

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

a. Explain five benefits of lubrication in aircraft engines.
b. Explain properties of organic and synthetic aircraft lubricating oil.

c. Discuss types of reciprocating engine lubrication systems.

d. Explain lubricating system components and component functions.

e. Discuss lubrication system instrumentation.

f. Explain how spectrometric oil analysis is used in monitoring component wear.

2. Learning Activities:

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

3. Module Outline Six: Lubrication Systems

a. Function of the Lubrication System
   1. Reduces Friction
   2. Seals and Cushions
   3. Removes Heat
   4. Cleans Inside of Engine
   5. Protects Against Corrosion
   6. Performs Hydraulic Action

b. Reciprocating Engine Lubricating Oils
   Characteristics of the Reciprocating Engine Lubricating Oil
   a) Viscosity
   b) Viscosity Index
   c) Gravity
   d) Ignition Points
   e) Low-Temperature Points
   f) Color
   g) Residue

c. Types of Reciprocating Engine Lubricating Oil
   1. Straight Mineral Oil
   2. Metallic-Ash Detergent Oil
   3. Ashless-Dispersant Oil
   4. Multiviscosity Oil
   5. Synthetic Oil
   6. Semisynthetic Oil
   7. Extreme Pressure (EP) Lubricants
d. Compatibility of Lubricating Oils

e. Reciprocating Engine Lubrication Systems
   Types of Lubrication Systems
   a) Oil Supply Storage
      1) Wet-Sump
      2) Dry-Sump
   b) Internal Lubrication

f. Lubrication Systems Components
   1. Pumps
      a) Spur-Gear Pump
      b) Gerotor Pump
   2. Pressure Relief Valve
   3. Oil Filter Systems
   4. Oil Filter Elements
   5. Oil Coolers
   6. Oil Reservoirs
      a) Wet-Sump
      b) Dry-Sump
   7. Lubrication System Instrumentation
      a) Oil Pressure Measurement
      b) Oil Temperature Measurement

g. Spectrometric Oil Analysis

G. Module Seven: Exhaust Systems

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

   a. Discuss the evolution of reciprocating engine exhaust systems.

   b. Explain how cabin and carburetor heat are provided.

   c. Explain the use of mufflers.

   d. Discuss the function of augmentor tubes.

   e. Explain how turbochargers and power recovery turbines affect engine performance.

   f. Perform exhaust system inspections and repairs.

2. Learning Activities:

   Successfully complete examination 1 covering material presented in this module. (F1,F5,F10)
3. **Equipment and Materials:**

   a. Operational reciprocating engine with exhaust system components installed in an airframe and maintenance manual.

   b. Basic hand tools, safety wire, goggles, shop towels and hand cleaner.

4. **Module Outline Seven: Exhaust Systems**

   a. Evolution of Reciprocating Engine Exhaust Systems
   c. Mufflers
   d. Augmentor Tubes
   e. Power Recovery Devices
      1. Turbochargers
      2. Power Recovery Turbines
   f. Exhaust System Inspection and Repair
      1. Carbon Monoxide Detection
      2. Exhaust System Inspection
      3. Exhaust System Repairs

H. **Module Eight: Transformation of Energy**

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

   Explain thermal efficiency, fuel consumption, fuel mixture ratio and engine power, detonation and preignition.

2. **Learning Activities:**

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

3. **Module Outline Eight: Transformation of Fuel**

   a. Thermal Efficiency
   b. Specific Fuel Consumption
   c. Mixture Ratio and Engine Power
   d. Detonation and Preignition

I. **Module Nine: Reciprocating Engine Fuels**

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
a. Identify by color and explain the grades of aviation gasoline.

b. Explain aviation gasoline characteristics including critical pressure and temperature.

c. Explain the importance of proper fuel grade use and the destructive consequences of improper use.

2. Learning Activities:

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

3. Module Outline Nine: Reciprocating Engine Fuels

   a. Aviation Gasoline
      1. Gasoline Specifications
         a) Heat Energy Content
         b) Vapor Pressure
         c) Critical Pressure and Temperature
      2. Gasoline Additives
      3. Gasoline Ratings
   b. Automobile Gasoline
   c. Importance of Proper Fuel Grade

J. Module Ten: Reciprocating Engine Fuel Metering and Antidetonation Injection Systems

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

   a. Explain the operation of different types of float carburetors, maintenance, run-up and idle adjustments.

   b. Explain operation of pressure carburetors, maintenance, run-up and idle adjustment.

   c. Discuss Precision Airmotive RSA fuel injection systems, maintenance, run-up and idle adjustment.

   d. Discuss Teledyne-Continental fuel injection systems, maintenance, and adjustment of high and low unmetered fuel pressure.

   e. Explain the operation and purpose of Antidetonation Injection Systems.
2. **Learning Activities:**

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

3. **Module Outline Ten:** Reciprocating Engine Fuel Metering and Antidetonation Injection Systems

a. Float Carburetors
   1. Main Metering System
      a) Air Bleed
      b) Airflow Regulation
   2. Idling System
   3. Acceleration System
   4. Mixture Control System
   5. Power Enrichment or Economizer System

b. Service and Maintenance of Float Carburetors
   Run-up an Idle Adjustment

c. Pressure Carburetors
   1. Bendix PS Pressure Carburetors
      a) Main Metering System
      b) Idling System
      c) Acceleration System
      d) Mixture Control System
      e) Power-Enrichment System
   2. Pressure Carburetor Installation and Maintenance
      Run-up and Idle Adjustment

d. Fuel Injection Systems
   1. Precision Airmotive RSA Fuel Injection System
      a) Main Metering System
      b) Idling System
      c) Mixture Control System
      d) Power-Enrichment System
      e) Flow Divider
      f) Nozzles
   2. Installation and Maintenance of RSA Fuel Injection Systems
      Run-up and Idle Adjustment
   3. Teldyne-Continental Fuel Injection System
      a) Injector Pump
      b) Fuel-Air Control Unit
      c) Fuel Manifold Valve
      d) Injector Nozzles
   4. Installation and Maintenance of TCM Fuel Injection Systems
Adjusting High and Low Unmetered Fuel Pressure

5. Antidetonation Injection Systems

K. Module Eleven: Reciprocating Engine Induction Systems

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

   a. Explain naturally aspirated, supercharger, turbosupercharger and turbocharger induction systems for reciprocating engines.
   
   b. Explain controls associated with turbocharger systems.

2. Learning Activities:

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

3. Module Outline Eleven: Reciprocating Engine Induction Systems

   a. Naturally Aspirated Engine Induction Systems
      Alternate Air Systems
   
   b. Superchargers
      1. Internal Superchargers
      2. Turbosuperchargers and Turbochargers
         Turbocharger Controls
         1) Adjustable Bypass Restrictor
         2) Manually-Controlled Waste Gate
         3) Automatic Turbocharger Control System
         4) Teledyne-Continental Motors (TMC) Systems
         5) Textron-Lycoming Engine Turbocharger Controls

L. Module Twelve: Ignition Systems

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

   a. Explain principles of reciprocating engine ignition systems
   
   b. Perform inspections, adjustments, repairs and troubleshooting on magneto ignition systems.
c. Identify, inspect, service, repair and install various types of spark plugs.

2. Learning Activities:

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

3. Equipment and Materials:

   a. Ignition magnetos, aircraft spark plugs, ignition harness, and serviceable reciprocating engine airframe with maintenance manual.

   b. Basic hand tools, shop towels and hand cleaner, spark plug cleaner, magneto timing light, ignition harness tester, spark plug gapping tools for massive electrode and fine wire electrode spark plugs and multimeters.

4. Module Outline Twelve: Ignition Systems

   a. Introduction to Reciprocating Engine Ignition Systems
      1. Battery Ignition Systems
      2. Magneto Ignition Systems
         a) High-Tension Magneto Systems
         b) Low-Tension Magneto Systems

   b. Auxiliary Starting Systems
      1. Impulse Coupling
      2. Induction Vibration Systems

   c. Special Types of Magnetos
      1. Double Magnetos
      2. Magnetos with Compensated Cams

   d. Magneto Installation
      1. Internal Timing
      2. Timing the Magneto to the Engine
         a) Preparing the Engine
         b) Installing Magnetos without Impulse Couplings
         c) Installing Magnetos with Impulse Couplings

   e. Magneto Inspection and Servicing
      1. Magneto Overhaul
      2. Magneto Check on Engine Run-up
      3. Magneto Safety Check

   f. Ignition Harness

   g. Spark Plugs
      1. Spark Plug Design
         a) Spark Plug Size
         b) Electrodes
1) Massive Electrodes  
2) Fine-Wire Electrodes  
3) Projecting Electrodes  
c) Insulation  
d) Shielding  
e) Resistors  
f) Reach  
g) Hear Range  

2. Spark Plug Construction  
h. Spark Plug Servicing  
1. Removal  
2. Inspection  
3. Cleaning  
4. Gapping  
a) Massive Electrode Spark Plugs  
b) Fine-Wire Spark plugs  
5. Testing  
6. Installation  

M. Module Thirteen: Starting Systems  

1. **Learning Outcomes**: upon successful completion of this module, the Student will:  
   
a. Discuss the evolution of reciprocating engine starting systems.  
b. Discuss electric starters for large and small engines and starter drive systems.  
c. Demonstrate troubleshooting and maintenance procedures for aircraft starters.  

2. **Learning Activities**:  

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

3. **Equipment and Materials**:  

   a. Serviceable reciprocating engine aircraft with maintenance manual, large and small electric starters for exhibit.  
b. Basic hand tools, multimeter, shop towels and hand cleaner.  

4. **Module Outline Thirteen**: Starting Systems  

   a. The Evolution of Reciprocating Engine Starting Systems
b. Electric Starters for Large Engines

c. Electric Starters for Small Engines
   1. Starters with an Overrunning Clutch
   2. Starters with Bendix Drive
   3. Starters with Right-Angle Drive Adapter

d. Electric Starter Troubleshooting and Maintenance

N. Module Fourteen: Operation and Maintenance

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

   a. Discuss reciprocating engine ground operations.

   b. Perform Annual, One-Hundred-Hour, visual and nondestructive inspections on reciprocating engines and related systems.

   c. Discuss engine overhaul procedures from inspections and repairs to reassembly.

   d. Demonstrate troubleshooting skills and engine removal and installation.

2. Learning Activities:

   Successfully complete examination 1 covering material presented in this module. (C18,F1-F6,F10)

3. Equipment and Materials:

   a. Serviceable reciprocating aircraft engine with all accessories and maintenance manual; engine stand, engine hoist

   b. Basic hand tools, dial indicators, micrometers, “T” gages, torque wrenches, die penetrant inspection kit, multimeter, shop towels and hand cleaner.

4. Module Outline Fourteen: Operation and Maintenance

   a. Engine Service Life

   b. Reciprocating Engine Operation
      1. Starting Reciprocating Engines
         a) Starting Engines with Float Carburetors
         b) Starting Engines with the TCM Fuel Injection System
c) Starting Engines with The RSA Fuel Injection System

2. Engine Ground Fires

3. Reciprocating Engine Ground Check
c. Reciprocating Engine Maintenance Inspections

1. One-Hundred-Hour and Annual Inspections
   a) Preparation for Inspection
   b) The Actual Inspection
      1) Compression Check
      2) Lubrication System
      3) Ignition System
      4) Fuel System
      5) Induction System
      6) Exhaust System
      7) Turbocharger
      8) Cooling System
      9) Electrical System
     10) Instrument System
     11) General Condition
     12) Propeller
   c) Post Inspection Run-Up and Records

2. Reciprocating Engine Overhaul
   a. Top Overhaul
   b. Major Overhaul and Rebuilding
   c. Major Overhaul Procedures
      1) Disassembly
      2) Cleaning
      3) Inspection
         (a) Visual Inspections
         (b) Nondestructive Inspections
            (1) Magnetic Particle Inspection
            (2) Circular Magnetization
            (3) Longitudinal Magnetization
            (4) The Actual Inspection
         (c) Fluorescent Penetrant Inspection
      4) Dimensional Inspection
         (a) Cylinder and Head Assembly
         (b) Valves and Valve Springs
         (c) Piston Rings
         (d) Crankshaft
         (e) Connecting Rods
      5) Repair
         (a) Crankcase
         (b) Crankshaft
         (c) Cylinders
O. Module Fifteen: Propulsion Principles

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

   Discuss the physics of matter, mass, weight, force, work and power and how they relate to the production of thrust in a turbine engine including a review of Newton’s Laws of Motion and Bernoulli’s Principle. Explain Subsonic and Supersonic airflow through ducts and how pressure and temperature are affected under these conditions.

2. Learning Activities:

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

3. Module Outline Fifteen: Propulsion Principles

   a. A Practical Review of Physics
      1. The Physics of Energy and Matter
      2. Energy
         a) Potential Energy
         b) Kinetic Energy
   b. Matter
   c. Mass
   d. Weight
   e. Force
   f. Work
g. Power
   
   Horsepower

h. The Physics of Motion
   1. Speed
   2. Velocity
   3. Momentum
   4. Acceleration
   5. Newton’s Laws of Motion

i. The Physics of Gas Flow
   1. Bernoulli’s Principle
   2. Subsonic Flow Through a Duct
   3. Supersonic Flow Through a Duct
   4. Pressure Waves
      a) Normal Shock Waves
      b) Oblique Shock Waves
      c) Expansion Waves
   5. Airflow through a Choked Nozzle

j. Pressure

k. Heat and Temperature

l. Standard Atmospheric Conditions
   a) Total Pressure
   b) Dynamic Pressure
   c) Static Pressure

P. **Module Sixteen: Aircraft Turbine Engines & Thrust**

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

   Discuss different types of jet/turbine engine designs and the production of thrust.

2. **Learning Activities:**

   Successfully complete examination 2 covering material presented in this module. (F1-F5,F10,F12)

3. **Module Outline Sixteen:** Aircraft Turbine Engines & Thrust

   a. Non-Air Breathing (Rocket) Engines
   b. Air-Breathing Reaction Engines
      1. Pulse-Jet Engines
      2. Ramjet Engines
      3. Turbojet Engines
   c. Gas Turbine Engines
      Types of Gas Turbine Engines
Q. Module Seventeen: Engine Terms, Definitions and the Cold Section

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
   
a. Identify and explain the different major sections of a turbine engine.

   b. Explain the function and different designs of the Cold Section in a turbine engine.

   c. Discuss subsonic inlet ducts and supersonic inlet ducts, compressors, and compressor blade design.

2. **Learning Activities:**

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

3. **Module Outline Seventeen:** Engine Terms and Definitions & The Cold Section

   a. Engine Station Designations

   b. The Cold Section
      
      1. Air Inlet Ducts
a) Subsonic Inlet Ducts
   1) Blow-in Doors
   2) Foreign-Object Damage
b) Supersonic Inlet Doors

2. Compressors
   a) Types of Compressors
      1) Centrifugal Compressors
         Principle of Operation
      2) Axial-Flow Compressors
         (a) Principle of Operation
         (b) Compression Ratio
         (c) Surges and Stalls
         (d) Angle of Attack
         (e) Cascade Effect
         (f) Types of Axial-Flow Compressors
             (1) Single-Spool Axial-Flow Compressors
             (2) Dual-Spool Axial-Flow Compressors
   b) Turbofans
      1) Turbofan Engine Configurations
      2) Turbofan Engine Bypass Ratio
      3) Turbofan Pressure Ratio
   c) Compressor Design Features
      1) Convergent Airflow Path
      2) Blade Attachment
      3) Blade Design
      4) Guide Vanes and Stator Vanes
      5) Hybrid Compressor Engine

3. Diffuser Section

R. Module Eighteen: The Hot Section & Accessory Systems

1. Learning Outcomes: upon successful completion of this module, the Student will:
   a. Discuss different designs of combustion sections, turbine and turbine blade design and construction.
   b. Explain different types accessory drive systems and propeller gear reduction drives.

2. Learning Activities:

   Successfully complete examination 2 covering material presented in this module. (F1,F5,F10,F12)
3. **Module Outline Eighteen: The Hot Section & Accessory Systems**
   a. **Combustion Section**
      1. Multiple-Can Combustors
      2. Can-Annular Combustors
      3. Annular Combustors
      4. Reverse-Flow Annular Combustors
   b. **Turbine Section**
      1. Turbine Section Elements
      2. Turbine Inlet Guide Vanes
      3. Turbine Design and Construction
      4. Turbine Blade Design
         Shrouded Turbine Blades
      5. Blade-Tip Clearance Control
      6. Turbine Cooling
      7. Turbine Blade Construction
      8. Turbine Failures
   c. **Accessory Systems**
      1. Accessory Drives
      2. Propeller Reduction Gear Systems

S. **Module Nineteen: Lubrication and Cooling Systems**

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
   a. Discuss turbine engine lubrication requirements, different lubrication systems, seals, bearings, filters; pressure, temperature and chip detector indicators and detection system.
   b. Perform services, troubleshooting and repairs on turbine engine lubrication systems.

2. **Learning Activities:**

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

3. **Module Outline Nineteen: Lubrication and Cooling Systems**
   a. **Requirements for Turbine Engine Lubrication**
      Synthetic Lubricating Oil
   b. **Turbine Engine Lubrication Systems**
      1. Wet-Sump Lubrication Systems
      2. Dry-Sump Lubrication Systems
a) Hot-Tank Lubrication Systems  
b) Cold-Tank Lubrication Systems  

3. Lubrication System Subsystems  
a) Pressure Subsystems  
b) Scavenge Subsystems  
c) Vent Subsystems  

4. Bearings and Seals  
a) Bearings  
b) Seals  
   (1) Carbon Seals  
   (2) Labyrinth Seals  
c) Bearing Lubrication  

5. Lubrication System Components  
a) Oil Tanks  
b) Oil Pumps  
c) Oil-Pressure Relief Valves  
d) Oil Filters  
   Last-Chance Filters  
e) Oil Coolers  
f) Air-Oil Separator  
g) Breathers and Pressurizing Components  
h) Chip Detector  

6. Lubrication System Instrumentation  
a) Oil Pressure  
   Low-Pressure Warning Light  
b) Oil Temperature  
c) Oil Quantity  
d) Filter Bypass Warning Light  

7. Lubrication System Servicing  
   Oil Analysis  

c. Turbine Engine Cooling Systems  

T. Module Twenty: Turbine Engine Fuels  
1. Learning Outcomes: upon successful completion of this module, the Student will:  

   Explain the properties of turbine engine jet fuels, additives and handling precautions.  

2. Learning Activities:  

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

3. Module Outline Twenty: Turbine Engine Fuels
a. Jet Fuel Volatility
b. Jet Fuel Viscosity
c. Microbial Growth in Jet Fuel Tanks
d. Fuel Anti-Icing
e. Fuel Handling

U. Module Twenty One: Turbine Engine Fuel Systems

1. Learning Outcomes: upon successful completion of this module, the Student will:
   a. Explain the sequential function of fuel system components in turbine engine fuel systems and the purpose and safety features engineered into each component of the system.
   b. Explain the operation of turbine engine fuel controls and perform adjustments.

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

3. Module Outline Twenty One: Turbine Engine Fuel Systems
   a. Fuel System Components
      1. Fuel Pumps
      2. Fuel Strainers
      3. Fuel Controls
      4. Fuel Flowmeter
      5. Fuel-Oil Heat Exchanger
      6. Fuel Nozzles
      7. Pressurizing and Dump Valve
   b. Turbine Engine Fuel Control
      Hydromechanical Fuel Control
      a) Emergency Fuel Control
      b) Turboprop Engine Fuel Control
   c. Electronic Engine Control Systems
      1. Supervisory Electronic Engine Control
      2. Full-Authority Digital Electronic Control (FADEC)
   d. Fuel Control Adjustments

V. Module Twenty Two: Turbine Engine Operation

1. Learning Outcomes: upon successful completion of this module, the Student will:
Explain precautions and proper procedures for starting turbine engines and immediate actions required to prevent or minimize engine damage.

2. **Learning Activities:**

   Successfully complete examination 2 covering material presented in this module. (F1,F5,F6,F9,F10)

3. **Module Outline Twenty Two: Turbine Engine Operation**

   Starting Gas Turbine Engines
   Improper Starts
   a) No Oil Pressure
   b) Hot Start
   c) Hung Start

W. **Module Twenty Three: Turbine Engine Maintenance**

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

   Explain on-condition maintenance, trend monitoring and performance monitoring data used to aid in the maintenance of turbine engines.

2. **Learning Activities:**

   Complete examination 2 covering material presented in this module. (F1,F6,F10)

3. **Module Outline Twenty Three: Turbine Engine Maintenance**

   a. On-Condition Maintenance
   b. Trend Monitoring
   c. Types of Maintenance

X. **Module Twenty Four: Turbine Engine Inspection and Repair**

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

   a. Explain the use of electronic imaging used to aid maintenance personnel in inspecting turbine engines. Conduct routine and
non-routine, inspections, services and repairs on turbine engines.

b. Demonstrate proper use of torque wrenches with adaptors and safety wire techniques.

2. Learning Activities:

Successfully complete examination 2 covering material presented in this module. (C18,F1-F6,F10)

3. Equipment and Materials:

a. Borescope or fiberscope, basic hand tools, torque wrenches with adapters, safety wire 0.020-0.025” diameter, 0.032-0.041” diameter and 0.050-0.060” diameter wire and safety goggles.

b. Non-serviceable turbine engine with service manual on a stand for students to practice maintenance techniques and repair procedures on.

4. Module Outline Twenty Four: Turbine Engine Inspection and Repair

a. Borescope, Fiberscope, Electronic Imaging

b. Routine Inspections
1. Preflight Inspections
2. Cold Section Inspection
   a) Compressor Cleaning
   b) Compressor Repair

3. Hot Section Inspection

c. Nonroutine Inspections
1. Foreign Object Damage (FOD)
2. Overtemperature or Overspeed Operation

d. Repair Considerations
1. Torque Wrenches
2. Safety Wiring

Y. Module Twenty Five: Turbine Engine Testing

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

Perform tests on engine instruments, test run and trim a turbine engine according to manufacturer instructions using the JetCal Analyzer/Trimmer.
2. **Learning Activities:**

Successfully complete examination 2 covering material presented in this module. (C18,F1-F6,F10)

3. **Equipment and Materials:**

Jet/Cal Analyzer/Trimmer, turbine engine powered aircraft with operator and maintenance manuals and basic hand tools.

4. **Module Outline Twenty Five: Turbine Engine Testing**

   Engine Trimming

Z. **Module Twenty Six: Turbine Engine Troubleshooting**

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

   Troubleshoot turbine engines using logical steps to isolate faults by dividing engine system functions and comparing actual operation to ideal operation.

2. **Learning Activities:**

   Successfully complete examination 2 covering material presented in this module. (F1,F5,F6,F9,F10,F12)

3. **Module Outline Twenty Six: Turbine Engine Troubleshooting**

AA. **Module Twenty Seven: Instrument Systems**

1. **Learning Outcomes:** upon successful completion of this module, the Student will:
   a. Discuss the evolution of powerplant instruments.
   b. Explain different types of pressure and pressure measuring instruments.
   c. Explain temperature measuring instruments for reciprocating and turbine engines.
   d. Discuss mechanical movement instruments including tachometers, fuel flow meters and torque meters.
e. Demonstrate proper handling, installation and marking of powerplant instruments.

f. Discuss various digital indicating and control systems associated with powerplant systems.

2. Learning Activities:

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

3. Equipment and Materials:

a. Operational reciprocating engine aircraft with all instruments operational and operators and maintenance manuals.

b. Basic hand tools, safety wire, goggles, shop towels and hand cleaner.

4. Module Outline Twenty Seven: Instrument Systems

a. The Evolution of Powerplant Instruments
b. Types of Powerplant Instruments
   1. Pressure Measurement
   2. Types of Pressure
      a) Absolute Pressure
      b) Gage Pressure
      c) Differential Pressure
      d) Total Pressure
      e) Dynamic Pressure
      f) Static Pressure
c. Pressure-Measuring Instruments
   1. Engine Lubricating Oil Pressure
   2. Pressure Gage—Measuring Oil Temperature
   3. Fuel Pressure
   4. Fuel Pressure Warning System
   5. Pressure Gage—Measuring Fuel Flow
   6. MAP (Manifold Absolute Pressure)
   7. EPR (Engine Pressure Ratio)
d. Temperature Instruments
   1. Ratiometer Instruments
   2. Thermocouple Instruments
      a) CHT (Reciprocating Engine Cylinder Head Temperature)
b) EGT (Reciprocating Engine Exhaust Gas Temperature)  
c) EGT (Turbine Engine Exhaust Gas temperature)  

e. Mechanical Movement  
1. Tachometers  
   a) Mechanical Tachometers  
   b) Electric Tachometers  
2. Synchroscopes  
3. Fuel Flowmeters for Large Reciprocating Engines  
4. Flowmeters for Turbine Engines  
5. Torquemeters  

f. Powerplant Instrument Marking, Installation and Maintenance  
1. Instrument Range Marking  
2. Instrument Installation  
3. Instrument Handling  

g. Electronic Instruments  
1. Digital Indicating and Control Systems  
   Microcomputers  
2. Computerized Fuel System  
3. EICAS (Engine Indication and Crew Alerting System)  

AB. Module Twenty Eight: Electrical Systems  

1. Learning Outcomes: upon successful completion of this Module, the Student will:  
   a. Explain the generation of electrical current produced by magnetism.  
   b. Demonstrate knowledge of AC and DC generator theory.  
   c. Explain the use of AC and DC current and voltage control devices.  
   d. Explain typical AC generator and control devices used in large aircraft.  
   e. Explain the function of inverters.  

2. Learning Activities:  
   Successfully complete examination 3 covering material presented in this module. (F1,F4,F5,F10,F12)
3. **Equipment and Materials:**
   
a. Serviceable airframe with maintenance manual and electrical schematic diagrams.

b. Basic hand tools, multimeter, shop towels and hand cleaner.

4. **Module Outline Twenty Eight: Electrical Systems**
   
a. Generation of Current Electricity
b. Electricity Produced by Magnetism
   1. AC Generator Principles
   2. DC Generator and Alternators
      a) Field Magnets
      b) Armature
         1) Armature Reaction
         2) Compensating Windings and Interpoles
      e) DC Generator Controls
         1) Current Limiter
         2) Reverse-Current Cutout and Switch
         3) Voltage Regulator
      d) Small Aircraft DC Generator Systems
      e) DC Alternators
         DC Alternator Controls
      f) Starter Generators
   c. AC Power for Large Aircraft
      1. AC Generators
      2. AC Generator Controls
d. Inverters

AC. **Module Twenty Nine: Fire Protection Systems**

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

a. Identify the different classes of fire and fire zones within an aircraft structure.

b. Describe the different types of fire detection and warning systems commonly installed in aircraft.

c. Describe the different types of fire extinguishing systems and agents used in aircraft.

d. Demonstrate maintenance and service procedures for fire-detection systems.
e. Demonstrate maintenance and service procedures for fire-extinguishing systems.

2. Learning Activities:

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

3. Equipment and Materials:

   a. Airframe with serviceable fire detection and extinguishing system and maintenance manual with fire detection and extinguishing system schematics.

   b. Basic hand tools, multimeter and safety wire, Shop towels and hand cleaner.

4. Module Outline Twenty Nine: Fire Protection Systems

   a. Fire Protection Systems
      1. Types of Fires
      2. Fire Zones

   b. Fire Detection and Warning Systems
      1. Thermoswitch-Type Fire Detection System
      2. Rate-of-Temperature-Rise Detection System
      3. Continuous-Loop Fire and Overheat Detection Systems
         a) Thermistor-Type Continuous-Loop System
         b) Pneumatic-Type Continuous-Loop Systems

   c. Fire-Extinguishing Systems
      1. Fire-Extinguishing Agents
         a) Carbon Dioxide (CO₂)
         b) Liquid Nitrogen (N₂)
         c) Halogenated Hydrocarbons
      2. Powerplant Fire-Extinguishing Systems
         a) Carbon Dioxide Extinguishing Systems
         b) HRD (High-Rate-Discharge) Extinguishing Systems
      3. Complete Fire Protection Systems
      4. Maintenance and Service of Fire-Detection Systems
      5. Maintenance and Service of Fire-Extinguishing Systems

AD. Module Thirty: Introduction to Aircraft Propellers
1. **Learning Outcomes:** upon successful completion of this module, the Student will:

   Explain the multiple forces acting on a propeller, propeller efficiency, typical materials used to manufacture propellers and pitch change mechanisms.

2. **Learning Activities:**

   Successfully complete examination 4 covering material presented in this module. (F1,F5,F10,F12)

3. **Module Outline Thirty:** Introduction to Aircraft Propellers

   a. Propeller Theory
      1. Propeller Pitch
      2. Angle of Attack
      3. Tip Speed
      4. Propeller Efficiency
      5. Forces Acting on Propellers
         a) Centrifugal Force
         b) Thrust Bending Force
         c) Torque Bending Force
         d) Aerodynamic Twisting Force
         e) Centrifugal Twisting Force
      6. Asymmetrical Loading

   b. Classifications of Propellers
      1. Materials
      2. Number of Blades
      3. Pitch Change Methods

AE. **Module Thirty One:** Propellers for Reciprocation Engines

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

   a. Identify and explain the types of wood and metallic propellers used on reciprocating engine aircraft.

   b. Explain the various types of pitch control, counter balance, propeller feathering and speed control devices used.

2. **Learning Activities:**

   Successfully complete examination 4 covering material presented in this module. (F1,F5,F10)
3. **Module Outline Thirty One:** Propellers for Reciprocating Engines

a. Fixed Pitch Propellers
   1. Wood Propellers
   2. Metal Propellers
b. Ground Adjustable Propellers
c. Controllable-Pitch Propellers
   Two Position Propellers
d. Automatic Propellers
e. Constant-Speed Propellers
   1. Principles of Operation
      a) Counterweight Propellers
      b) Noncounterweight Propellers
   2. Propeller Governor
f. Feathering Constant-Speed Propellers
   1. Hamilton Standard Hydromatic Feathering Propeller
   2. Hartzell Steel Hub Feathering Propeller
   3. McCauley Constant-Speed Feathering Propeller
g. Reversible Constant-Speed Feathering Propeller

AF. **Module Thirty Two:** Propellers for Turbine Engines

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

   a. Explain the operation of typical turbine engines and how power and condition lever controls affect trust.

   b. Explain the function of different instruments used to monitor turbine engine operation.

   c. Discuss turbine engine propellers and power management.

2. **Learning Activities:**

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

3. **Module Outline Thirty Two:** Propellers for Turbine Engines

a. Turboprop Engines
   1. Garrett TPE331 Engine
      a) Propeller
      b) Power Management
   2. Pratt & Whitney of Canada PT6 Engine
AG. Module Thirty Three: Propeller Installation, Inspection and Maintenance

1. **Learning Outcomes**: upon successful completion of this module, the Student will:
   a. Perform installation of various types of propellers.
   b. Perform balance and track procedures on propellers.
   c. Inspect for reparability and perform minor repairs and properly store propellers.

2. **Learning Activities**:

   Successfully complete examination 4 covering material presented in this module. (C18,F1,F3,F5,F10)

3. **Equipment and Materials**:

   a. Condemned propellers of different material to serve as examples to be inspected by students. An airframe with engine and propeller for hands on removal and installation.
   b. Tools and ground support equipment necessary to perform propeller removal and installation.
   c. Serviceable airframe with maintenance manual and compatible track and balance equipment.
   d. 4X, 6X magnifying glasses, explosion proof flashlights, dial indicating depth gages, metal files, file cards, sanding cloth of various grits 100-600 grit, alodine, mixing cups, acid brushes and vinyl or latex gloves.

4. **Module Outline Thirty Three**: Propeller Installation, Inspection and Maintenance
a. Installation on a Flanged Shaft
   Propeller Spinners
b. Installation on a Splined Shaft
c. Installation on a Tapered Shaft
d. Propeller Vibration
e. Propeller Track
f. Propeller Balance
g. Propeller Inspection
   1. Wood Propellers
   2. Metal Propellers
h. Propeller Storage
i. Composite Propeller Blades
j. Propeller Repairs and Alterations
k. Determining Propeller Reparability

AH. Module Thirty Four: Propeller Auxiliary Systems

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

   Explain and describe the function of synchronizer systems, synchrophasing systems and ice control systems.

2. Learning Activities:

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

3. Module Outline Thirty Four: Propeller Auxiliary Systems

   a. Synchronizer Systems
   b. Synchrophasing Systems
c. Ice Control Systems