I. INTRODUCTION

A. An introduction to the refrigeration cycle, heat transfer theory, temperature/pressure relationship, refrigerant handling, refrigeration components and safety.

B. Refrigeration Principles (HART 1407) is a required course for the completion of a two-year Associate of Applied Science degree in Heating, Air Conditioning and Refrigeration or a Certificate of Completion in Residential or Commercial Heating Air Conditioning and Refrigeration.

C. This course is occupationally related and serves as a preparation for careers in the Heating, Air Conditioning and Refrigeration field.

D. Prerequisite(s): None

E. Alphanumeric coding used throughout the syllabus denotes the integration of SCANS occupational competencies (C) and Foundation Skills (F).

II. LEARNING OUTCOMES

Upon the successful completion of this course, Refrigeration Principles, the student will:

A. Identify the components and explain the application and operation of the basic refrigeration cycle. (C15, F1)

B. Explain theories of thermodynamics and heat transfer. (F2, F4, F5)

C. Demonstrate proper application and use of tools, test equipment, and safety procedures. (C18)

D. Demonstrate accepted refrigeration applications. (C20)
III. INSTRUCTIONAL MATERIALS

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

B. Supplementary Reading: As assigned by the instructor.

C. References: As selected by the instructor.

D. Audio-Visual Aids: Currently none recommended. May be selected by the instructor.

E. Other Instructional Materials: As selected by the instructor.

IV. COURSE REQUIREMENTS

A. Your first responsibility is scholarship. The grade you receive will be the result of your efforts both in the classroom and in the laboratory.

B. This course is designed to require a steady, continuous effort from the student. Class participation, initiative, attendance, and work efforts will be considered in grade computation.

C. Reading and study assignments will be made by the instructor. Reading of all study assignments is required, as well as specific tasks outlined by the instructor or listed on handouts, laboratory activity sheets, or in the student workbook (if used). Specific reading assignments will be assigned by the instructor or in the student workbook if used. Students are required to complete these assignments by the time specified by the instructor. Quizzes may be given on any or all reading assignments.

D. The study of a subject is not limited to the classroom, laboratory, or limits of the syllabus. Each student should seek out and study all available material available on the subject being taught. This might include use of the Internet or the library. In general, two hours of study outside the regular class period is recommended for each hour of classroom work.

E. Students are required to attend class and laboratory sessions regularly. Those who fail to do so may be dropped from the course with a grade of “FN”.

F. Students are required to be present for all examinations. See paragraph V (Examinations) for additional information.
G. Laboratory assignments will be completed on an individual basis except when limited by tools and/or materials. Projects will be subjectively graded by the instructor. When group projects are graded, all students will receive the same grade. Students assigned to a group must be present at all times when the project is being worked on. Students who are not present while a project is in progress will be given a “0” for the project. Students are required to complete all laboratory assignments by the time specified by the instructor.

V. EXAMINATIONS

A. There will be a minimum of three major examinations:

1. Three Week Exam
2. Mid Term Exam
3. Final Exam (this is a comprehensive exam)
4. Additional examinations may be given if the instructor determines it is necessary for proper evaluation of the students in the class.

B. Students must be present for all examinations. Make up examinations will not be given. Students who know they will be absent on the day of an examination must make arrangements with the instructor prior to the absence. Students who are absent on the day of the examination due to illness or other extenuating circumstances must present to the instructor an acceptable reason for the absence on the day following the absence.

C. Students without an excused absence will be given a zero for that examination.

VI. SEMESTER GRADE COMPUTATIONS

A. Grade Computation

<table>
<thead>
<tr>
<th>Course</th>
<th>Points</th>
</tr>
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<tbody>
<tr>
<td>Three Week Exam</td>
<td>100</td>
</tr>
<tr>
<td>Mid Term Exam</td>
<td>100</td>
</tr>
<tr>
<td>Final Exam</td>
<td>250</td>
</tr>
<tr>
<td>Quizzes</td>
<td>100</td>
</tr>
<tr>
<td>Hands on performance testing</td>
<td>150</td>
</tr>
<tr>
<td>Laboratory</td>
<td>300</td>
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</tbody>
</table>

Total Points 1000 points
B. Ratio: Points to Grade

<table>
<thead>
<tr>
<th>Points</th>
<th>Grade</th>
<th>Points Per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>900-1000</td>
<td>A</td>
<td>4</td>
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<tr>
<td>800-899</td>
<td>B</td>
<td>3</td>
</tr>
<tr>
<td>700-799</td>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>600-699</td>
<td>D</td>
<td>1</td>
</tr>
<tr>
<td>0-599</td>
<td>F</td>
<td>0</td>
</tr>
<tr>
<td>Withdraw</td>
<td>W</td>
<td>0</td>
</tr>
<tr>
<td>Incomplete</td>
<td>I</td>
<td>0</td>
</tr>
</tbody>
</table>

C. Students must take the final examination to receive a grade for the course.

D. Students absent on days a laboratory assignment is presented will lose the points for that laboratory assignment. This point loss may be recovered (only by students having an excused absence) by making up the assignment at a time other than regular class periods. The student must present the excuse to the instructor on the first class day after the absence and coordinate the make up time with the instructor. The lab must be completed within four working days after the absence. If the make up is not completed within the allotted time the student will receive an “0” for the lab.

VII. NOTES AND ADDITIONAL INSTRUCTIONS FROM THE COURSE INSTRUCTOR

A. **Course Withdrawal**: It is the student’s responsibility to officially withdraw from a course if circumstances prevent attendance. Any student who desires to, or must, officially withdraw from a course after the first scheduled class meeting must file a Central Texas College Application for Withdrawal (CTC Form 59). The withdrawal form must be signed by the student. CTC Form 59 will be accepted at any time prior to Friday of the 12th week of classes during the 16-week fall and spring semesters. The deadline for sessions of other lengths is:

- **10-week session**: Friday of the 8th week
- **12-week session**: Friday of the 11th week

The equivalent date (75% of the semester) will be used for sessions of other lengths. The specific last day to withdraw is published each semester in the Schedule Bulletin.

A student who officially withdraws will be awarded the grade of “W” provided the student’s attendance and academic performance are satisfactory at the time of official withdrawal. Students must file a withdrawal application with the College before they may be considered for withdrawal.
A student may not withdraw from a class for which the instructor has previously issued the student a grade of “F” or “FN” for nonattendance.

B. **Administrative Withdrawal**: An administrative withdrawal may be initiated when the student fails to meet College attendance requirements. The instructor will assign the appropriate grade on CTC Form 59 for submission to the registrar.

C. **Incomplete Grade**: The College catalog states, “An incomplete grade may be given in those cases where the student has completed the majority of the coursework but, because of personal illness, death in the immediate family, or military orders, the student is unable to complete the requirements for a course...” Prior approval from the instructor is required before the grade of “I” for Incomplete is recorded. A student who merely fails to show for the final examination will receive a zero for the final and an “F” for the course.

E. **Cellular Phones**: Cellular phones will be turned off while the student is in the classroom or laboratory.

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

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

G. **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.

H. Absence from the class may be unavoidable in some situations. These include illness, military/civilian job requirements, or a death in the immediate family. Documentation is required in the case of excused absences for job requirements, excuses will be on company letterhead stationary signed by the immediate supervisor stating the reason for the absence in for civilian jobs. Excuses for military personnel must be signed by the 1st Sergeant or the Company Commander. For more than one day of illness, the individual must have a statement from the doctor treating the illness.
A. **Lesson One**: Theory of Heat

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

   a. Define terms that apply to the HVAC&R field (C7, F6).
   b. Identify the components and explain the application and operation of the basic refrigeration cycle (C7-C15, F1-F6).
   c. Explain the cycle of refrigeration (C7-C15, F6).
   d. Compute area and volume (F3)
   e. Compute quantities of heat (F3)
   f. Convert temperature measurements (F3)
   g. Explain the theories of thermodynamics and heat transfer (C5-C7, F2, F4, F6).

2. **Learning Activities**:

   a. The student will complete reading assignments as assigned (F1, F11, C5, C6).
   b. The student will study the words/terms and complete written assignments specified by the instructor (F1, F11, C5, C6).
   c. The student will attend classroom lectures and participate in classroom discussions (F5, F6, F7, F9, F10, C1, C5, C6, C7).
   d. The student will observe demonstrations performed by the instructor (F5, F10, C5, C6, C14).
   e. The student will complete laboratory learning activities assigned by the instructor. See the laboratory learning activity list attached (F1 thru F17, C1, C3, C5 thru C9, C14 thru C16, C18 thru C20).

3. **Equipment and Materials**:

   a. TV/VCR
   b. Tape measure
   c. Folding ruler
   d. Step ladder
   e. Calculator, pencil, paper
   f. Safety equipment
   g. Gauge manifold
   h. Refrigerant
   i. Valve wrench
   j. Stem thermometer
   k. Walk in cooler
   l. Refrigeration systems in the classroom
   m. Refrigeration equipment
n. Hand tools
o. Project materials
p. Overhead projector (as required)
q. Other as required by the instructor

4. Audio-Visual Aids: (Recommended)
a. As required by the instructor

5. Lesson Outline:

a. Introduction to the course
   (1) Instructor policies
   (2) Disseminate
      (a) syllabus
      (b) handouts
   (3) Have students annotate printout of class roster
   (4) Have students sign policy statement, indication they understand the class policy

b. Cycle of refrigeration
   (1) Major components
   (2) Pressure areas
   (3) Changes of state
   (4) Diagram
   (5) Refrigeration cycle trainer

c. Measurements
   (1) Linear
   (2) Area
   (3) Volume
   (4) Area and volume measurements

d. Thermodynamics
   (1) Energy conservation (first law of thermodynamics)
   (2) Heat flow (second law of thermodynamics)
   (3) Temperature
   (4) Temperature scales
   (5) Temperature measurements and calculations
   (6) Absolute zero
   (7) Heat transfer
   (8) Sensible heat
   (9) Latent heat
   (10) Specific heat
   (11) Heat calculations

e. Refrigeration cycle exercise

f. Pressure
   (1) Atmospheric pressure
   (2) Absolute pressure
B. **Lesson Two:** Refrigeration Circuits, Tools and Materials

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

   a. Identify types of copper tubing used in refrigeration circuits (C5, C7).
   b. Swage copper tubing (C18-C20, F9).
   c. Cut copper tubing (C18-20, F9).
   d. Construct a silver braze joint (C18-C20, F9).
   e. Construct a mechanical joint (C18-C20, F9).
   f. Use the lever type tubing bender (C18-20, F9).
   g. Demonstrate proper application and use of tools, test equipment, and safety procedures (C18-C20).

2. **Learning Activities:**

   a. The student will complete reading assignments as assigned (F1, F11, C5, C6).
   b. The student will study the words/terms and complete written assignments specified by the instructor (F1, F11, C5, C6).
   c. The student will attend classroom lectures and participate in classroom discussions (F5, F6, F7, F9, F10, C1, C5, C6, C7).
   d. The student will observe demonstrations performed by the instructor (F5, F10, C5, C6, C14).
   e. The student will complete laboratory learning activities assigned by the instructor. See the laboratory learning activity list attached (F1 thru F17, C1, C3, C5 thru C9, C14 thru C16, C18 thru C20).

3. **Equipment and Materials:**

   a. TV/VCR
   b. Hand Tools
   c. Copper tubing
   d. Swage set
   e. Ruler or tape measure
f. Files
  g. Silver brazing tools
  h. Silver solder
  i. Oxy-acetylene welding set
  j. Channel lock pliers
  k. 3/8" ACR tubing
  l. Tubing bender
  m. Other as required by the instructor

4. **Audio Visuals Aids:** (Recommended)

   a. As required by the instructor

5. **Lesson Outline:**

   a. ACR copper tubing
      (1) Soft copper tubing
      (2) Hard drawn copper
   b. Nominal sized copper tubing
   c. Preparing copper tubing
      (1) The tubing cutter
      (2) Reaming copper
      (3) Filing copper
   d. Joining copper tubing
      (1) The anvil
      (2) The punch
   e. Bending copper tubing
   f. Construct a refrigeration circuit
   g. Oxyacetylene welding outfit
      (1) Safety
      (2) Set up
      (3) Operations
      (4) Demonstration
      (5) Practical application using silver solder
   h. Refrigeration tools
   i. Review for Mid Term exam
   j. Mid Term exam

C. **Lesson Three:** Compression Systems and Components

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

   a. List the components of a refrigeration system (C5-C7, F2).
   b. Explain the function of each component (C5-C7, F6).
   c. Draw and explain a refrigeration cycle diagram (C5-C7, F6, F7).
d. Discuss two types of motor controls (C5-C7, F6).
e. Identify and discuss four types of compressors (C5-C7, F6).
f. Discuss compressor operations (C5-C7, F6).
g. Name the internal parts of a compressor (C5-C7, F6).
h. Demonstrate safe refrigerant recovery and recycling techniques (C5-C7, C18-C20, F8, F9).
i. Evacuate a system with a vacuum pump (C18-C20, F8, F9).
j. Service the vacuum pump (C5, C18-C20, F8, F9).
k. Charge a split residential system (C5, C18-C20, F8, F9).
l. Identify methods for leak detection (C5, C18-C20).
m. Demonstrate proper application and use of tools, test equipment and safety procedures (C18-C20).

2. Learning Activities:

a. The student will complete reading assignments as assigned (F1, F11, C5, C6).
b. The student will study the words/terms and complete written assignments specified by the instructor (F1, F11, C5, C6).
c. The student will attend classroom lectures and participate in classroom discussions (F5, F6, F7, F9, F10, C1, C5, C6, C7).
d. The student will observe demonstrations performed by the instructor (F5, F10, C5, C6, C14).
e. The student will complete laboratory learning activities assigned by the instructor. See the laboratory learning activity list attached (F1 thru F17, C1, C3, C5 thru C9, C14 thru C16, C18 thru C20).

3. Equipment and Materials:

a. TV/VCR
b. Hand Tools
c. Leak detector (halide and electronic)
d. Vacuum pump oil
e. Nitrogen cylinder w/pressure regulator
f. Semi-hermetic compressor
g. Special tools as required
h. Hot water
i. Cylinders of R-22 and 502
j. Gauge Manifold set
l. Ice and water
m. Operating refrigeration system
n. Refrigerant recover/recycle machine
o. Vacuum pump
p. Approved recovery cylinder
q. Other as required by the instructor.
4. **Audio Visual Aids:** (Recommended)
   
a. As required by the instructor

5. **Lesson Outline:**
   
a. Refrigeration system components design
   (1) Evaporator
   (2) Condenser
   (3) Refrigerant flow control
   (4) Compressor
   (5) Compressor disassembly and assembly

b. Refrigerants and pressure/temperature relationship exercise
   (1) Understand the relationship of temperature on refrigerant pressures
   (2) Measure the temperature of liquids and vapors

c. Refrigeration system components operations
   (1) Evaporator
   (2) Condenser
   (3) Refrigerant flow control
   (4) Compressor

d. Motor control

e. Types of compressors
   (1) Reciprocating
   (2) Rotary
   (3) Helical or screw
   (4) Centrifugal

f. Refrigerants
   (1) Safety
   (2) Detection
   (3) Characteristics
   (4) Recovery
   (5) Recycling
   (6) Reclamation

g. Refrigerant handling, recovery, and recycling exercise

h. System evacuation and vacuum pump exercise

i. System charging

j. Leak detection

k. Review for Final Exam (This is a comprehensive exam)

l. Final exam