I. INTRODUCTION

A. A study of heat pumps, heat pump control circuits, defrost controls, auxiliary heat, air flow, and other topics related to heat pump systems.

B. Heat Pumps (HART 2449) is a required course for the completion of a Level II Certificate of completion or a two-year Associate of Applied Science degree in Heating, Air Conditioning and Refrigeration or a Level I Certificate of Completion in Residential Heating Air Conditioning and Refrigeration.

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

D. Prerequisite(s): This course has a prerequisite of HART 1403 (A/C Control Principles) and 1441 (Residential Air Conditioning) or consent of Department Chair.

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

II. LEARNING OUTCOMES

Upon successful completion of this course, Heat Pumps, the student will:

A. Explain a reverse cycle system. (F1, F5, F6)

B. List the mechanical and electrical components for the heat pump operation. (F2)

C. Explain the operation of heat pump modes including cooling, heating, defrost, emergency heat, and auxiliary heat mode. (F1, F6)

D. Identify and explain different methods of accomplishing defrost. (F1, F2, F6)

E. Charge a system correctly in the heating and cooling mode. (C20)

F. Troubleshoot electrical and mechanical components. (C20)
G. Perform tests for adequate air flow. (C20)
H. Determine balance point and coefficient of performance (C.O.P.). (F3)
I. Perform mechanical troubleshooting using computer simulations. (C20)

III. INSTRUCTIONAL MATERIALS

A. Instructional materials for this course may be found at www.ctcd.edu/books
B. Supplementary Reading: As assigned by the instructor.
C. References: As selected by the instructor.
D. Audio-Visual Aids: As selected by 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 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 COMPUTATION

A. Grade Computation:

<table>
<thead>
<tr>
<th></th>
<th>Points</th>
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<tbody>
<tr>
<td>Three Week Exam</td>
<td>100</td>
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<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>
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<tr>
<td>Hands on Performance test</td>
<td>100</td>
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<tr>
<td>Computer Exams</td>
<td>50</td>
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<tr>
<td>Laboratory</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1000</strong></td>
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B. Ratio: Points to Grade

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<thead>
<tr>
<th>Points Range</th>
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<th>Hour</th>
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<tbody>
<tr>
<td>900-1000</td>
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<tr>
<td>800-899</td>
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<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>
</tbody>
</table>
C. Students must take the final examination to receive a grade for the course.

VII. NOTES AND ADDITIONAL INSTRUCTIONS FROM COURSE INSTRUCTOR

A. Course Withdrawal: It is the students 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
- 8-week session Friday of the 6th week
- 5-week session Friday of the 4th 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 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 awarded. A student who merely fails to show for the final examination will receive a zero for the final and an F for the course.
D. **Cellular Phones:** Cellular phones will be turned off while the student is in the classroom or laboratory.

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

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. In cases of illness, one day absences may be excused on a statement from the individual stating the reason. For more than one day of illness, the individual must have a statement from the doctor treating the illness. **Quizzes and Labs missed due to unexcused absence will not be made up. A score of zero “0” will be given. All Labs will be turned in when at the beginning of class. Late Labs will be will have 5 points deducted for each class period the lab is late. When the student is absent during Labs, the student will co-ordinate with the instructor and Lab Assistant to make up missed work. No made up labs will be turned in to the instructor without the Lab Assistant’s initials.**
VIII. COURSE OUTLINE

A. **Lesson One: Introduction to Heat Pump Systems**

1. **Learning Outcomes:** Upon successful completion of this lesson the student will:
   
a. Explain a reverse cycle system. (F1, F5, F6)
   
b. List the mechanical and electrical components for the heat pump operation. (F2)
   
c. Explain the operation of heat pump modes including cooling, heating, defrost, emergency heat, and auxiliary heat mode. (F1, F6)
   
d. Identify and explain different methods of accomplishing defrost. (F1, F2, 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. Electrical test instruments
   
b. Split heat pump system
   
c. Hand tools
   
d. TV/VCR (as required)
   
e. Other as selected by the instructor
4. **Audio-Visual Aids:** (Recommended)
   a. To be selected by the instructor from those listed in Section IIID above
   b. Others as selected by instructor

5. **Lesson Outline:**
   a. Introduction to the course
   b. Disseminate handouts
   c. Have students annotate class roster
   d. Introduction to heat pumps
      (1) Heat pump definition
      (2) Benefits of a heat pump
      (3) Heat pump special requirements
      (4) Basic Operations
   e. Types of heat pump systems
      (1) Water to water
      (2) Water to air
      (3) Air to air
      (4) Split system
      (5) Package unit
   f. Auxiliary heating
   g. Heat pump cycles
      (1) Cooling mode
      (2) Heating mode
   h. Defrost methods and control
      (1) Purpose of the defrost
      (2) Methods of the defrost
(3) Defrost controls
i. Efficiency and capacity
j. Heat pump components
   (1) Compressor
   (2) Reversing valve
   (3) Metering device
   (4) Check valves
   (5) Accumulator
   (6) Accumulator heat exchanger
   (7) Indoor and outdoor coils
   (8) Auxiliary heating elements
   (9) Crankcase heaters
   (10) Refrigerant piping and insulation
   (11) Heat exchanges
   (12) Strainers
   (13) Driers
   (14) Mufflers
   (15) Air filters
k. Review for Three Week exam
l. Three Week Exam

B. Lesson Two: Heat Pump Controls

1. Learning Outcomes: Upon successful completion of this lesson the student will:
   a. List the mechanical and electrical components for the heat pump operation. (F2)
   b. Explain the operation of heat pump modes including cooling,
heating, defrost, emergency heat, and auxiliary heat mode. (F1, F6)

c. Identify and explain different methods of accomplishing defrost. (F1, F2, F6)

d. Troubleshoot electrical and mechanical components. (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. Electrical test instruments

b. Residential split system heat pump system

c. Hand tools

d. TV/VCR (as required)

e. Other as selected by the instructor

4. Audio-Visual Aids: (Recommended)

a. To be selected by the instructor from those listed in Section IIID above

b. Others as selected by instructor

5. Lesson Outline:

a. Introduction to heat pump controls

b. Transformers
c. Thermostats
   (1) Indoor
   (2) Outdoor
   (3) Low ambient control
d. Anticipators
   (1) Heating
   (2) Cooling
e. Defrost controls
   (1) Defrost thermostat
   (2) Time-temperature defrost
   (3) Air pressure-temperature defrost
   (4) Solid-state defrost
   (5) Air-pressure differential defrost
f. Defrost relay
g. Indoor fan relay
h. Emergency heat relay
i. Contractors
j. Overload-protectors
   (1) Internal
   (2) External
k. Pressure controls
   (1) High-pressure control
   (2) Low-pressure control
   (3) Defrost termination pressure switch
l. Low-ambient switch
m. Mild-weather control
n. Heat sequences
o. Motor starting relays
   (1) Potential relay
   (2) Solid state relay
p. Lockout relay
q. Review for Mid Term exam
r. Mid Term exam

C. **Lesson Three**: Heat Pump Selection and Installation

1. **Learning Outcomes**: Upon successful completion of this lesson the student will:
   
   a. Explain a reverse cycle system. (F1, F5, F6)
   b. List the mechanical and electrical components for the heat pump operation. (F2)
   c. Explain the operation of heat pump modes including cooling, heating, defrost, emergency heat, and auxiliary heat mode. (F1, F6)
   d. Identify and explain different methods of accomplishing defrost. (F1, F2, F6)
   e. Charge a system correctly in the heating and cooling mode. (C20)
   f. Troubleshoot electrical and mechanical components. (C20)
   g. Perform tests for adequate air flow. (C20)
   h. Determine balance point and C.O.P. (coefficient of performance). (F3)
   i. Perform mechanical troubleshooting using computer simulations. (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. Electrical test instruments
   
b. Split heat pump system
   
c. Hand tools
   
d. TV/VCR (as required)
   
e. Other as selected by the instructor

4. **Audio-Visual Aids:** (Recommended)
   
a. To be selected by the instructor from those listed in Section IIID above
   
b. Others as selected by instructor

5. **Lesson Outline:**
   
a. Introduction
   
b. Selection guidelines
   
c. Equipment selection
   
      (1) Winter conditions
   
      (2) Summer conditions
   
d. Air-distribution and duct design
   
      (1) Air supply ducts
   
      (2) Return duct systems
(3) Air quality

e. Installation
   (1) Outdoor unit
   (2) Indoor unit
   (3) Refrigerant lines
   (4) Control wiring

f. Start up and service procedures

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

h. Final examination