I INTRODUCTION

A. An advanced course in application of troubleshooting principles and use of test instruments to diagnose air conditioning and refrigeration components and system problems including conducting performance tests.

B. Air Conditioning Troubleshooting (HART 2436) 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 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) or Co-requisite(s): This course has a prerequisite of HART 1401, Basic Electricity for HVAC, HART 1403, Air Conditioning Control Principles, HART 1407, Refrigeration Principles, HART 1441 Residential Air Conditioning, and HART 2431 Advanced Electricity (co-requisite) or consent of Department Chair.

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

II LEARNING OUTCOMES

Upon successful completion of this course, Air Conditioning Troubleshooting, the student will:

A. The student will test and diagnose components, systems, and accessories (C18, C19, and C20).

B. Exhibit knowledge of system’s sequence of operation, accessory applications, and component operation (F2, F12, and F9).
C. Install a residential split-system (C20).
D. Remove and replace a compressor (C20).
E. Perform troubleshooting using computer simulations (C20, F12, and F9).

III INSTRUCTIONAL MATERIALS
A. Text: 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 selected. May be 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 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. If the instructor grants an excused absence, he will at that time assign a subject on which the student must prepare a ten page paper typed double spaced and in accordance with Campbell’s Guide of Term and Research Papers. Campbell’s is available at the College bookstore or the library. Failure to turn the paper into the instructor on the date specified will result in the student receiving a “0” for the exam missed.

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></th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>Three Week Exam</td>
<td>100 points</td>
</tr>
<tr>
<td>Mid Term Exam</td>
<td>100 points</td>
</tr>
<tr>
<td>Final Exam</td>
<td>250 points</td>
</tr>
<tr>
<td>Quizzes</td>
<td>100 points</td>
</tr>
<tr>
<td>Incentive/Instructor Evaluation</td>
<td>150 points</td>
</tr>
<tr>
<td>Laboratory</td>
<td>300 points</td>
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<tr>
<td><strong>Total Points</strong></td>
<td><strong>1000 points</strong></td>
</tr>
</tbody>
</table>

B. Ratio: Points to Grade

<table>
<thead>
<tr>
<th>Points</th>
<th>Grade</th>
<th>Points Per Hour</th>
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</thead>
<tbody>
<tr>
<td>900-1000</td>
<td>A</td>
<td>4</td>
</tr>
<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>Withdrawal</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. Incentive points are given for attendance and instructor evaluation. Each absence, excused or unexcused, will result in 20 points be deducted from the incentive score. Students with an approved (by the instructor) excused absence may recover the lost points by submitting a five page double spaced, typed paper on a subject assigned by the instructor. The student must, on the first class day following the absence, present his excuse to the instructor and receive an assignment if the excuse is acceptable. This paper must be submitted to the instructor no later than four class days after the absence for evaluation. Failure to do so will result in a loss of the points.

E. 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 project 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 a “0” for the project.
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
- 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’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.

D. **Cellular Phones and Beepers**: Cellular phones and beepers will be turned off while the student is in the classroom or laboratory.
E. **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 requirement’s, 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. 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.

VIII **COURSE OUTLINE**

A. **Lesson One:** Introduction and Troubleshooting Electrical System Components

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

   a. The student will test and diagnose components, systems, and accessories (C18, C19, and C20).
   b. Exhibit knowledge of system’s sequence of operation, accessory applications and component operation (F2, F12, F9).
   c. Perform troubleshooting using computer simulations (C20, F12, and F9).
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, and C6).
   c. The student will attend classroom lectures and participate in classroom discussions (F5, F6, F7, F9, F10, C1, C5, C6, and C7)
   d. The student will observe demonstrations performed by the instructor (F5, F10, C5, C6, and C14).
   e. The instructor 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, and C18 thru C20).

3. **Equipment and Materials:**
   a. Components from residential heating and cooling system
   b. System component analyzers
   c. Simpson 260 Multi-tester
   d. Clamp-on ammeter
   e. Hand tools
   f. 3-phase A/C system
   g. 3-phase chiller
   h. 3-phase drill press
   i. Fluke 27/77 Digital Multimeter
   j. Residential Electrical Furnace w/central A/C
   k. Others as selected by the instructor

4. **Audio-Visual Aids:** (Recommended)
   a. None currently selected.
   b. Other as selected by the instructor.

5. **Lesson Outline:**
   a. Introduction
      (1) instructor policies
      (2) disseminate
         (a) syllabus
         (b) handouts
      (3) have students annotate printout of class roster
      (4) have students sign the policy statement, indicating they understand the class policy
b. Component testing: air conditioning and refrigeration
   (1) compressors
   (2) fan motors
   (3) contractors
   (4) relays
   (5) capacitors
   (6) switches

c. Laboratory: component testing

d. Component testing: Gas and electric furnace
   (1) relays
   (2) switches
   (3) sequencers
   (4) elements
   (5) safety controls
   (6) transformers

e. Laboratory: component testing

f. Review for three week exam

g. Three week exam

B. Lesson Two: Troubleshooting Compressors and Residential Heating Systems

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

   a. The student will test and diagnose components, systems, and accessories (C81, C19, and C20).
   b. Exhibit knowledge of system’s sequence of operation, accessory applications, and component operation (F2, F12, and F9).
   c. Remove and replace a compressor (C20).
   d. Perform troubleshooting using computer simulations (C20, F12, and F9).

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, and C6).
   c. The student will attend classroom lectures and participate in classroom discussions (F5, F6, F7, F9, F10, C1, C5, C6, and C7)
   d. The student will observe demonstrations performed by the instructor (F5, F10, C5, C6, and C14).
e. The instructor 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, and C18 thru C20).

3. **Equipment and Materials:**
   
a. Residential gas furnace w/direct spark ignition  
b. Residential electric furnace  
c. Manifold gauge set  
d. Hand tools  
e. Simpson 260 multimeter  
f. Fluke 27/77 digital multimeter  
g. TIF 1000 digital multimeter  
h. TIF Mega ohmmeter  
i. Central A/C system  
j. Oxy-acetylene welding outfit  
k. Compressor  
l. Silver solder  
m. Vacuum pump  
n. Refrigerant Recovery & Recycle Machine  
o. Refrigerant R22  
p. Manometer (water)  
q. Maglehelic gauge  
r. Others as selected by the instructor

4. **Audio-Visual Aids:** (Recommended)
   
a. None currently selected.  
b. Others as selected by the instructor.

5. **Lesson Outline:**
   
a. Test and replace a compressor  
b. The use of troubleshooting charts for solving problems in gas furnaces  
c. Laboratory  
   (1) start-up the gas furnace  
   (2) check-out the gas furnace  
   (3) troubleshooting the gas furnace  
   (4) gas furnace  
d. The use of troubleshooting charts for solving problems in electric furnaces
C. **Lesson Three:** Troubleshooting Commercial Refrigeration Systems and High Voltage Wiring

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

   a. The student will test and diagnose components, systems, and accessories (C18, C19, and C20).
   b. Exhibit knowledge of system’s sequence of operation, accessory applications, and component operation (F2, F12, and F9).
   c. Install a residential split-system (C20).
   d. Remove and replace a compressor (C20).
   e. Perform troubleshooting using computer simulations (C20, F12, and F9).

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, and C6).
   c. The student will attend classroom lectures and participate in classroom discussions (F5, F6, F7, F9, F10, C1, C5, C6, and C7)
   d. The student will observe demonstrations performed by the instructor (F5, F10, C5, C6, and C14).
   e. The instructor 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, and C18 thru C20).

3. **Equipment and Materials:**

   a. Commercial refrigeration trainer
   b. Test instruments (electrical)
   c. Hand tools
   d. Electrical distribution panel
e. A/C system w/electrical furnace
f. A/C system w/gas furnace
g. Heat pump system
h. Manifold gauge set
i. Thermometers
j. U-tube manometer
k. Sling psychrometer
l. Digital multimeter
m. Digital ammeter
n. Commercial refrigeration system
o. Refrigerant recovery and recycle machine
p. R-22
q. Commercial refrigeration system w/electric defrost
r. Breaker disconnect power
s. Residential outdoor unit
t. Outdoor disconnect
u. Switches and breakers (as required)
v. Others as selected by the instructor

4. **Audio-Visual Aids**: (Recommended)
   
a. None currently selected.
b. Others as selected by the instructor.

5. **Lesson Outline**:

   a. The use of troubleshooting charts for solving problems in refrigeration equipment
   b. Troubleshooting: refrigeration control circuits
   c. Laboratory: troubleshooting laboratory
   d. Review for Final Exam (This is a comprehensive exam)
   e. Final Exam
The satisfactory completion of the laboratory learning activities listed below is worth 300 points or 30% of your final course grade. Each activity will be worth 200 points. Each student will be responsible for maintaining the laboratory activity sheet. Students missing a laboratory activity must make arrangements with the instructor for a make-up time.

<table>
<thead>
<tr>
<th>NO.</th>
<th>EXERCISE</th>
<th>DATE</th>
<th>GRADE</th>
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<tbody>
<tr>
<td>1.</td>
<td>Demonstrate a working knowledge of three phase circuits.</td>
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<tr>
<td>2.</td>
<td>Test three phase contactors and thermostats</td>
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<tr>
<td>3.</td>
<td>Test 24V transformers and blower relays</td>
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<tr>
<td>4.</td>
<td>Test sequencers and heat relays</td>
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<td>5.</td>
<td>Test residential air conditioning system thermostats</td>
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<td>6.</td>
<td>Test single phase compressors</td>
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<tr>
<td>7.</td>
<td>Perform single phase compressor replacement</td>
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<td>8.</td>
<td>Test gas furnace gas pressures</td>
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<td>9.</td>
<td>Test electronic ignition systems on gas furnaces</td>
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<tr>
<td>10.</td>
<td>Demonstrate start up procedures for residential air conditioning systems</td>
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<tr>
<td>11.</td>
<td>Troubleshoot condenser fan motors</td>
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<td>12.</td>
<td>Test dirty evaporators and filters</td>
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<td>13.</td>
<td>Test thermostatic expansion valves</td>
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<td>14.</td>
<td>Test commercial refrigeration defrost circuits</td>
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<tr>
<td>15.</td>
<td>Install high voltage wiring and disconnects</td>
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</table>
COMPETENCY PROFILE

Program: Heating, Air Conditioning & Refrigeration Mechanic & Repairer
Course: HART 2436 Air Conditioning Troubleshooting, 4 Credits
Entry Occupation: HVAC Repairer Helper
Instructor:

Student Name: SSAN:
Date Enrolled: Date Completed/Withdraw:
Total Hours Absent: Final Grade

RATING SYSTEM

The instructor will evaluate the student by placing a check mark in the appropriate number block to indicate the student’s degree of competency. The rating for each task reflects the instructor’s evaluation of employability readiness rather than the grade given in the class. The final grade is not an average of ratings. The rating scale listed below will be used to rate the student.

RATING SCALE

1 = 90-100(A) = Mastered competency: Highly proficient. Can perform task without supervision. Can teach others. Meets or exceeds SCANS requirements.

2 = 80-89(B) = Mastered Competency: Proficient. Can perform task with limited supervision. Meets most SCANS requirements.

3 = 70-79(C) = Mastered Competency: Can perform task but requires close supervision. Meets minimum SCANS requirements.

4 = 0-69(N or F) = Did NOT master competency: Unable to or did not attempt to perform task. Does not meet SCANS requirements.
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
<td><strong>Learning Outcome 1:</strong> The student will test and diagnose components, systems, and accessories (C18, C19, and C20).</td>
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<tr>
<td><strong>Learning Outcome 2:</strong> Exhibit knowledge of system’s sequence of operations, accessory applications, and component operation (F2, F12, F9).</td>
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<tr>
<td><strong>Learning Outcome 3:</strong> Install a residential split-system (C20).</td>
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<tr>
<td><strong>Learning Outcome 4:</strong> Remove and replace a compressor (C20).</td>
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<tr>
<td><strong>Learning Outcome 5:</strong> Perform troubleshooting using computer simulations (C20, F12, and F9).</td>
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</tbody>
</table>
Workplace Know-How and Personal Characteristics

The rating system listed below will be used by the Worksite Supervisor to evaluate the student’s workplace know-how and personal characteristics. The Worksite Supervisor will evaluate the student on the following competency (task) listed by circling the appropriate rating from the rating scale below that best describes his/her observation of the student during the entire length of this course for the rated area (task). Enter the date the task was completed in the date column.

**Rating Scale**

1 = Above Average  
2 = Average  
3 = Below Average  
N/A = Not Observed

<table>
<thead>
<tr>
<th>WORKPLACE KNOW-HOW AND PERSONAL CHARACTERISTICS</th>
<th>Rating</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMPETENCIES:</strong> Effective workers can productively use:</td>
<td>Rating</td>
<td>Date</td>
</tr>
<tr>
<td>Resources: allocating time, money, materials, space, staff</td>
<td>1 2 3 N/A</td>
<td></td>
</tr>
<tr>
<td>Interpersonal Skills: working on teams teaching others, serving customers, leading, negotiating, and working well with people from culturally diverse backgrounds.</td>
<td>1 2 3 N/A</td>
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<tr>
<td>Information: acquiring and evaluating data, organizing and maintaining files, interpreting and communicating, and using computers to process information.</td>
<td>1 2 3 N/A</td>
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<tr>
<td>Systems: understanding social, organizational, and technological systems, monitoring and correcting performance, and designing or improving systems.</td>
<td>1 2 3 N/A</td>
<td></td>
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<tr>
<td>Technology: selecting equipment and tools, applying technology to specific tasks, and maintaining and troubleshooting technologies.</td>
<td>1 2 3 N/A</td>
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<tr>
<td><strong>THE FOUNDATION:</strong> Competence requires:</td>
<td>Rating</td>
<td>Date</td>
</tr>
<tr>
<td>Basic Skills: reading, writing, arithmetic and mathematics, speaking and listening.</td>
<td>1 2 3 N/A</td>
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<tr>
<td>Thinking Skills: thinking creatively, making decisions, solving problems, seeing things in the mind’s eye, knowing how to learn, and reasoning.</td>
<td>1 2 3 N/A</td>
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<tr>
<td>Personal Qualities: individual responsibility, self-esteem, sociability, self-management and integrity.</td>
<td>1 2 3 N/A</td>
<td></td>
</tr>
<tr>
<td><strong>PERSONAL CHARACTERISTICS</strong></td>
<td>Rating</td>
<td>Date</td>
</tr>
<tr>
<td>Relations with others: effectiveness in working with students, instructors, and others; cooperation; shows respect.</td>
<td>1 2 3 N/A</td>
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</table>
Dependability: attendance; loyalty; punctuality; adherence to schedules and deadlines; consistency and results; perseverance

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Work Attitudes: willingness to learn; willingness to accept and profit from evaluation; enthusiasm; initiative; commitment; pride in work

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Communication: listening; speaking; and nonverbal skills; effectiveness in communicating with staff and other workers.

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<th>N/A</th>
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Personal Hygiene-Grooming: personal health care and cleanliness, dresses and maintains self appropriately for a business environment.

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<th>2</th>
<th>3</th>
<th>N/A</th>
</tr>
</thead>
</table>

Based on my observation/evaluation of the student, he/she has: (place a “✓” in the appropriate block).

- Entry level skills now.
- Entry level skills after additional external learning experience.
- Entry level skills after additional course work.
- Entry level skills after additional course work and additional external learning experience.

Instructor Comments: (Please provide additional information regarding your evaluation of the student’s performance.

INSTRUCTOR CERTIFICATION

I certify this competency profile to be true and accurate to the best of my knowledge.

Signature ___________________________ Date ________________

I have seen this evaluation and discussed it with my Instructor.

Student Signature ___________________________ Date ________________

<table>
<thead>
<tr>
<th>Written Exams</th>
<th>First</th>
<th>Second</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Score</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>