Eastfield College  
Career Technologies Division  
Fall Semester 2015  
AC Controls  
HART 1403.41200

Instructor: Bill Milam,
Division Office: T-143  
Division Phone: 972-860-7143  
Lecture, 7:30 am to 9:50 am, Monday thru Thursday  
Lab, 9:50 am to 12:30 am, Monday thru Thursday  
Dates: October 9th to December 10th  
Class Room: T-105  
E-mail: BillMilam@dcccd.edu

This syllabus is intended as a set of guidelines for this course. Eastfield College and your instructor reserve the right to make modifications in content, schedule and requirements as necessary to promote the best education possible within prevailing conditions affecting the course.

Note: The final exam consists of two exams, a written exam and a lab exam. The final written exam score and the lab exam score will be added together and divided by two. You must average 70% of the combined grades to pass this course.

The lab final will consist of drawing a schematic of a residential split system air conditioner with gas heat and wiring system using the ST-22 trainer.

TEXTBOOK:

(This book is a requirement for this course. Later in your studies during the Heat Pump course [HART 2449] you will be required to take the I.C.E. (Industry Competency Exam). This book is an excellent study guide for this exam.

OTHER MATERIALS

Each student will need a small box of erasable colored pencils.
COURSE DESCRIPTION:

This course is an introduction to the concepts of electrical, pressure, and temperature controls including motor starting devices, operating relays, and troubleshooting safety controls and devices. Emphasis on use of wiring diagrams to analyze high and low voltage circuits. A review of The Principles of Electricity and Ohm's law as applied to AC controls and circuits. (3 hr Lecture, 3hr Lab, 4 Credit hrs)

COURSE OBJECTIVES:

The student will acquire a basic understanding of the design and purpose of controls and motor starting devices and demonstrate this understanding by the ability to test, repair, and/or replace control components. The student will become familiar with reading, interpreting, and drawing control circuits. The student will also become familiar with the terminology in the field.

PREREQUISITES: HART 1401 Principles of Electricity for HVAC

MODULES:

1. Unit 13. Introduction to Automatic controls
2. Unit 14. Automatic control Components and Applications
3. Unit 19. Motor Controls
4. Unit 15 & Handouts. Troubleshooting Basic Controls
5. Unit 16. Advanced Automatic controls
6. Unit 30. Electric Heat
7. Unit 39.

STUDENT LEARNING OBJECTIVES:

The following list of course goals will be addressed in the course. These goals are directly related to the performance objectives (Addendum A). (*Designates a CRUCIAL goal)

The Student will be able to:

1. List types of electrical diagrams used in air conditioning field
2. Draw symbols for loads
3. State difference between a contactor and a relay
4. State difference between a contactor and a line starter
*5. Draw symbols for switches
*6. Draw symbols for safety devices
7. State law of magnetic poles
8. Describe operation of a split phase motor
*10. Describe operation of single-phase motor
9. Identify electric motor overloads
*12. Troubleshoot AC motors (TECHNOLOGY C20.4)
*13. Check run and start capacitors
*14. Select correct start relay for a given AC motor
*15. Identify start relay terminals
*16. Wire motor circuits
*17. Draw electrical diagram of duel voltage AC motor
18. Draw diagram of delta and wye connected three phase motor
19. Draw diagram of motors and stacking components
*20. Troubleshoot stacking components
21. Describe operation of pressure switch
22. Describe operation of heating and cooling anticipator
23. Install stacking components (SYSTEMS C15.4)
*24. Test operation of a pressure switch (SYSTEMS C16.4)
25. Draw schematic of thermostat
26. Describe thermostat operation
27. Describe operation of fan-limit switch
*28. Wire circuits with safety controls
*29. Troubleshoot control circuits
*30. Test operation of a fan-limit switch
*31. Wire complex circuits
*32. Troubleshoot complex circuits
*33. Draw schematic of residential air conditioning system with gas heat or electric heat
*34. Wire residential AC system with gas heat
*35. Wire residential AC system with electric heat

**STUDENT CONTRIBUTIONS:**

Each student will spend at least 3 hours per week preparing for class. Attendance is critical in this class. Students should make every effort to be in class on time and prepared for class.

**CLASSROOM ENVIRONMENT:**

The classroom serves as a learning environment for everybody participating in this class. To facilitate academic and personal growth for everyone, you are expected to be courteous and respectful toward the instructor and other students. While I encourage an informal and friendly classroom environment that facilitates discussion and exploration, we must still accommodate one another’s differing perspectives and opinions.

Each student must adhere to the Student Code of Conduct. The Student code of conduct was passed out to each student at the beginning of this class. The Student Code of Conduct can be found in the current Eastfield College Catalogue, or on the DCCCD web site.

**Ringing cell phones** during the class period are a distraction. Unless it is an emergency call from a family member, all other cell phone calls are to be avoided. Family members and friends should be advised not to call during class time. If a student continues to receive numerous cell phone calls during the class period, the instructor may request the cell phone be turned OFF.

A student that is on call by his/her company may answer cell phones in the classroom. The student will then remove himself or herself from the classroom for the conversation. All other calls are to be avoided. The instructor may amend this rule as he/she sees fit.

**There will not be ANY texting in the classroom**
Voice mail and text messages can be retrieved outside of class only. I-Pods and other such devices will **NOT** be used during class times. If the student has to be excused during a test or quiz, the I-Pod will be placed and left at the front of his/her desk while they are gone.

*There will not be any profanity in the class room*

**ASSIGNED SEATING:**

The instructor reserves to right to assign seating

*The instructor* will be the only one talking unless the student is called upon to speak. If a student does not follow this rule, he/she may be asked to leave the classroom.

**CLASS ROOM FOOD AND DRINK POLICY**

Food, drinks and tobacco products are prohibited in Eastfield College classrooms.

However, according to Eastfield College procedures, if in a non-lab class setting, food and drink may be allowed.

During the lecture part of this class, students may bring food and drink into the classroom. To do so, each student must read and sign the Food and Drink Policy statement and adhere to the conditions outlined in the policy.

**COURSE EVALUATION:**

Your final grade will be made up of seven parts:

Daily work
(Home work, pop quizzes, and other daily work) 100 points each.

Lab work
Lab assignments, 100 points each
(Part of the lab grade will be how well you work as a team member in the lab and selection of tools to perform lab.) *Interpersonal Technology C18-5*

Lab Exams, 200 points each

Major Exams, 200 points each

Homework assignments, 100 points each *(Basic F2-4)*

Final Exam, 300 points

**Note:** The final exam consists of two exams, a written exam and a lab exam. The final exam score and the lab exam score will be added together and divided by two. You must average 70% of the combined grades to pass this course.
The lab final will consist of drawing a schematic of a residential split system air conditioner with gas heat and wiring system using the ST-22 trainer.

Notebook, 200 points
(Notebook will be graded on organization, content and neatness) more explanation later! (Information C6-4)

GRADE BREAKDOWN:

100 to 90 % of total possible points = A
89 to 80 % of total possible points = B
79 to 70 % of total possible points = C
69 to 60 % of total possible points = D
Below 60 % of total possible points = F

NOTE: Should you wish to question your grade, the information contained in the instructor’s grade book and your notebook will be the final authority for establishing the final grade. Therefore, your notebook should be retained for a period of time after the class is over.

OBTAINING YOUR GRADES AT THE END OF THE SEMESTER:

Final Grade Reports are no longer mailed. Convenient access is available online at http://www.econnect.dcccd.edu Use your student identification number to log onto e-Connect. This online system provides you with timely information regarding your college records.

FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT OF 1974 ERPA

In compliance with the Family Educational Rights and Privacy Act of 1974 (FERPA), the College may release information classified as “directory information” to the general public without the written consent of the student. Directory information includes: (1) student name, (2) student address, (3) telephone numbers, (4) date and place of birth, (5) weight and height of members of athletic teams, (6) participation in officially recognized activities and sports, (7) dates of attendance, (8) educational institution most recently attended, and (9) other similar information, including major field of student and degrees and awards received. Students may protect their directory information at any time during the academic year. If no request is filed, directory information is released upon written inquiry. No telephone inquiries are acknowledged. No transcript or academic record is released without written consent from the student, except as specified by law.

COURSE CLASS WORK

Exams: The exams will cover material from the assigned chapters in your textbook, quizzes, handouts and other assigned material. The exam can include multiple choice questions, true/false questions, fill-in-the-blank and short essay questions.
There will be NO make-up exam unless arrangements have been made with the instructor before the exam date!

**Final:** It is comprehensive, covering some material from the first two exams. The final can include multiple choice questions, true/false questions, fill-in-the-blank and short essay questions.

**Quizzes:** There will be quizzes and in-class assignments throughout the semester, covering material from your textbook, lecture and handouts. These quizzes and assignments may be announced or unannounced. There will NOT be any make-up for these quizzes.

**Notebook:** The notebook will be a binder with tabbed sections (name of the section on the tab). There will be a cover sheet at the front. The notebook will contain

- All class work
- Daily quizzes
- All homework
- All lab work
- All major exams
- All class notes
- All handouts

The notebook will:
- Be kept current and up to date
- Have each category tabbed and labeled
- Have a cover sheet in the notebook
- Due at the beginning of the written final exam period.
- Be considered late after the first 30 minutes of the class session.
- The notebook may be collected at any time during the semester without notice. If the notebook is not complete up to that point, there will be a % deduction in the total notebook grade.

**COURSE POLICIES:**

**Attendance:** You are expected to attend EACH CLASS MEETING, and you are expected to be here on time, prepared, with your book and materials.

- You will receive 10 points for each class meeting you are present and on time. You will receive 5 points for each class meeting you are present but tardy.
- The class roll will be called fifteen (15) minutes after the scheduled time the class is to begin. A “Tardy Sign In” sheet will be posted at the end of the first table. If you arrive late to class, you are to sign in on the Tardy Sheet.
- The instructor may choose to call the class roll at any time during the class or lab period. If you do not answer the roll call, you will be counted absent for the class, and not receive points for attending the class.
• If you arrive in the classroom more that 20 minutes after the scheduled time the class is to begin, you will not be allowed to begin the assignment that is already in progress. This includes pop quizzes and major exams. The Instructor’s timepiece will be used to mark the time.

If you miss a class, you are responsible to cover the missed material on your own. Have a classmate share notes with you and make sure you know about homework or other assignments due during the next class period.

Students who are receiving any form of financial aid should check with the Financial Aid Office prior to withdrawing from classes. Withdrawals may affect your eligibility to receive further aid and could cause you to be in a position of repayment for the current semester. Students who fail to attend or participate after the drop date are also subject to this policy.

**Preparation:** You are expected to do the reading assignment before you get to class. Waiting until you get to class to try to read the material does not promote an understanding of the material. There are several advantages to such an effort by you. You will have read the material, and the class will not have to spend time bringing you up to where the rest of the class is.

**Daily Tests:** You must be present in class each day when a daily test or pop quiz is given. You **CANNOT** make-up: any daily test or pop quiz.

**Major Tests:** You are expected to be here for each exam. You cannot “make-up” exams unless you have made specific arrangements with me before the scheduled exam. You **MUST** be present at the scheduled time for the final exam.

**Laboratory Work:** You cannot work in the lab if you do not have your required tools.
• The list of required laboratory tools will be given out in the first class meeting.
• You are expected to have your tools by the beginning of the second week of class.
• Laboratory work sheets are to be turned in when you complete each laboratory assignment.
• **Failure to hand them in at the required time will result in the loss of the lab’s point value.**
• Laboratory work will be done in numerical order according to the lab number.
• You are not to collect two or three laboratory assignments and turn them in at one time.
• If you are absent on a lab day, special arrangements will have to be made with your instructor, to make up the lab.
• You are to work with your laboratory partner. Each day a different lab partner will take the lead. The assignment is not complete until each of you have completed the assignment with good understanding.

**Laboratory Work Area:**
• Will be left clean. All test leads returned to racks on the ends of lab tables, all test boxes returned to cabinet and work area cleaned of all papers, etc.
• Failure to comply with the preceding rules will result in a 10% reduction from the lab grade.
SAFETY:
The student will participate in safety training and will sign off upon completion of the training.

SAFETY GLASSES: Safety glasses are required in all HVAC lab classes where the student is working on operating equipment. Your instructor is charged with enforcing this policy.

HART 1403, AC Controls for HVAC is not normally a class that requires safety glasses.

HOMEWORK:

Homework is due on the day the assignment in the textbook is covered. Homework will be taken up at the beginning of the class on that day. If you are absent from class on the day homework is due, your homework is to be turned in the next scheduled class.

Homework turned in after the day of assignment, **WILL NOT BE ACCEPTED**.

Homework is not group work and is to be completed individually.

WRITTEN WORK:

All written work (homework, etc.) **must be type written. An assignment that is not typed will not be accepted.**

WRITING EXPECTATIONS:

**All homework assignments must be typewritten.**

In completing homework assignments, **you must write out the question in a complete legible sentence/statement.** No abbreviations or short words. (If the question is a multiple choice question, do not make your answer the letter corresponding to the correct answer) Turning in a homework paper that does not meet these standards will result in the paper being returned to you with a comment to **“Redo”**

*Homework will not be accepted anytime after the homework questions are covered in class.*

EXAMPLE:
Question: Define superheat

Your answer might be “Superheat is the temperature of refrigerant vapor above its saturation-change of state temperature.”

REAPEATABILITY ISSUE:
Effective for the Fall Semester 2005, the Dallas County Community Colleges will charge a higher tuition rate to students registering the third or subsequent time for a course. All third and subsequent attempts of the majority of credit and Continuing education/Workforce Training courses will result in higher tuition to be charged. Developmental Studies and some other courses will not be charged a higher tuition rate. Third attempts include courses taken at any of the Dallas County community Colleges since the Fall 2002 semester. For complete information and updates, go to http://www.dcccd.edu/ThirdCourseAttempt/.

STOP BEFORE YOU DROP

For Students who enrolled in college level courses for the first time in the fall of 2007, Texas Education Code 51.907 limits the number of courses a student may drop.

You may drop no more than 6 courses during your entire undergraduate career unless the drop qualifies as an exception. Your campus counseling/advising center will give you more information on the allowable exceptions.

Remember that once you have accumulated 6 non-exempt drops, you cannot drop any other courses with a “W”, therefore please excise caution when dropping courses in any Texas public institution of higher learning, including all seven of the Dallas County Community colleges.

For more information, you may access: https://www1.dcccd.edu.coursedrops

The drop date for HART 1403 is the 3rd of December 2015.

WITHDRAWAL POLICY:

If you are unable to complete this course, it is your responsibility to formally withdraw. Each course has a specific drop date. For this class, the drop/withdrawal request must be received in the Registrar’s Office by 3rd of December 2015.

If you drop a class or withdraw from the college on or before the official drop/withdrawal deadline, you will receive a “W” (Withdraw) in each class dropped. Failure to complete and official withdrawal by the assigned date will result in your receiving a performance grade, usually an “F.”

For complete information on the drop requirements, policies and procedures, refer to the current online college catalog at www.dcccd.edu at the following link https://www1.dcccd.edu/catalog/ss/oep/dw.cfm?use_nav=acad_info&loc=econ

SIX COURSE DROP RULE:

As a result of passage of Senate Bill 1231 during the 80th Texas Legislature, Section 51.907 was added to the Texas education Code. This statute applies to students who enroll in a Texas public institution of higher education for the first time in fall of 2007 or later. Based on this law, DCCCD or any other Texas public institution of higher education may not permit
students to drop more than six courses during their entire undergraduate career. All college level courses dropped after the official drop and add period are included in the six course limit, including courses dropped at another Texas public institution of higher education, unless the reason qualifies as an exception.

**STUDENT E-MAIL:**

Legal privacy issues prevent your instructor from discussing your work or your grades on commercial e-mail accounts. If you wish to send your papers as attachments to an e-mail (and the instructor permits it), or if you have a question about your grade, you must open a student e-mail account. The account is free. You may set it up by going to [www.dcccd.edu](http://www.dcccd.edu) and click on Student Services, Online services, and Student NetMail. All students receiving financial aid must open a student NetMail account.

**INCOMPLETES:**

An incomplete grade of “I” may be given when an unforeseen emergency prevents you from completing the work in a course. The “I” must be converted to a performance grade (A-F) within 90 days after the first day in any subsequent regular semester. If the work is not completed after 90 days, the "I" is converted to a performance grade, usually “F”.

**PRINTING ON CAMPUS:**

Printing in the Computer Lab (L-108), Library, and Learning Assistance Center will cost 5 cents a page. Students must bring a $1.00, $5.00, $10.00, or $20.00 bill to the lab to create an account. Accounts must be created before attempting to print. No change is made in the lab. Once the money is in the bill acceptor, it cannot be retrieved. Cash refunds are not possible. Accounts stay active as long as the account has value.

**EMERGENCY & INCLEMENT WEATHER PROCEDURE:**

In case of emergency or inclement weather conditions, Eastfield students should listen to KEOM-FM Radio station (88.5 FM) as the primary media source. In partnership with the Mesquite Independent school District, Eastfield College Administration will notify KEOM FM immediately after a decision is made to cancel classes on any given day of inclement weather or for emergency purposes. Students may also monitor other local radio and television stations. The earliest an announcement may be broadcast on KEOM Radio is 6 a.m. Students may also refer to the Eastfield College web page [www.eastfieldcollege.com](http://www.eastfieldcollege.com) for the Inclement Weather announcement under the Features area of the front page. The announcement will be posted immediately following the decision to close the college.

**SEXUAL HARRASSMENT:**

Eastfield College has a zero tolerance policy on sexual harassment. All students shall report complaints of sexual harassment informally to the college Human Resources Director or formally to the Vice Chancellor of Educational Affairs

**ACADEMIC HONESTY:**
Scholastic dishonesty is a violation of the Code of Student Conduct. Scholastic dishonesty includes, but if not limited to, cheating on a test, plagiarism, and collusion.

As a college student, you are considered a responsible adult. Your enrollment indicates acceptance of the DCCCD Code of Student Conduct. Published in the DCCD Catalog at http://www1.dcccd.edu/cat0506/ss/code.cfm Internet at http://dcccd.edu.

Academic dishonesty includes, but is not limited to, cheating on tests, plagiarism and collusion.

**Cheating** includes copying from another student’s test or homework paper, using materials not authorized, collaborating with or seeking from another student during a test, knowingly using, buying selling, stealing, or soliciting the contents of an unadministered test, and substituting for another person to take a test.

**Plagiarism** is the appropriating, buying, receiving as a gift, or obtaining by any means another’s work and the unacknowledged submission or incorporation of it in one’s own written work.

**Collusion** is the unauthorized collaboration with another person in preparing written work for the fulfillment of course requirements. Academic dishonesty is a serious offense in college. You can be given a failing grade on an assignment or test, can be failed for the class, or you can even be suspended from college.

**FINANCIAL AID STUDENTS:**

If you are receiving Financial Aid grants or loans, you must begin attendance in all class. Do not drop or stop attending any class without contacting the financial Aid Office. Changes in your enrollment level and failing grades may require that you repay financial aid funds. Failure to contact the instructor will result in your name being submitted to the Financial Aid Office as a “non-attendee”. All students receiving financial aid must open an e-mail account through NetMail. See direction in the syllabus for opening an e-mail account.

**ABSENCE FOR OBSERVATION OF HOLY DAYS:**

Absences for observance of a religious holy day are excused. A student whose absence is excused to observe a religious hold day is allowed to contract with the instructor to take a make-up examination or complete an assignment within a reasonable time after the absence.

**AMERICANS WITH DISABILITIES ACT COMPLIANCE:**

Students requiring accommodations due to the presence of a disability must identify themselves thirty days before the semester begins and demonstrate/document the need for accommodation at the Disability Services Office. For information regarding the rights and responsibilities of students with disabilities, contact the DSO at 972-860-8348. http://www.eastfieldcollege.edu/SSI/DSO

**HAZARDOUS MATERIAL:**
You have the right to know that you may be working with, or in the presence of Hazardous Materials. A list of specific materials is posted on the “Green” Safety Bulletin Boards. Material safety Data sheets are available from the tool room. Students will be trained on the safe handling of these materials.

This syllabus in intended as a set of guidelines for this course. Eastfield College and your instructor reserve the right to make modifications in content, schedule and requirements as necessary to promote the best education possible within prevailing conditions affecting the course.
TENTATIVE HOMEWORK ASSIGNMENTS 10/15/2015

Nov 9th  Go over syllabus and discuss what is expected in class.
         Turn in homework for Unit 13
         Take quiz over Unit 13.
         Watch Power Point presentation on Introduction to Automatic Controls.
         Before next class, read Unit 14 and answer questions at the end of Unit 14.

Nov 10th Discuss Unit 13 and go over questions at the end of Unit 13.
         Turn in homework for Unit 14
         Take quiz over Unit 14.
         Watch Power Point presentation on Automatic Control Components and
         Give handout on electric symbols and Capacitor to study for next class

Nov 11th Discuss Unit 14 and go over questions at the end of Unit 14
         Do handout of Electronic Symbols
         Discuss symbols and Capacitors in class.
         Take quiz over electric symbols and Capacitors.
         Do handout of Electronic Symbols
         Watch Power Point presentation of Thermostats, Go over sequence of operation
         both in cooling and heating.
         Give handout on Thermostats

Nov 12th Take Quiz on Electronic Symbols
         Watch Power Point Presentation wiring diagrams.
         Take quiz over wiring diagrams.
         Before next class, read Unit 19 and answer questions at the end of Unit 19.

Nov 16th Discuss questions at the end of Unit 19
         Take quiz over Unit 19.
         Discuss fan relays and their connection in a ladder diagram on relays and
         how they are connected to multiple speed motors.
         Before next class, read Unit 15 and answer questions at the end of Unit 15.

Nov 17th Turn in homework for Unit 15
         Discuss questions at the end of Unit 15.
         Watch Power Point presentation on Troubleshooting Basic controls.
         Before next class, read handout of transformers and Unit 16 and answer
         questions at the end of Unit 16.

Nov 18th Turn in homework for Unit 16
         Discuss questions at the end of Unit 16.
Take quiz over Unit 16.
Watch Power Point presentation on Advanced Automatic Controls.
Read before next class Unit 30.8 thru 30.15, and answer questions at the end of Unit.

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<tr>
<td>Nov 19th</td>
<td>Turn in homework for unit 30</td>
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<td>Discuss questions at the end of Unit 30</td>
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<td>Take quiz over Unit 30</td>
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<td>Watch Power Point presentation on Electric Heat.</td>
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<td>Give handout on Unit 39 and answer questions at the end of Unit</td>
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<th>Date</th>
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<tr>
<td>Nov 23rd</td>
<td>Turn in homework for Unit 39</td>
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<td>Discuss questions at the end of Unit 39</td>
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<td></td>
<td>Take quiz over Unit 39</td>
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<td></td>
<td>Watch Power Point presentation on Controls.</td>
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<td>Give handout on Circuit Protection Devices for next class</td>
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<th>Date</th>
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<tr>
<td>Nov 24th</td>
<td>Final Written Test</td>
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<td>Nov 25th</td>
<td>Lab Finals</td>
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The instructor may change the reading and testing assignments as required to accomplish the objectives of the course
ADDENDUM A

PERFORMANCE OBJECTIVES

1. The student will not be allowed references. The student will list types of electrical diagrams used in air conditioning field. Performance will be satisfactory if the three types of diagrams used are listed.

2. The student will not be allowed references. The student will draw symbols for loads. Performance will be satisfactory if symbols for loads are drawn and the symbol is consistent with textbook.

3. The student will not be allowed references. The student will state difference between a contactor and a relay. Performance will be satisfactory if differences are stated and the statement is consistent with textbook. (BASIC SKILLS F2.4)

4. The student will not be allowed references. The student will state difference between a contactor and a line starter. Performance will be satisfactory if differences are stated and the statement is consistent with textbook. (BASIC SKILLS F2.4)

5. The student will not be allowed references. The student will draw symbols for switches. Performance will be satisfactory if symbols are drawn and symbol is consistent with textbook.

6. The student will not be allowed references. The student will draw symbols for safety devices. Performance will be satisfactory if symbol for safety devices are drawn and symbol is consistent with textbook.

7. The student will not be allowed references. The student will list difference between single and three phase current. Performance will be satisfactory if difference is listed and the listing is correct.

8. The student will not be allowed references. The student will list factors in sizing circuit conductor. Performance will be satisfactory if factors are listed and the listing is consistent with textbook.

9. The student will be given length of wire and size of wire. The student will solve problems involving voltage drop in conductors. Performance will be satisfactory if problems are solved and calculations are correct.

10. The student will not be allowed references. The student will state law of magnetic poles. Performance will be satisfactory if law of magnetic poles is stated and the statement is consistent with textbook.
11. The student will not be allowed references. The student will describe how frequency effects electric motor operation. Performance will be satisfactory if motor operation is described and the description is correct.

12. The student will be given the frequency and number of poles. The student will calculate synchronous speed of a motor. Performance will be satisfactory if motor speed is calculated and the calculation is correct.

13. The student will be given a selection of motors. The student will identify five types of motors used in air conditioning. Performance will be satisfactory if motors are identified and the identification is correct.

14. The student will be allowed references. The student will describe operation of a split phase motor. Performance will be satisfactory if motor operation is described and the description is consistent with textbook.

15. The student will be provided tools. The student will disassemble and label parts of an electric motor. Performance will be satisfactory if motor is disassembled and parts are correctly identified.

16. The student will not be allowed references. The student will describe operation of single phase motor. Performance will be satisfactory if operation of a single phase motor is described and the description is consistent with textbook.

17. The student will be provided tools. The student will test single phase motors. Performance will be satisfactory if motors are tested and problems are identified. *(Technology C20-4)*

18. The student will be provided tools and meters. The student will troubleshoot AC motors. Performance will be satisfactory if AC electric motors are troubleshot and problems identified.

19. The student will not be allowed references. The student will identify electric motor overloads. Performance will be satisfactory if overloads are identified and the identification is correct.

20. The student will be provided tools. The student will test electric motor overloads. Performance will be satisfactory if overloads are tested and any problems identified. *(Technology C20-4)*

21. The student will be given a capacitor, multimeter, and a power source. The student will check run and start capacitors. Performance will be satisfactory if capacitors are checked correctly.

22. The student will be allowed references. The student will select correct start relay for a given AC motor. Performance will be satisfactory if start relay is selected and the selection is consistent with blue book.
23. The student will be given a start relay. The student will not be allowed references. The student will identify start relay terminals. Performance will be satisfactory if terminals are identified and 5, 2 and 1 are correctly identified.

24. The student will be provided tools and wiring schematics. The student will wire motor circuits. Performance will be satisfactory if circuits are wired and motor operate correctly.

25. The student will not be allowed references. The student will draw electrical diagram of duel voltage AC motor. Performance will be satisfactory if diagram is drawn and the drawing is consistent with textbook.

26. The student will be given a list of components and sequence of operation. The student will draw diagram of motors and stacking components. Performance will be satisfactory if electrical schematic is drawn and the drawing receives a rating of 80.

27. The student will be provided tools, schematic and meters. The student will troubleshoot stacking components. Performance will be satisfactory if electrical components are troubleshooting and problem(s) found. Student may use computer for this objective. *(INFORMATION C8.4)*

28. The student will not be allowed references. The student will describe operation of a pressure switch. Performance will be satisfactory if operation of pressure switch is described, including cut-in, cut-out and differential. *(BAISC SKILLS F6.4)*

29. The student will be provided tools. The student will install stacking components. Performance will be satisfactory if components are installed and the installation receives a rating of 80.

30. The student will be provided tools. The student will test operation of a pressure switch. Performance will be satisfactory if switch is tested and any problems identified. *(Technology C20-4)*

31. The student will not be allowed references. The student will describe operation of heating and cooling anticipator. Performance will be satisfactory if operation of anticipators is described and the description contains reason for anticipator.

32. The student will be allowed references. The student will draw schematic of thermostat. Performance will be satisfactory if schematic is drawn and drawing is correct.

33. The student will not be allowed references. The student will describe thermostat operation. Performance will be satisfactory if operation is described and the description is consistent with textbook.

34. The student will not be allowed references. The student will describe operation of fan-limit switch. Performance will be satisfactory if operation of different types of fan-limit switches is described and the description is correct.
35. The student will be provided tools and a variety of safety controls. The student will wire circuits with safety controls. Performance will be satisfactory if safety controls are wired correctly.

36. The student will be provided tools, schematic and meters. The student will troubleshoot control circuits. Performance will be satisfactory if control circuits are troubleshooting and problems identified. *(Technology C20-4)*

37. The student will be provided tools. The student will test operation of a fan-limit switch. Performance will be satisfactory if switch is tested and any problems in operation identified.

38. The student will be provided tools and wiring schematic. The student will wire complex circuits. Performance will be satisfactory if complex circuits are wired and circuits function properly. *(THINKING SKILLS F9.4)*

39. The student will be provided tools, meters and schematic. The student will troubleshoot complex circuits. Performance will be satisfactory if complex circuits are troubleshooting and faults are identified. *(TECHNOLOGY C20.4)*

40. The student will be given list of components. The student will draw schematic of residential air conditioning system with gas heat. Performance will be satisfactory if schematic is drawn and the drawing receives a rating of 80.

41. The student will be given a wiring schematic, an AC unit and tools. The student will wire Residential AC system. Performance will be satisfactory if residential AC system, with gas heat is wired and unit functions properly. *(THINKING SKILLS F10.4)*

Developed/Revised: Oct 23, 2007
Each student must furnish a set of hand tools and instruments for laboratory performances in HART 1403. Prices for the following tools may vary depending on where they are purchased. After a reasonable amount of time (determined by the instructor) the student will not be able to participate in the labs if he/she does not have the proper tools.

NOTE: The supply and tool room does not have tools for students use.

**GENERAL TOOLS**

- Safety glasses
- Tool box or pouch

**BASIC INSTRUMENTS:**

Choose one of the following.
- Any multimeter that will measure Volts, Amps, Ohms, Temperature and Capacitance

Examples of these meters are the following:
- Fluke 116/322 Combination Kit
- Fieldpiece SC 76 or SC 77
- UEI DL 379 or DL 389
- Kline CL 200 (this meter will only check capacitance 0 – 100 mfd)

**REFRIGERANT TOOLS:**

- Compound manifold gauge set with hoses and one 90° low loss fitting
- Refrigerant valve core
  You will be required to purchase a second set of manifold gauges.
  This set will be used with refrigerant 410a ONLY

**HAND TOOLS:**

- 8 in. and 12 in. adjustable open-end wrenches
- Allen wrench set
- Refrigeration ratchet wrench & with hex key bits
- 6 in. combination pliers (Channel Locks)
- Wire cutters pliers
- Crimping pliers
- Six-in-one screwdriver