

Curriculum Alignment Planning For Heating, Ventilation, Air Conditioning and Refrigeration In California Community Colleges

A Review of HVACR Certificate Programs in Southern California

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Executive Summary

This review is presented as the basis for alignment of Heating, Ventilation, Air Conditioning, and Refrigeration (HVACR) curriculum among five community colleges in Southern California to create a seamless regional career pathway. While the review is not exhaustive, it provides an analysis that can be used by faculty to complete the alignment process.

Each of these five colleges offer an HVACR certificate that prepare entry-level workers for employment. Although the standard community college process for curriculum alignment is through a Course Identification Numbering System (C-ID), the HVACR program structure at these colleges required a different approach. The time and resource intensity was simply too great for C-ID standardization of certificates that range from 18 to 42 units.

As an alternative to C-ID, Applied Learning Science benchmarked the colleges' 49 courses against an industry workforce standard recommended by the Western HVAC Performance Alliance. This certification is not widely used by employers as a recruiting tool, but is generally recognized as the highest competency standard for entry-level HVACR workers.

Faculty identified next steps as a comprehensive review of this benchmarking process, followed by actions that enable credit transfer among the five colleges.

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More information on the HVACR Sector Strategy: www.ECUsectorDWM.com

Project Overview

Applied Learning Science was commissioned to perform a comprehensive review of the HVACR certificate programs in Southern California as well as the HVACRedu online program. The objectives of this review are as follows:

- Perform a crosswalk of the programs' content with *HVAC Excellence* Employment Ready industry certification (www.hvacexcellence.org). *HVAC Excellence* is a non-profit organization that created the first and largest programmatic accreditation for HVACR programs in the United States. It is widely accepted as setting the standard for HVACR program quality. Note that the purpose of the current review was NOT to determine the extent to which each college's program met the standard for *HVAC Excellence* accreditation, but rather to provide documentation of course content in relation to the competencies included in the *HVAC Excellence* framework.
- Assess the extent to which the participating colleges adequately document the content of their HVACR certificate courses. The current effort did not aim to evaluate the quality of the curriculum or the likelihood that students are adequately prepared to enter the workforce as HVACR technicians.

Methodology

Participating Schools:

The review included five (5) Southern California Community College HVACR certificate programs:

- College of the Desert; Palm Desert, CA
- Mount San Antonio College; Walnut, CA
- Cypress College; Cypress, CA
- Los Angeles Trade Technical College; Los Angeles, CA
- El Camino College; Torrance, CA

Additionally, we analyzed the content for HVACRedu, an online certificate program which can be found at www.itsaboutq.net.

Evaluation Approach:

Applied Learning Science partnered with each of the programs being reviewed to gather course outlines for all courses included in the HVACR certificate programs. Over seventy (70) courses were reviewed as part of this study. However, we were not able to gain access to all applicable courses. Note that program gaps, in some cases, exist as a function of missing documentation as opposed to actual course content.

To perform the curriculum crosswalk for each program, we first developed a competency framework based on the competencies and tasks included in the *HVAC Excellence* program. For brevity and ease of interpretation, effort was taken to condense the content in each competency. Care was taken to preserve the intent of each competency. After developing the evaluation framework, a key word search approach was adopted to identify the extent to which each course mapped onto the competencies included in the *HVAC Excellence* program.

We erred on the side of giving the schools “credit” for comprehensively covering the required objectives. However, the level of detail and style of documentation varied greatly across the programs. Our main goal in mapping program content to the *HVAC Excellence* program was to provide a baseline assessment of overlap. Caution should be taken in interpreting the results until the program owners validate the findings.

Courses included in the review:

[see Table on next page]

College of the Desert	Mt SAC	Cypress College	LA Trade Tech	El Camino College	HVACRedu
ACR60 Air Cond / Refrig I	AIRC 10 Technical Mathematics	AC/R 100 Principles of Thermodynamics and Heat Transfer	REF A/C 101 Air Conditioning and Refrigeration Principles and Practices	ACR 5 Electrical	050 HVACR Applied Math
ACR61 Air Cond / Refrig II	AIRC 11 Welding for Air Conditioning	AC/R 110 Air Conditioning I	REF A/C 123 Pipe and Tube Joining Processes	ACR 6 Refrigeration and Air Conditioning Control Systems	101 HVACR Fundamentals
ACR64 Air Cond / Refrig Elec I	AIRC 12 Air Conditioning Codes and Standards	AC/R 120 Piping Practice, Tools and Safety	REF A/C 124 Refrigeration Electrical Circuits and Controls	ACR 21 Air Conditioning Fundamentals	102 HVACR Safety
ACR65 Air Cond / Refrig Elec II	AIRC 20 Refrigeration Fundamentals	AC/R 036 Refrigerants, Charging and Recovery	REF A/C 125 Refrigeration System Components	ACR 22 Basic Refrigeration	103 HVACR Basic Sheet Metal
ACR75 HVACR Systems Design	AIRC 25 Electrical Fundamentals	AC/R 137 Blueprints and Dimension Analysis	REF A/C 133 Refrigeration Service Procedures I	ACR 23 Commercial Refrigeration Applications	106 HVACR Building Systems
ACR76 Facilities Maintenance/Chillers	AIRC 26 Gas Heating Fundamentals	AC/R 105 Electricity for A/C and Refrigeration I	REF A/C 134 Service for Air Conditioning Equipment I	ACR 25 Residential Air Conditioning	107 Principles of Building Science
ACR77 Energy Conservation Methods	AIRC 30 Heat Load Calculations & Design	AC/R 115 Gas Heating and Carbon Monoxide	REF A/C 135 Air Conditioning and Refrigeration	ACR 27 Heating Technologies	109 Basic Hand and Power Tools
ACR78 Safe Refrigerant Mgmt.	AIRC 31 Commercial Electrical	AC/R 106 Electricity for Air Conditioning and Refrigeration II	REF A/C 141 Applied Refrigeration and Air Conditioning Principles	ACR 30 Electrical Controls	110 HVACR Blueprints
ACR80 Gas Heating	AIRC 32A Air Properties and Measurement	AC/R 210 Commercial Refrigeration		ACR 31 HVAC Electronics	111 HVACR Electrical DC Theory Plus
ACR83 All-Weather Systems	AIRC 34 Advanced Mechanical Refrigeration	AC/R 220 A/C Controls and Energy Management			112 HVACR Electrical AC Theory Plus
		AC/R 230 Heat Pumps			113 HVACR Electrical Common Components
		AC/R 205 Commercial Air Conditioning			114 HVACR Electrical Motors
					121 HVACR Systems Air Properties and Measurement
					122 HVACR Systems: Load Calculations
					123 HVACR Air Distribution
					131 HVACR Oil Heat I
					133 HVACR Gas Heat I
					135 HVACR Heat Pumps
					139 HVACR Electric Heat
					141 HVACR Refrigeration I
					142 HVACR Refrigeration II
					201 High Efficiency HVAC
					203 High Efficiency HVAC System Maintenance – Cooling Towers

Evaluation Findings

High-level findings:

To best illustrate coverage of the *HVAC Excellence* content across the schools, a dashboard was created that shows the extent to which the courses included in each certificate program map on to the *HVAC Excellence* competencies.

<i>Program</i> <i>Competency</i>	College of the Desert	Mt SAC	Cypress College	LA Trade Tech	El Camino College	HVACRedu
Core / Electrical	90%	90%	90%	90%	90%	90%
Electric Heat	50%	50%	50%	25%	90%	90%
Air Conditioning	90%	90%	90%	90%	90%	90%
Gas Heat	90%	90%	90%	50%	50%	90%
Oil Heat	90%	90%	90%	25%	90%	90%
Heat Pumps	50%	90%	90%	90%	90%	90%
Light Commercial Air Conditioning	90%	90%	90%	90%	90%	90%
Light Commercial Refrigeration	50%	90%	90%	90%	90%	90%

KEY	
90%	Comprehensive Coverage of Learning Objectives
75%	Significant Coverage of Learning Objectives
50%	Learning Objectives Minimally Covered
25%	Few Learning Objectives Covered
0-25%	Competency not included as part of the Curriculum

Key Takeaways:

For all programs included in the review, the alignment in documentation is fairly strong across the *HVAC Excellence* competencies. We have concluded that the programs' curriculum adequately cover the content required to satisfy the *HVAC Excellence* program. There is variation across schools in terms of structure and the level of detail provided in the published course outlines, which likely contributes to the above findings.

Additional findings:

- Program structure differs considerably across programs, both in duration of program and number of courses required to complete the certificate.
- Across nearly all programs, multiple courses must be taken to meet the requirements for each of the *HVAC Excellence* competencies. This will likely provide a challenge if a stackable credentialing program is to be developed across the programs.
- The level of detail and terminology included in the published course outlines was inconsistent. This not only presented a challenge for the current study, but likely will serve as an issue for students who are trying to determine which program focuses on the skills they are most interested in obtaining.

Cross-walk of Courses by Competency: Core Competencies and Electrical Basics

Core / Electrical	College of the Desert	Mt SAC	Cypress College	LATTC	El Camino College	HVACRedu
Mathematics for HVACR		10, 30	137			101, 111, 112, 121
HVACR industry organizations	60	20,	220	101, 124		101
Energy resources		20	220	101	25	101, 111
Air and water vapor thermodynamics	60	10	100	101, 134, 135		101
Energy efficiency ratings	77	20	230	141	25, 30, 34	107, 111, 123
Duct sizing formulas	75	10, 12	110, 137			103, 121
Heat loss and gain	60, 75	10	145	101	5	107
Describe the process and demonstrate the ability to calculate a residential structure heat loss and gain	60, 75	10	145		30	107
Define and differentiate between Renewable and Sustainable energy	77			41	34, 62	111
State the meaning of the following acronyms BIM, CBECS, ECM, EIA		12	106			142
Describe an energy audit	77		145		62	
Describe a Life Cycle cost Analysis	77		145, 215		25	
Define: EER, SEER, AFUE, HSPF, COP, ECM		12	106, 220, 230		25	107, 142
Define psychrometrics fundamentals.	60	30, 32A	100, 110, 145	101	22	101
Explain the thermodynamics of air and water vapor	60	10, 32A	100	101, 135, 134	22	101, 121
Explain the water vapor cycle in the Earth's atmosphere	60	30	100	101	22	101
Define standard air volume and density	60	10, 32A	100, 110, 145	101, 135	22	101
Identify and explain each line on a psychrometric chart	60	10	100, 110, 145	101	22	101, 121
Explain the comfort zone and the different temperatures and relative humidity's effect on human comfort	60	30, 32A	100, 110, 145	101, 141	22	101, 107, 121, 123, 124
Describe the eight processes of air conditioning and how to plot each on a psychrometric chart	83	32A	110, 145	101	22	121
Define and use the Process Triangle on the psychrometric chart to calculate, sensible heat, latent heat and total heat	60	10, 32A	100, 110, 145	101, 135	22	101, 121, 123, 141
Calculate mixed air problems for infiltration and ventilation		12, 30	110			101
Foundational knowledge of Electrical Theory (e.g., structure of an Atom, Ohms Law, Electrical Safety, AC/DC, motors, electrical diagrams, etc...)	64, 65	25	105, 106, 205	101, 124, 125	5, 21, 30, 31	101, 111, 112, 114, 121
Knowledge and application of safety requirements (i.e., Ladder and fall protection procedures, Lock-out / Tag-out, identification of conductors, grounding procedures, PPE, First Aid, prevention and first aid for electrical shocks and burns, etc...)	64	25	105, 120	101, 124, 125	5, 21, 30, 31	102, 111
Define and measure Locked Rotor Amps, and Full Load Amps.	64	25	105	101	21, 30	111
Disassemble and assemble, and describe the function of the parts of an induction motor.	65	20	106	124, 125, 135	21	113
Describe and demonstrate the method used to change rotation direction in a three phase motor.	65	31	105, 106	124, 125, 135	5, 21	114, 142
Describe a dual voltage three phase motor and demonstrate the wiring configurations.	65	30, 31	106, 220	124, 125, 135	5, 21, 31	114, 142
Demonstrate and explain the purpose of checking the resistance of motor windings.	65	25	105, 106	124, 125, 135	21	114
Describe and demonstrate setup and adjustment of a Variable Frequency Drive (VFD).	76	31		125	31	142
Describe and demonstrate setup and adjustment of a Variable Speed Drive (VSD).	76	31		125	31	142
Determine sequence of operation using schematic wiring diagrams.	64, 65	25	100, 105, 205, 220	124, 125	5, 21, 25, 30	111, 113
Service, install equipment power supply.	64, 66		105	124, 125	5, 21	113
Service, install equipment control circuit.	64, 67	25	105, 220	124, 125	5, 21, 30, 31	113
Clean evaluate and install a contactor.	64, 68	25	105	124, 125	5, 21, 30, 31	113
Clean evaluate and install a control relay.	64, 69	25	105, 106	124, 125	5, 6, 21, 30	113
Evaluate and install start relays (current, potential, and solid state).	64, 70	25	105, 106	124, 125	5, 6, 21, 30	113
Evaluate and install a defrost timer.	64, 71	25	106			
Evaluate and install a line starter.	64, 72	31	106, 120	124, 125		113
Evaluate and install a digital thermostat.	64, 73	25	105	124, 125	5, 6, 31	113
Clean, service and evaluate and install a single stage thermostat.	64, 74	25	105	124, 125	5, 6, 31	113
Clean, service and evaluate and install a dual stage thermostat.	64, 75	25	105	124, 125	5, 6, 31	113
Evaluate and install a transformer.	64, 76	31	105	124, 125	5, 6, 31	114
Evaluate and install a solenoid valve.	64, 77	25	100	101, 135	6	114, 142
Evaluate and install temperature coefficient thermistors.	64, 78		220	135	31	
Clean, evaluate and install a run and start capacitor.	64, 79	25	220	124, 125	21	114
Clean evaluate and install different types of motors (Shaded pole, split phase, PSC, CSR, and ECM).	65		106	124, 125	21	114, 142
Draw and interpret electrical diagrams for the purpose of troubleshooting	64, 65	25	105	124, 125, 135, 133	5	111
Test instruments and tools (e.g., Ohmmeter, Multimeter, Ammeter, Voltmeter, Wattmeter, Megger, Capacitor analyzer...)	60, 61, 64, 65	20, 25, 34	105	124, 125, 135, 101	5, 6, 21, 25, 30, 31	109

Cross-walk of Courses by Competency: *Electric Heat*

Electric Heat	College of the Desert	Mt SAC	Cypress College	LATTC Courses:	El Camino College	HVACRedu
· Foundational knowledge of Electric Heat Theory (e.g., system components, thermostats, installation and service procedures, air flow etc...)	60, 64, 65, 75	30, 31	105, 106, 115	101, 124, 125, 135	5, 27, 30, 31	101, 139
· Ability to apply foundational knowledge (e.g., define BTU, resistive vs inductive load, voltage, static pressure etc...)	60, 64, 65, 76	30, 31	100, 105, 115	124, 125	5, 27, 30, 31	101, 111, 112
· Knowledge and application of safety requirements (i.e., Ladder and fall protection procedures, Lock-out / Tag-out, identification of conductors, grounding procedures, PPE, First Aid, proper use of hand tools, etc...)	60, 64, 65	25,	105, 120	125	27	102, 111
· Describe a dual transformer system	83	25, 31		124, 125	27	139
· Identify the material used to construct electric heater elements					27	139
· Describe the operation of, and evaluate/replace a limit switch		25	115	134, 133, 124	27	139
· Describe the operation and purpose of, and evaluate/replace a fan interlock switch					27	139
· Describe how electric heating elements are rated	64, 65	25				139
· Describe how a sequencer controls blower operation				124	6, 27	139
· Describe the types and proper sizing of drive belts		31				139
· State the typical operating characteristics of a direct drive blower					27	139
· Identify the various types of motor mounts used on residential furnace blower assemblies		26	115		21, 27	139
· State the minimum required clearances for service and safety of an electric furnace		26			27	139
· Determine appropriate wire size for electric furnace installation		26			27	139
· Describe and demonstrate the proper soldering procedures for electrical wiring	60	11	120	101, 135, 123	21	112
· Describe and calculate wire sizing as it applies to voltage drop and length of wiring run	64, 65	25	105		5	112
· Identify the proper location for and install a conventional thermostat	64, 65	25	105	124, 125	5, 31	113, 139
· Explain the detailed wiring and operation of a setback programmable thermostat	64, 65	25	105	124, 125	5, 31	139
· Explain the procedure for setting a heat anticipator on an electric furnace					27	139
· Identify the NEC code requirements for residential thermostat wiring	64, 65	25	105	124, 125	5, 31	113, 139
· State the recommended air velocities throughout the supply and return duct system	75	12, 30	137		27	123
· Describe the construction and efficiencies of varying filtering media and systems		30				139
· Describe "R" values and application of various duct insulation materials	75	30	120, 137			103, 123
· Evaluate and replace a heating element and a sequencer					27	139
· Evaluate, describe its operation, install, and set a pressure differential switch		25	230		27	139
· Evaluate, describe its operation, and install a duct heater						139
· Explain and measure temperature rise	60	30	145		27	139
· Demonstrate the procedure for finding CFM	75		110			101, 123
· Demonstrate and determine the amp draw of electric heating element	64, 65				27	139
· Measure the effects of static pressure on air flow	75, 77	25	110			107, 139
· Measure air velocities throughout the supply and return duct system	75	12, 30	137			123
· Describe the application of and install turning vanes			110			
· Describe and demonstrate the procedure to adjust air flow on a belt driven blower assembly	80		115		27	139
· Choose and install the proper bearings for a residential belt driven blower assembly			115		27	139
· Choose and use the proper lubricant for residential blower motor maintenance					21, 27	139
· Describe and demonstrate the method of wiring heating elements in a single-phase-system		20, 30, 31	105		5	139
· Describe and demonstrate the method of wiring heating elements in a three-phase system (wye or delta)		20, 30, 31	105, 106		5	114, 139
· Describe, fabricate and install various types of duct connectors	75	12, 30	137			103, 123
· Install a setback programmable thermostat	64, 65	25	115	124, 125	5, 31	139
· Test instruments and tools (e.g., ohmmeter, multimeter, ammeter, voltmeter, wattmeter, megger, capacitor analyzer, etc...)	64, 65	25, 34	105	101, 135	5, 6, 21, 25, 27, 30, 31	109, 139

Cross-walk of Courses by Competency: Air Conditioning

Air Conditioning	College of the Desert	Mt SAC	Cypress College	LATTC Courses:	El Camino College	HVACRedu
· Foundational knowledge of Air Conditioning Theory (e.g., leak detectors, laws of Thermodynamics, atmospheric pressure, pressure, refrigerant charging methods, etc...)	60, 61, 78	20, 25, 10, 31, 32A, 34	36, 100, 105, 106, 110, 205	101, 133, 134, 125	5, 6, 21, 22, 23, 31	101, 107, 111, 112, 113, 114, 121, 141, 142
· Ability to apply foundational knowledge (e.g., define enthalpy and entropy, explain condensation and vaporization, describe vacuums as they relate to the HVACR industry, etc...)	60, 61	20, 25, 10, 31, 32A, 34	36, 100, 105, 106, 110, 205	101, 134, 135, 125	5, 6, 21, 22, 23, 31	101, 107, 111, 112, 114, 121, 141, 142
· Knowledge and application of safety requirements (i.e., Ladder and fall protection procedures, Lock-out / Tag-out, safe handling of refrigerants, PPE, First Aid, proper use of hand tools, etc...)	60, 61	20, 25, 10, 31, 34	36, 105, 120	101, 135, 125, 123, 134	5, 6, 21, 22, 23, 31	102, 109, 111, 142
· Advanced knowledge of AC system components including how to evaluate, clean, and replace each (e.g., evaporators, accumulators, condensers, etc...)	60, 61	20, 34	100, 105, 110	101, 135	5, 6, 21, 22, 23	141
· Describe the state of refrigerant, and explain what occurs in each major component during normal operation	60, 61	20, 34	100, 110, 120	101	5, 6, 21, 22, 23	141
· Describe a compressor efficiency test.	61	20, 34	100, 205	101, 135	6, 21, 23	141
· Describe and demonstrate proper soldering and brazing techniques.	60	AIRC11	120	101, 135, 123	21, 22, 23	103
· Identify proper charging of a blended refrigerant into an operating system.	60	20	36, 205	101, 135	21, 22, 23	141
· Identify proper charging of a blended refrigerant into an empty system.	60	20	36, 205	101, 135	21, 22, 23	141
· Identify proper charging of a compound refrigerant into an empty system.	60	20	36, 205	101, 135	21, 22, 23	141
· Identify proper charging of a compound refrigerant into an operating system.	60	20, 34	36, 205	135	21, 22, 23	141
· Describe charging using the superheat method.	61	20, 34	36, 205, 210, 220	101, 135	21, 23, 22, 25	141
· Describe charging using the subcooling method.	61	20, 34	36, 205, 210, 220	101, 135	21, 23, 22, 25	141
· Explain vacuum pump selection		20, 31	36	101, 135	21, 23	141
· To measure wet and dry-bulb temperatures		32A	110, 145	135	21, 22, 23	101
· To measure vacuum		20	36, 145	101, 135	21, 22, 23	141
· Use saturation tables.	60		36, 100		21, 22, 23	141
· Properly use a gauge manifold assembly.	60	20	36	134, 135	21, 22, 23	141
· To obtain gauge pressure using compound gauges and convert to absolute	60	20	110	101, 135	21, 22, 23	141
· To pinpoint a refrigerant leak in a system	60	20	36	135, 125	21, 22, 23	141
· The proper use and handling of nitrogen in the leak detection process	60, 78	20	36, 120	123, 135	21, 22, 23	141
· Demonstrate proper use of leak detectors.	60, 78	20		101, 135, 123	21, 22, 23	141
· Demonstrate the proper method of connecting a micron gauge	78	20		101, 135	21, 22, 23	141
· Demonstrate the triple evacuation method.		20	36	101, 135	21, 22, 23	141
· Demonstrate proper charging of HCFC and HFC refrigerants into an operating system	78	20	36	135	21, 22, 23	142
· Demonstrate proper charging of HCFC and HFC refrigerants into an empty system	78	20	36	135	21, 22, 23	142
· Demonstrate charging using the manufacturers literature	60, 78	20	36	135	21, 22, 23	142
· Determine and demonstrate superheat and subcooling on an operating system	61, 78	20, 34	36, 205, 210, 220	101	21, 23, 25	141
· Calculate and demonstrate the weigh-in charging method	61	20	36	135	21, 22, 23	142
· Select the proper refrigerant oil and add it to an operating system.	60, 61, 78	20	205, 210, 220	135	21, 22, 23	142
· Test instruments and tools (e.g., thermometers, refrigerant throttling valve, gauge manifold assembly, etc...)	60, 61, 64, 65, 76	20, 34	100, 105	101, 135	5, 6, 21, 22, 23, 25, 30, 31	109, 141

Cross-walk of Courses by Competency: *Gas Heat*

Gas Heat	College of the Desert	Mt SAC	Cypress College	LATTC Courses:	El Camino College	HVACRedu
- Foundational knowledge of Gas Heat Theory (e.g., combustion theory and heating fuels, BTU content of natural and propane gases, gas temperatures, venting categories, ignition temperature, etc...)	80	26, 12	100, 115	101, 124, 125, 135	5, 27, 30, 31	101, 107, 133
- Ability to apply foundational knowledge (e.g., define AFUE, define and differentiate between primary air and excess air, understand "flashback, Carbon Dioxide, polarity wiring on solid state circuits, etc...)	80	26, 12	106, 115	124, 125	5, 27, 30, 31	101, 133
- Knowledge and application of safety requirements (i.e., Ladder and fall protection procedures, clearances to combustibles for venting procedures, maximum carbon monoxide levels gas leaks, etc...)	80	26, 12	105, 120	125	5, 27, 30, 31	102, 107, 111, 133
- Describe an orifice and its function	80	26	115	101		133
- Describe a pilot burner and its function	80	26	115		27	133
- Describe an in-shot burner and its operation	80	26	115		27	133
- Describe the function of a heat anticipator	80	25	115		27	133
- Describe the function of a dual stage thermostat	64, 75, 80	25	115	124, 125	5, 6, 31	133
- Describe the function flue baffles	80		115		27	133
- Describe a blower housing cut-off plate	80		115		27	133
- Describe the principles of humidification	80	30	115			
- Describe the principles of dehumidification	80	30	115			
- Describe the operation of and the testing method for gas heat components.	80	26	115	125	5, 27	133
- Describe "R" values and noise reduction elements of various duct materials.	75	12, 30	137			123
- Describe and size wire as it applies to voltage drop and length of wiring run.	64, 65	30	105	124	5	112
- Describe and demonstrate proper soldering procedures for electrical wiring.	60	11, 25	120	124	21	103
- Describe the procedure and adjust air flow on a belt driven blower assembly.	80	26	115	124	27	133
- Identify the different types of conduit used for power wiring.	80	12	106	124, 125, 135		112
- Cut and thread gas pipe	80	12	115, 120	123		
- Install a fire stops support plate	80		115			133
- Install duct connectors and hangers	75	12, 30	115			103, 123
- Adjust blower fan speed	80	26	115	124	27	123
- Service and install a heat exchanger	80	26	100, 120		27	133
- Describe thermocouple	80	26	115	135		133
- Describe thermopile	80	26	115	135		133
- Service and install a combination fan and limit switch	80	25, 26	115	134, 133, 124	27	133
- Service and install door safety switch	80	25, 26	115	135	27	133
- Service and install a blower motor relay	80	25, 26	115	124	21, 30	133
- Service and install a spark igniter	80	25, 26	115		6	133
- Service and install a vent motor relay	80	25, 26	115		21, 30	133
- Service and install a flame sensor	80	25, 26	115			133
- Service and install an ignition module	80	25, 26	115	125	6	133
- Service and install a run and start capacitor	64, 79, 80	25, 26	115	124	21	114
- Service and install a residential gas valve	80	26	115		6	133
- Service and install a vent pressure switch	80	26	115	124	27	
- Test instruments and tools (e.g., combustion analyzer, ohmmeter, combustible gas detector, voltmeter, carbon monoxide detector, etc...)	64, 65, 80	25, 26, 34	105, 115	101, 135	5, 6, 21, 25, 27, 30, 31	133

Cross-walk of Courses by Competency: *Oil Heat*

Oil Heat	College of the Desert	Mt SAC	Cypress College	LATTC Courses:	El Camino College	HVACRedu
• Foundational knowledge of Oil Heat Theory (e.g., BTU content of fuel oil, venting categories, gravity of #2 fuel oil, gas temperatures, pour point, viscosity, etc...)	60, 64, 65, 75, 83	26	100, 115	101, 124, 125, 135	5, 27, 30, 31	101, 107, 131
• Ability to apply foundational knowledge (e.g., define BTU, define AFUE, state the quantity of combustion air required to burn one gallon of fuel oil, define and differentiate between primary air and excess air, polarity wiring on solid state circuits, etc...)	60, 64, 65, 75, 83	26	100, 106, 115	124, 125	5, 27, 30, 31	101, 131
• Knowledge and application of safety requirements (i.e., Ladder and fall protection procedures, clearances to combustibles for venting procedures, proper safety procedures to follow on discovery of an oil leak, etc...)	60, 64, 65		105, 120	125	5, 27, 30, 31	102, 107, 111
• Describe function of a thermostat heat anticipator	80	26	115		27	139
• Describe the function of a programmable thermostat	64, 65	25, 26	105	124, 125	5, 31	113
• Describe the procedure to measure static pressure	77	25	110			107
• Describe the function of flue baffles	80		115		27	131, 133
• Describe a blower housing cut-off plate	80		115		27	131
• Describe the principles of humidification	75	30	115			131
• Describe the principles of dehumidification	75	30	115			131
• Describe the procedure to de-rate an oil furnace at altitudes of 2,000 feet and above		26			27	131, 133
• Identify the different types of conduit used for power wiring	75	25	106	124, 125, 135		112
• Describe the purpose and operation of delayed action solenoid valve	64, 77	25	100	101, 135	6	131
• Describe the testing and adjustment procedure of a barometric draft control					6	
• Describe the function of and the testing method for a fuel unit cut-off		26			27	131
• Identify duct connectors and hangers	75	12, 30	137			123
• Explain "R" value and noise reduction elements of various duct materials	75	12, 30	137			123
• Describe wire sizing as it applies to voltage drop and length of wiring run	64, 65	26	105		5	112
• Describe and proper soldering procedures for electrical wiring	60	26	120		21	112
• Describe the procedure to adjust air flow on a belt driven blower assembly	80	26	115	124	27	131
• Describe the procedure to perform a smoke density test on an oil furnace		26			27	131
• Service and install a high voltage ignition system		25, 26			6	131
• Service and install a blower motor relay	80	25, 26	115	124	21, 30	131
• Service and install a door safety switch	80	25, 26	115	135	27	131
• Service and install a heat exchanger	80	25, 26	100, 120		27	131
• Service and install a cadmium sulfide cell		25, 26				131
• Service and install a run and start capacitor	64, 79, 80	25, 26	220	124, 125		114, 131
• Service and install a burner primary safety control	76	25, 26			6	131
• Service and install a single stage thermostat	64, 65, 80	25, 26	105	124, 125	5, 31	131
• Service and install a fuel oil pump					27	131
• Service and install a fan and limit switch	80	25, 26	115	134, 133, 124	27	13
• Service and install a Install duct connectors and hangers	75	12, 30	115		43	123
• Perform a smoke density test on an oil furnace					27	131
• Service and install a fire stop support plate	80		115			
• Test instruments and tools (e.g., combustion analyzer, stack thermometers, pressure gages, pipe reamers, meters, etc...)	64, 65, 80	26	105, 120	101, 135	5, 6, 21, 25, 27, 30, 31	131

Cross-walk of Courses by Competency: Heat Pumps

Heat Pumps	College of the Desert	Mt SAC	Cypress College	LATTC Courses:	El Camino College	HVACRedu
- Foundational knowledge of Heat Pump Theory (e.g., refrigerant recovery, refrigerant recycling, refrigerant reclamation, soldering and brazing, thermodynamics, psychromatics, etc...)	60, 61, 76, 78, 83	20, 26, 30, 31, 34	36, 100, 110, 115, 120, 230	101, 125, 135	6, 21, 23, 25, 27, 30, 31	101, 121, 135, 141, 142
- Ability to apply foundational knowledge of Heat Pump Theory (e.g., humidification/dehumidification, leaks, charging, superheat & subcooling, micron gauges, line driers, compressors, heat/cool relays, defrost controls, valves, etc...)	60, 61, 78, 83	20, 26, 30, 31, 34	36, 100, 115, 205, 220, 230	101, 125, 136	6, 21, 23, 25, 27, 30, 31	101, 114, 135, 141, 142
- Describe a heat pump's design, configuration for both the heating and cooling cycle	83	25,	230	101	27	135
- Differentiate between a compressor designed for use in a heat pump and one that is designed for use in a cooling only air conditioner		25, 34	205, 230	101	27	135
- Find and repair a refrigerant leak	60, 77, 78	20	36	135, 125	21, 22, 23	135
- Handle and use nitrogen in the leak detection process	78	20	36, 120		21, 22, 23	135
- Demonstrate the operation and use of a gauge manifold assembly	60	20	230	101	21, 22, 23	135, 141
- Correctly use a micron gauge and connect to the system	78	20	230	101	21, 22, 23	101
- Perform the triple evacuation method	78	20	36, 230	101	21, 22, 23	135
- Demonstrate proper charging of HCFC and HFC refrigerants into an operating and empty system	78	20	36	101, 135	21, 22, 23	135, 142
- Select the proper and add refrigerant oil it to an operating system	60	20	36	101, 135	21, 22, 23	135, 142
- Demonstrate charging using the manufacturers literature	60	20	36		21, 22, 23	135
- Calculate and demonstrate the weigh-in charging methods	60	20	36	101, 135	21, 22, 23	135
- Accurately charge using the subcooling method	61	20	230	101, 135, 133,	21, 22, 23	135
- Describe the function of a lockout relay in a circuit		25	105, 106	133, 124	6, 21, 30	135
- Test and install a run and start capacitor	64, 79, 80	25		135, 124	21, 22, 23	114
- Evaluate and install a compressor potential start relay		25	105, 106	101, 133, 124	21, 23, 30	135
- Evaluate and install low and high pressure switches	64, 65	25	230	134, 133, 124	21, 22, 23	135, 139
- Evaluate and install a service valve	76	20	100, 230	101, 135, 124	21, 22, 23	135, 142
- Evaluate and install a liquid line drier		25	100, 230			135, 142
- Evaluate and install a liquid line bi-flow drier			100, 230			135, 142
- Evaluate and install a suction line filter drier			100, 230			135
- Perform a compressor efficiency test	61	25, 26, 34	100, 230	101, 135, 133,	6, 21, 23	135
- Install a heat/cool relay	64, 71	25	230	124,	21, 27	135
- Install a mechanical defrost control	64, 71	31, 34	230	101,	6, 23	
- Install a time/temperature defrost control	64, 71	31, 34	230	101	6, 23	135
- Install a solid state defrost control	64, 71	31, 34	230	101	6, 23	135
- Service and install a bimetal outdoor coil temperature sensor.		25	230	135	27	135
- Service and install a thermistor type temperature sensor (PTC & NTC)		31, 34	230	135	23, 31	135
- Service and install a defrost relay	64, 71	25, 31	230		23	135
- Service and install an outdoor thermostat.	64, 71	25	105	135, 133	5, 31	135
- Evaluate and replace a reversing valve	83	25	100, 230	101	6, 27	135
- Evaluate and replace an accumulator		30, 34	230			135
- Evaluate and replace a capillary tube		25, 30, 34	100, 230	101	23	135
- Service and install a fixed orifice	60, 78, 80	26	100	101		135, 141
- Service and install a thermostatic expansion valve		25, 34	100, 230	101, 135	23	135
- Service and install an electronic expansion valve.		25, 34	100, 230	101, 135	23	135
- Service and install a Control Circuit Fuse.	64, 65	25	220	124	5, 30	135, 137
- Install a printed circuit board (PC).	64, 65	25	220	124	5, 30	135
- Install a heat pump thermostat with emergency heat feature		25	230	101	27	135
- Evaluate and replace a defrost board		31	230	101	27	135
- Measure system air flow	75	25	110	101		123
- Evaluate and replace a check valve	76	25	100	101	6, 27	135
- Test instruments and tools (e.g., thermometers, gauge manifold assembly, recovery equipment, vacuum pump, micron gauge, leak detectors, etc...)	60, 61, 64, 65, 76, 78	25, 34	100, 105, 230	101, 135	5, 6, 21, 25, 27, 30, 31	107, 135, 141

Cross-walk of Courses by Competency: Light Commercial Air Conditioning

Light Commercial AC	College of the Desert	Mt SAC	Cypress College	LATTC Courses:	El Camino College	HVACRedu
- Foundational knowledge of Light Commercial Air Conditioning Theory (e.g., leak detectors, laws of thermodynamics, recovery and recycling processes, refrigerant piping, soldering and brazing, pressure controls, etc...)	60, 61, 76, 78	20, 25, 10, 31, 32A, 34	36, 100, 106, 120, 205, 220	101, 124, 125, 134, 135	5, 6, 21, 22, 23, 31	101, 103, 104, 123, 141, 142
- Ability to apply foundational knowledge (e.g., service valves, compressors, micron gauges, functions of an accumulator, evaporators, condensers, pump-down systems, refrigerant oils, wet bulb depression, economizers, SEER and EER, leak detectors, etc...)	60, 61, 76, 78	20, 25, 10, 31, 32A, 34	36, 100, 110, 205, 220	101, 124, 125, 135	5, 6, 21, 22, 23, 31	101, 103, 114, 121, 141, 142
- Knowledge and application of safety requirements (i.e., lock out and tag out procedures, system leak-test pressures and nitrogen regulator installation and adjustment, connecting a micron gauge to the system, etc...)	60, 78	20, 34	36, 100, 105, 120, 205	101, 124, 125, 135	5, 6, 21, 22, 23, 31	102, 111, 141, 142
- Define and demonstrate refrigerant recovery	60, 76, 78	20	36, 205	101	21, 22, 23, 34	142
- Define and demonstrate refrigerant recycling	60, 76, 78	20	36, 205	135	21, 22, 23, 34	142
- Explain and demonstrate the method for pinpointing a leak.	60	20	36, 205	101, 135, 123	21, 22, 23, 34	141
- Demonstrate the proper use of each type of leak detector and their applicability.	78	20	36, 205	101, 135, 123	21, 22, 23, 34	107
- Explain and demonstrate the proper use and handling of nitrogen in the leak detection process.	78	20	100	123, 135	21, 22, 23, 34	141
- Describe and demonstrate proper soldering and brazing techniques.	60	11	120	101, 135, 123	21	103, 104
- Describe and demonstrate the operation and use of a gauge manifold assembly.	60	20	36, 205	101	21, 25	141
- Identify and demonstrate the proper method of charging a blended refrigerant into an operating system.	78	20	36, 205	101, 135	21, 22, 23	141
- Identify and demonstrate the proper method of charging a blended refrigerant into an empty system.	78	20	36, 205	101, 135	21, 22, 23	141
- Identify and demonstrate the proper method of charging a compound refrigerant into an empty system.	78	20	36, 205	101, 135	21, 22, 23	141
- Identify and demonstrate the proper method of charging a compound refrigerant into an operating system.	78	20	36, 205	101, 135	21, 22, 23	141
- Describe and demonstrate charging using the superheat method.	61, 78	20, 34	36, 205, 210	101, 135	21, 23, 25	141
- Describe and demonstrate charging using the subcooling method.	61, 78	20, 34	36, 205, 210	101, 135	21, 23, 25	141
- Describe and demonstrate the triple evacuation method.	78	20	205	101, 135	21, 23	141
- Explain and demonstrate the proper method of connecting a micron gauge to the system.	78	20	205	101, 135	21, 22, 23	101, 141
- Describe the function of, and install a lockout relay in a circuit.	64, 65	25	105	133, 124	6, 21, 30	113
- Describe the operation of and install a contactor.	64, 65	25	220	133, 134	21	113
- Describe, test, and install a run and start capacitor.	64, 65	25	220	124, 125	21	114
- Describe and install a compressor potential start relay.	64, 65	25	105, 106	101, 133, 124	6, 21, 30	113
- Describe the operation of and test a high pressure switch.	64, 65	25	220	134, 133, 124	6, 21	
- Describe the operation of and test a low pressure switch.	64, 65	25	220	101	6, 21	
- Test a blower or fan motor and its circuit.	64, 65	25	220	124, 125	31, 21	123
- Describe and wire the terminal connections of a thermostat temperature control.	64, 65	25	105	135	5, 30	113
- Describe and install a liquid line drier.			100			135, 142
- Describe and install a suction line filter drier.			100			135, 142
- Describe and test thermistor type temperature sensors (PTC & NTC).		31, 34	220	135	31	
- Describe the function and check the operation and of an oil pressure safety control.	76	31		101	6	142
- Describe the operation of and test a solenoid valve.	76	25	100	101, 135	6	141, 142
- Describe the operation of and test a hot gas bypass valve.	76	31, 34	100		6	141
- Describe the operation of and test a liquid line solenoid valve.	76	25	100		6	141, 142
- Describe the operation of and adjust an inline, and pilot operated evaporator pressure regulator.		34	100		23	141, 142
- Describe the operation of and install a fixed orifice metering device.	60, 78	34	100	101		141
- Describe the operation of and install a thermostatic expansion valve.	76	25	100	101, 135	23	141
- Describe the operation of and install a refrigerant receiver.	76	34	100			141
- Describe the operation and function of a flooded evaporator and its metering device.	76	34	100	101	23	141
- Install and adjust a water regulating valve.	76	31, 34	220		23	141
- Install and adjust a low ambient temperature control.		25	220		6	142
- Size, design, and install refrigerant lines.	76	31, 34		133, 134	21, 22, 23	141
- Describe the required CFM for system operation and calculate air flow.	75	31, 34	110	124		101, 123
- Install and properly adjust an economizer		31, 34	220			
- Install a condensate drain.			220			
- Test instruments and tools (e.g., ammeter, oil pressure gauge, oil pump, nitrogen cylinder, vacuum pump, sling psychrometer, thermometers, recovery equipment, charging scales, cylinder, gauge manifold assembly, etc...)	60, 61, 64, 65, 78	20, 25, 34	36, 100, 105	101, 135	5, 6, 21, 25, 30, 31	101, 109, 121, 141

Cross-walk of Courses by Competency: Light Commercial Refrigeration

Light Commercial Refrigeration	College of the Desert	Mt SAC	Cypress College	LATTC Courses:	El Camino College	HVACRedu
- Foundational knowledge of Light Commercial Refrigeration Theory (e.g., leak detectors, laws of thermodynamics, recovery and recycling processes, refrigerant piping, soldering and brazing, pressure controls, etc...)	60, 76, 78	20, 25, 10, 31, 32A, 34	36, 100, 106, 120, 205, 210, 220	101, 124, 125, 134 135	5, 6, 21, 23, 31	141, 142
- Ability to apply foundational knowledge (e.g., service valves, compressors, micron gauges, functions of an accumulator, evaporators, condensers, pump-down systems, refrigerant oils, wet bulb depression, economizers, SEER and EER, leak detectors, etc...)	60, 76, 78	20, 25, 10, 31, 32A, 34	36, 100, 110, 120, 205, 210, 220	101, 124, 125, 135	5, 6, 21, 23, 31	141, 142
- Knowledge and application of safety requirements (i.e., lock out and tag out procedures, system leak-test pressures and nitrogen regulator installation and adjustment, connecting a micron gauge to the system, etc...)	76, 78	20, 25, 10, 31, 34	36, 100, 105, 120	101, 124, 125, 135	5, 6, 21, 23, 31	141, 142
- Describe a cascade system its application and operation	76	34	210	135	21, 22, 23	201
- Describe the automatic pump-down system and its operation		34	210	135	23	201
- Describe the application and operation of the following types of compressors; (reciprocating, scroll, rotary, screw, centrifugal)	76	34	36, 100, 205	101, 135	23	142
- Describe defrost cycle initiation and termination	76	31, 34	210	135	23	141
- Describe the purpose and applicability of a defrost cycle		31, 34	210	135	23	141
- Describe a drain and drain pan heater and their operation		31, 34	210			
- Describe a Head Master and its operation		34	210			142
- Describe a capillary / distributor tube sizing and selection procedure		32A, 34	100, 120	135	23	141
- Describe a fixed orifice metering device and its operation	76, 78	20, 34	100	101	23	141
- Describe a refrigerant receiver and its function	76	20, 34	100	135	21	142
- Describe an oil separator and its function		34	100	135		142
- Describe dry type evaporators and their operation	76	34	100, 110	135	23	141
- Describe an air cooled condenser, its function, and operating parameters	76	34	100	135	23	141, 142
- Describe the proper procedure for measuring and adjusting superheat		34	36, 205, 210	101, 135	21, 23, 25	141
- Describe the proper maintenance of a low temperature evaporator	76	34	36	135	23	141
- Describe the operation and function of a flooded evaporator and its metering device	76	34	36, 100	135	23	141
- Describe types of water cooled condensers and their operation	76	34	36, 100	101	23	141
- Describe cooling towers and their operating limitations	76	34	210	101, 135	23	201, 203
- Describe the function and purpose of a multiple compressor system	60	34	36, 100, 205	135	23	201
- Describe the purpose and proper selection of, and install a suction line heat exchanger		34	100, 120		23, 27	
- Describe the operation of and test various fan controls		20, 32A, 34	110, 220	124, 125	6, 30	141
- Define and state the applications of High, Medium, and Low temperature refrigeration	76	34	205, 210	135		141
- Define fractionation and temperature glide		32A, 34	210			
- State the reason why capillary tube systems require a critical charge		32A, 34	100	101	23	141
- Define "Expendable Refrigerant"	76		100		21	
- Define and explain the use of high humidity evaporator coils	76	32A	100, 110	101		141
- Describe the various methods of compressor capacity control	76	34	205, 210	101	6, 23	142
- Describe the function, selection and installation of a vibration eliminator		34	205, 210			
- Describe the basic operation of ice makers		34	205, 210	135		
- State the selection process for refrigerant oils	76	20, 34	205, 210	135	21	142
- Explain the procedures to retrofit a system from a CFC to an HFC, & an HCFC to an HFC	76, 78		36	135	6	142
- Describe the design structure, function, operation, and selection of refrigerant distributors and feeder tubes		32A, 34	205			141
- Install and adjust a low pressure switch used for temperature control	64, 65		210	134, 133, 124	23, 30	141
- Install a condensate drain	75	34	205, 210			141
- Size, design and install refrigerant lines	76	32A, 34	205	101, 135	21, 22, 23	141
- Test instruments and tools (e.g., ammeter, oil pressure gauge, oil pump, nitrogen cylinder, vacuum pump, sling psychrometer, thermometers, recovery equipment, charging scales.cylinder, gauge manifold assembly, etc...)	60, 61, 64, 65, 78	31, 34	36, 100, 105, 210	101, 135	5, 6, 21, 25, 30, 31	141