

Interprovincial Program Guide Refrigeration and Air Conditioning Mechanic --- 2015

**CANADIAN
STANDARD
OF EXCELLENCE
FOR SKILLED TRADES**



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Employment and
Social Development Canada

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Développement social Canada

Canada 

Refrigeration and Air Conditioning Mechanic

2014

Trades and Apprenticeship Division

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Foreword

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Interprovincial Program Guide (IPG) as the national curriculum for the occupation of Refrigeration and Air Conditioning Mechanic.

Jurisdictions have long recognized the benefit of pooling resources in the development and maintenance of apprenticeship training standards. A successful example of this is the Interprovincial Standards Red Seal Program itself. Essential to the establishment of standards is the development of suitable training systems and programs which enable tradespeople to acquire certification based on these standards. While certification is the responsibility of Apprenticeship administrators throughout Canada, the development and delivery of technical training is the responsibility of jurisdictions.

In 1999, work to develop common training for apprenticeship programs within the Atlantic Provinces began. To date, 22 Curriculum Standards have been developed through the Atlantic Standards Partnership (ASP) project to assist programming staff and instructors in the design and delivery of technical training. Similarly, the CCDA embarked on a process for the development of national IPGs for the Boilermaker, Carpenter and Sprinkler System Installer trades. At its January 2005 strategic planning session, the CCDA identified developing common training standards as one of the key activities in moving towards a more cohesive apprenticeship system.

With the support of Employment and Social Development Canada (EDSC), several provinces and territories have partnered to build on the ASP and the CCDA processes to further develop IPGs to be used across the country. This partnership will create efficiencies in time and resources and promote consistency in training and apprentice mobility.

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Michael Melanson	New Brunswick
Jason Rockson	British Columbia

In addition to the representatives above, various federal, provincial and territorial representatives contributed to the development of this document including the host province of Saskatchewan.

As this program guide will be amended periodically, comments or suggestions for improvement should be directed to:

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User Guide

According to the Canadian Apprenticeship Forum, the IPG is: "a list of validated technical training outcomes, based upon those sub-tasks identified as common core in the National Occupational Analysis (NOA), and validated by industry in the provinces and territories as incorporating the essential tasks, knowledge and skills associated with a given trade."

Learning outcomes contained in the IPG represent the minimum common core content for the development of jurisdictional training standards and outlines. IPGs are developed based on the NOAs and extensive industry consultation. The IPG is intended to assist program development staff in the design of jurisdictional plans of training. Each jurisdiction has the flexibility to add additional content.

The IPG was deliberately constructed for ease of use and flexibility of structure in order to adapt to all delivery requirements. It details units of training, unit outcomes and objectives. It does not impose a delivery model or teaching format.

Jurisdictions and/or training providers will select and develop delivery materials and techniques that accommodate a variety of learning styles and delivery patterns. The IPG does not dictate study materials, textbooks or learning activities to be used in delivery.

The IPG document includes a recommended levelling structure to facilitate mobility for apprentices moving from one jurisdiction to another. Because of difference in jurisdictional regulations and program durations, levels are offered as suggestions only.

Structure

The IPG is divided into units which are identified by unique codes. The unit codes are used as a means of identification and are not intended to convey the order of delivery. Prerequisites have not been detailed. Each unit consists of *Learning Outcomes* and *Objectives and Content*.

The *Learning Outcomes* are the specific performances that must be evaluated. Wording of the learning outcomes, "Demonstrate knowledge of...", acknowledges the broad spectrum of ways in which knowledge can be shown. It is at the discretion of each jurisdiction to determine the manner in which learning outcomes are evaluated; theoretically, practically or a combination of both.

User Guide (continued)

The *Objectives and Content* for the unit details the information to be covered in order to achieve the performances specified in the *Learning Outcomes*. These objectives can be either theoretical or practical in nature, based on the requirements identified through the industry consultation process. The learning activities used to cover the objectives are at the discretion of the jurisdiction; however, practically worded objective statements have been used where industry indicated a need for the apprentices to receive exposure to performing the task or skill outlined while attending technical training. For example, this exposure could be done through instructor demonstration or individual or group performance of the skill or task. This practical training will help to reinforce the theoretical component of the technical training.

Detailed content for each objective has not been developed. Where detail is required for clarity, content has been provided. The content listed within the IPG document is **not** intended to represent an inclusive list; rather, it is included to illustrate the intended direction for the objective. Content may be added or extended in jurisdictional training plans as required.

Jurisdictions are free to deliver the IPG units one at a time or concurrently, provided that all *Learning Outcomes* are met. The IPG does not indicate the amount of time to be spent on a particular unit as the length of time required to deliver the *Learning Outcomes* successfully will depend upon the learning activities and teaching methods used.

IPG Glossary of Terms

These definitions are intended as a guide to how language is used in the IPGs.

ADJUST	To put in good working order; regulate; bring to a proper state or position.
APPLICATION	The use to which something is put and/or the circumstance in which you would use it.
CHARACTERISTIC	A feature that helps to identify, tell apart, or describe recognizably; a distinguishing mark or trait.
COMPONENT	A part that can be separated from or attached to a system; a segment or unit.
DEFINE	To state the meaning of (a word, phrase, etc.).
DESCRIBE	To give a verbal account of; tell about in detail.
DIAGNOSE	To analyze or identify a problem or malfunction.
EXPLAIN	To make plain or clear; illustrate; rationalize.
IDENTIFY	To point out or name objectives or types.
INTERPRET	To translate information from observation, charts, tables, graphs, and written material.
MAINTAIN	To keep in a condition of good repair or efficiency.
METHOD	A means or manner of doing something that has procedures attached to it.
OPERATE	How an object works; to control or direct the functioning of.
PROCEDURE	A prescribed series of steps taken to accomplish an end.

IPG Glossary of Terms (cont'd)

PURPOSE	The reason for which something exists or is done, made or used.
TECHNIQUE	Within a procedure, the manner in which technical skills are applied.
TEST	<p>v. To subject to a procedure that ascertains effectiveness, value, proper function, or other quality.</p> <p>n. A way of examining something to determine its characteristics or properties, or to determine whether or not it is working correctly.</p>
TROUBLESHOOT	To follow a systematic procedure to identify and locate a problem or malfunction and its cause.

Essential Skills Profiles

Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all the other skills that enable people to evolve within their jobs and adapt to workplace change.

Over the past several years, the Government of Canada has conducted research examining the skills people use at work. From this research, Essential Skills Profiles have been developed for various occupations.

For more information regarding Essential Skills and to access Essential Skills Profiles for specific occupations, visit Employment and Social Development Canada's Essential Skills website at:

<http://www.esdc.gc.ca/eng/jobs/les/profiles/index.shtml>

Profile Chart

COMMON OCCUPATIONAL SKILLS			
RACM-100 Safety	RACM-105 Hoisting, Lifting, Rigging and Access/ Egress Equipment	RACM-110 Tools and Equipment	RACM-160 Communication and Trade-Related Documentation
RACM-255 Blueprints/Drawings and Specifications	RACM-440 Job Coordination		
ROUTINE TRADE ACTIVITIES			
RACM-120 Refrigerants, Gases and Oils	RACM-135 Piping, Tubing, Soldering and Brazing	RACM-140 Leak Testing, Evacuation and Charging	RACM-250 Control Circuits and Wiring Diagrams
INSTALLATION PLANNING			
RACM-115 Refrigeration Fundamentals	RACM-125 Compressors Fundamentals	RACM-145 Electrical Fundamentals	RACM-150 Motor Fundamentals
RACM-230 Air Conditioning Fundamentals	RACM-240 Control Fundamentals	RACM-300 Refrigeration Load Calculations	RACM-305 Refrigeration System Design
RACM-360 Capacity Controls	RACM-400 Air Conditioning Load Calculations	RACM-405 Air Conditioning System Design	RACM-410 Duct Systems and Design
INSTALLATION			
RACM-130 Valves and Accessory Devices	RACM-165 Refrigeration and Air Conditioning Installation	RACM-205 Evaporators	RACM-210 Residential and Commercial Compressors
RACM-215 Condensers	RACM-220 Metering Devices	RACM-225 Refrigerant Flow Controls and Accessory Devices	RACM-310 Large Commercial/Industrial Compressors

Profile Chart *(continued)*

RACM-315 Heating Systems	RACM-320 Commercial Refrigeration Systems	RACM-325 Split Air Conditioning Systems	RACM-330 Packaged Air Conditioning Systems
RACM-335 Heat Pumps Systems	RACM-340 Fluid Dynamics and Pumps	RAMC-355 Advanced Motors	RACM-415 Evaporative Condensers, Cooling Towers and Fluid Coolers
RACM-425 Chillers and Chiller Systems	RACM-430 Industrial Refrigeration Systems		
COMMISSIONING			
RACM-235 Air Movement and Indoor Air Quality	RACM-345 Control Systems	RACM-420 Air Measurement and System Air Balancing	
MAINTENANCE AND SERVICE			
RACM-200 Pressure Enthalpy Diagrams and System Analysis	RACM-350 Troubleshooting Refrigeration and Air Conditioning Electronic Controls	RACM-435 Troubleshooting with Schematics Wiring Diagrams	

Recommended Level Structure

Level 1			Level 2		
Unit Code	Title	Page	Unit Code	Title	Page
RACM-100	Safety	24	RACM-200	Pressure Enthalpy Diagrams and System Analysis	52
RACM-105	Hoisting, Lifting, Rigging and Access/Egress Equipment	26	RACM-205	Evaporators	53
RACM-110	Tools and Equipment	29	RACM-210	Residential and Commercial Compressors	55
RACM-115	Refrigeration Fundamentals	31	RACM-215	Condensers	57
RACM-120	Refrigerants, Gases and Oils	33	RACM-220	Metering Devices	59
RACM-125	Compressor Fundamentals	35	RACM-225	Refrigerant Flow Controls and Accessory Devices	61
RACM-130	Valves and Accessory Devices	37	RACM-230	Air Conditioning Fundamentals	63
RACM-135	Piping, Tubing, Soldering and Brazing	39	RACM-235	Air Movement and Indoor Air Quality	64
RACM-140	Leak Testing, Evacuation and Charging	41	RACM-240	Control Fundamentals	66
RACM-145	Electrical Fundamentals	43	RACM-250	Control Circuits and Wiring Diagrams	67
RACM-150	Motor Fundamentals	45	RACM-255	Blueprints/Drawings and Specifications	69
RACM-160	Communication and Trade-Related Documentation	47			
RACM-165	Refrigeration and Air Conditioning Installation	49			
Level 3			Level 4		
Unit Code	Title	Page	Unit Code	Title	Page
RACM-300	Refrigeration Load Calculations	72	RACM-400	Air Conditioning Load Calculations	97
RACM-305	Refrigeration System Design	73	RACM-405	Air Conditioning System Design	98
RACM-310	Large Commercial/Industrial Compressors	75	RACM-410	Duct Systems and Design	100
RACM-315	Heating Systems	77	RACM-415	Evaporative Condensers, Cooling Towers and Fluid Coolers	102
RACM-320	Commercial Refrigeration Systems	79	RACM-420	Air Measurement and System Air Balancing	104
RACM-325	Split Air Conditioning Systems	81	RACM-425	Chillers and Chiller Systems	105
RACM-330	Packaged Air Conditioning Units	83	RACM-430	Industrial Refrigeration Systems	107
RACM-335	Heat Pump Systems	85	RACM-435	Troubleshooting with Schematic Wiring Diagrams	109
RACM-340	Fluid Dynamics and Pumps	87	RACM-440	Job Coordination	110
RACM-345	Control Systems	89			
RACM-350	Troubleshooting Refrigeration and Air Conditioning Electronic Controls	91			
RACM-355	Advanced Motors	92			
RACM-360	Capacity Controls	94			

2014 NOA Sub-task to IPG Unit Comparison

NOA Sub-task		IPG Unit	
Task 1 – Performs safety-related functions.			
1.01	Maintains safe work environment.	RACM-100	Safety
1.02	Performs lock-out, tag-out and isolation procedures.	RACM-100	Safety
1.03	Uses personal protective equipment (PPE) and safety equipment.	RACM-100	Safety
Task 2 – Uses and maintains tools and equipment.			
2.01	Maintains hand tools.	RACM-110	Tools and Equipment
2.02	Maintains portable and stationary power tools.	RACM-110	Tools and Equipment
2.03	Maintains brazing and soldering equipment.	RACM-110	Tools and Equipment
2.04	Maintains recovery and recycling equipment.	RACM-110	Tools and Equipment
2.05	Maintains evacuation tools and equipment.	RACM-110	Tools and Equipment
2.06	Maintains charging tools and equipment.	RACM-110	Tools and Equipment
2.07	Maintains diagnostic and measuring tools and equipment.	RACM-110	Tools and Equipment
2.08	Uses access equipment.	RACM-105	Hoisting, Rigging, Lifting and Access/Egress Equipment
2.09	Uses rigging, hoisting and lifting equipment.	RACM-105	Hoisting, Rigging, Lifting and Access/Egress Equipment
2.10	Uses digital technology.	RACM-160	Communication and Trade-Related Documentation
		RACM-350	Troubleshooting Refrigeration and Air Conditioning Electronics
Task 3 – Organizes work.			
3.01	Interprets codes, regulations and procedures.		Throughout
3.02	Interprets blueprints and specifications.	RACM-255	Blueprints/Drawings and Specifications
3.03	Uses documentation and reference material.	RACM-160	Communication and Trade-Related Documentation
		RACM-440	Job Coordination
3.04	Plans job tasks and procedures.	RACM-440	Job Coordination

NOA Sub-task		IPG Unit	
3.05	Communicates with others.	RACM-160	Communication and Trade-Related Documentation
		RACM-440	Job Coordination
Task 4 – Performs work site preparation.			
4.01	Prepares work site.	RACM-100	Safety
		RACM-440	Job Coordination
4.02	Handles materials and supplies.		Throughout
4.03	Installs fasteners, brackets and hangers.	RACM-135	Piping, Tubing, Soldering and Brazing
		RACM-165	Refrigeration and Air Conditioning Installation
Task 5 – Performs routine trade activities.			
5.01	Uses refrigerants, gases and oils.	RACM-120	Refrigerants, Gases and Oils
5.02	Performs brazing and soldering.	RACM-135	Piping, Tubing, Soldering and Brazing
5.03	Performs leak and pressure tests on systems.	RACM-140	Leak Testing, Evacuation and Charging
		RACM-165	Refrigeration and Air Conditioning Installation
5.04	Evacuates systems.	RACM-140	Leak Testing, Evacuation and Charging
		RACM-165	Refrigeration and Air Conditioning Installation
5.05	Performs field wiring of systems.	RACM-145	Electrical Fundamentals
		RACM-150	Motor Fundamentals
		RACM-250	Control Circuits and Wiring
		RACM-345	Diagrams Control Systems
		RACM-355	Advanced Motors
5.06	Applies sealants and adhesives.	RACM-135	Piping, Tubing, Soldering and Brazing
Task 6 – Plans installation of HVAC/R systems.			
6.01	Verifies HVAC/R system parameters and requirements.	RACM-115	Refrigeration Fundamentals
		RACM-125	Compressor Fundamentals
		RACM-150	Motor Fundamentals
		RACM-220	Metering Devices
		RACM-230	Air Conditioning Fundamentals
		RACM-235	Air Movement and Indoor Air Quality
		RACM-300	Refrigeration Load Calculations
		RACM-340	Fluid Dynamics and Pumps
	RACM-360	Capacity Controls	

NOA Sub-task		IPG Unit	
		RACM-305	Refrigeration System Design
		RACM-400	Air Conditioning Load Calculations
		RACM-405	Air Conditioning System Design
		RACM-410	Duct Systems and Design
		RACM-415	Evaporative Condensers, Cooling Towers and Fluid Coolers
		RACM-425	Chillers and Chiller Systems
6.02	Selects HVAC/R equipment, components and accessories.	RACM-130	Valves and Accessory Devices
		RACM-205	Evaporators
		RACM-210	Residential and Commercial Compressors
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls and Accessory Devices
		RACM-305	Refrigeration System Design
		RACM-310	Large Commercial/Industrial Compressors
		RACM-340	Fluid Dynamics and Pumps
		RACM-360	Capacity Controls
		RACM-405	Air Conditioning System Design
		RACM-410	Duct Systems and Design
		RACM-415	Evaporative Condensers, Cooling Towers and Fluid Coolers
		RACM-425	Chillers and Chiller Systems
6.03	Determines placement of HVAC/R equipment, components and accessories.	RACM-130	Valves and Accessory Devices
		RACM-165	Refrigeration and Air Conditioning Installation
		RACM-205	Evaporators
		RACM-210	Residential and Commercial Compressors
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls and Accessory Devices
		RACM-305	Refrigeration System Design
		RACM-310	Large Commercial/Industrial Compressors
		RACM-340	Fluid Dynamics and Pumps

NOA Sub-task		IPG Unit	
		RACM-360	Capacity Controls
		RACM-405	Air Conditioning System Design
		RACM-410	Duct Systems and Design
		RACM-415	Evaporative Condensers, Cooling Towers and Fluid Coolers
		RACM-425	Chillers and Chiller Systems
6.04	Performs HVAC/R material take-off.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Split Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Systems
		RACM-335	Heat Pump Systems
		RACM-430	Industrial Refrigeration Systems
Task 7 – Plans installation of control systems.			
7.01	Verifies control system parameters and requirements.	RACM-145	Electrical Fundamentals
		RACM-240	Control Fundamentals
		RACM-250	Control Circuits and Wiring Diagrams
		RACM-345	Control Systems
7.02	Selects control system components and accessories.	RACM-145	Electrical Fundamentals
		RACM-250	Control Circuits and Wiring Diagrams
		RACM-345	Control Systems
7.03	Determines placement of control system components and accessories.	RACM-145	Electrical Fundamentals
		RACM-250	Control Systems
		RACM-345	Control Systems
7.04	Performs control system take-off.	RACM-145	Electrical Fundamentals
		RACM-250	Control Circuits and Wiring Diagrams
		RACM-345	Control Systems
Task 8 – Installs HVAC/R systems.			
8.01	Confirms system layout.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-305	Refrigeration System Design
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Unit
		RACM-335	Heat Pump Systems

NOA Sub-task		IPG Unit	
8.02	Assembles HVAC/R equipment, components and accessories.	RACM-405	Air Conditioning System Design
		RACM-430	Industrial Refrigeration Systems
		RACM-165	Refrigeration and Air Conditioning Installation
		RACM-305	Refrigeration System Design
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Air Conditioning Systems
		RACM-335	Heat Pump Systems
		RACM-405	Air Conditioning System Design
		RACM-430	Industrial Refrigeration Systems
8.03	Places HVAC/R equipment, components and accessories.	RACM-130	Valves and Accessory Devices
		RACM-165	Refrigeration and Air Conditioning Installation
		RACM-205	Evaporators
		RACM-210	Residential and Commercial Compressors
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls and Accessory Devices
		RACM-310	Large Commercial/Industrial Compressors
		RACM-315	Heating Systems
		RACM-335	Heat Pump Systems
		RACM-340	Fluid Dynamics and Pumps
		RACM-355	Advanced Motors
		RACM-415	Evaporative Condensers, Cooling Towers and Fluid Coolers
		RACM-425	Chillers and Chiller Systems
		RACM-430	Industrial Refrigeration Systems
8.04	Installs HVAC/R piping and tubing.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-315	Heating Systems
		RACM-335	Heat Pump Systems
		RACM-430	Industrial Refrigeration Systems
8.05	Applies HVAC/R holding charge.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Air Conditioning Systems
		RACM-335	Heat Pump Systems

NOA Sub-task		IPG Unit	
		RACM-430	Industrial Refrigeration Systems
Task 9 – Installs control systems.			
9.01	Places control system components.	RACM-250	Control Circuits and Wiring Diagrams
		RACM-345	Control Systems
9.02	Connects system wiring and control tubing.	RACM-250	Control Circuits and Wiring Diagrams
		RACM-345	Control Systems
Task 10 – Commissions HVAC/R systems.			
10.01	Performs pre start-up checks for HVAC/R systems.	RACM-150	Motor Fundamentals
		RACM-165	Refrigeration and Air Conditioning Installation
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Split Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pump Systems
		RACM-430	Industrial Refrigeration Systems
10.02	Performs start-up of HVAC/R systems.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Split Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pump Systems
		RACM-420	Air Measurement and System Air Balancing
		RACM-430	Industrial Refrigeration Systems
10.03	Completes HVAC/R system charge.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Split Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pumps Systems
		RACM-430	Industrial Refrigeration Systems
10.04	Sets up primary and secondary HVAC/R components.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Split Air Conditioning Systems

NOA Sub-task		IPG Unit	
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pump Systems
		RACM-420	Air Measurement and System Air Balancing
		RACM-430	Industrial Refrigeration Systems
Task 11 – Commissions control systems.			
11.01	Performs start-up checks for control systems.	RACM-345	Control Systems
11.02	Verifies/sets operating parameters.	RACM-345	Control Systems
Task 12 – Maintains HVAC/R systems.			
12.01	Inspects HVAC/R systems.	RACM-305	Refrigeration System Design
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pump Systems
		RACM-355	Advanced Motors
		RACM-405	Air Conditioning System Design
		RACM-430	Industrial Refrigeration Systems
12.02	Performs predictive and scheduled maintenance on HVAC/R systems.	RACM-305	Refrigeration System Design
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pumps Systems
		RACM-405	Air Conditioning System Design
12.03	Tests HVAC/R system components and accessories.	RACM-305	Refrigeration System Design
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pump Systems
		RACM-405	Air Conditioning System Design
Task 13 – Services HVAC/R systems.			
13.01	Troubleshoots HVAC/R systems.	RACM-115	Refrigeration Fundamentals
		RACM-125	Compressor Fundamentals
		RACM-150	Motor Fundamentals
		RACM-200	Pressure Enthalpy Diagrams
		RACM-230	Air Conditioning Fundamentals

NOA Sub-task		IPG Unit	
		RACM-235	Air Movement and Indoor Air Quality
		RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Split Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pump Systems
		RACM-350	Troubleshooting Refrigeration and Air Conditioning Electronics
		RACM-355	Advanced Motors
		RACM-410	Duct Systems and Design
		RACM-420	Air Measurement and System Air Balancing
		RACM-430	Industrial Refrigeration Systems
		RACM-435	Troubleshooting with Schematics Wiring Diagrams
13.02	Repairs HVAC/R systems.	RACM-315	Heating Systems
		RACM-320	Commercial Refrigeration Systems
		RACM-325	Split Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pump Systems
		RACM-430	Industrial Refrigeration Systems
Task 14 – Maintains and services control systems.			
14.01	Performs maintenance on control systems.	RACM-345	Control Systems
14.02	Troubleshoots control systems.	RACM-250	Control Circuits and Wiring Diagrams
		RACM-345	Control Systems
		RACM-350	Troubleshooting Refrigeration and Air Conditioning Electronics
		RACM-435	Troubleshooting with Schematics and Wiring Diagrams
14.03	Repairs control systems.	RACM-345	Control Systems
14.04	Calibrates operating and safety controls.	RACM-345	Control Systems

LEVEL 1

RACM-100 Safety

Learning Outcomes:

- Demonstrate knowledge of personal protective equipment (PPE) and safety equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of safe work practices.
- Demonstrate knowledge of the procedures used to lock-out, tag-out and isolate equipment.
- Demonstrate knowledge of regulatory requirements pertaining to safety.

Objectives and Content:

1. Define terminology associated with PPE and safety equipment.
2. Identify workplace hazards and describe safe work practices and equipment.
 - i) personal
 - ii) workplace environment
 - electrical
 - confined spaces
 - working from heights
 - noise
 - fire
 - refrigerants
 - pressurized gases
 - iii) environmental
 - ozone depleting substances
 - hazardous materials
 - greenhouse gases
3. Interpret codes and regulations pertaining to workplace hazards and safe work practices.
4. Identify types of PPE and safety equipment, and describe their applications and procedures for use.
5. Describe the procedures used to care for, maintain and store PPE and safety equipment.

6. Describe the procedures used to lock-out, tag-out and isolate equipment.
7. Describe the procedures used to utilize, store, transport and dispose of hazardous materials.
8. Describe the procedures used to maintain a safe work environment and to remediate the potential dangers related to workplace hazards.

RACM-105 Hoisting, Lifting, Rigging and Access/Egress Equipment

Learning Outcomes:

- Demonstrate knowledge of hoisting, lifting, rigging and access/egress equipment, their applications and procedures for use.
- Demonstrate knowledge of basic hand signals.

Objectives and Content:

1. Define terminology associated with hoisting, lifting, rigging and access/egress.
2. Identify hazards and safe work practices pertaining to hoisting, lifting, rigging and using access/egress equipment.
3. Interpret codes and regulations pertaining to hoisting, lifting, rigging and using access/egress equipment.
4. Interpret information pertaining to hoisting, lifting, rigging and using access/egress equipment found on drawings and specifications.
5. Identify types of rigging equipment and accessories, and describe their applications, limitations and procedures for use.
 - i) belts
 - ii) ropes
 - iii) cables
 - iv) slings
 - v) shackles
 - vi) spreader bars
6. Identify types of hoisting and lifting equipment and accessories, and describe their applications, limitations and procedures for use.
 - i) jacks
 - ii) hoists
 - iii) come-a-longs/tuggers
 - iv) chainfalls
7. Identify types of access/egress equipment, and describe their applications, limitations and procedures for use.

- i) ladders
 - ii) staging
 - iii) scaffolding
 - iv) lifts
8. Identify types of knots, hitches and bends, and describe their applications and associated procedures.
9. Identify the factors to consider when selecting hoisting, lifting, rigging and access/egress equipment.
- i) safety factor
 - ii) load characteristics
 - iii) environment
 - iv) application
10. Identify the factors to consider when rigging a load (material and/or equipment) for hoisting and lifting.
- i) load characteristics
 - ii) equipment and accessories
 - iii) environmental factors
 - iv) anchor points/attachment locations
 - v) sling angles
 - vi) machine capacity/load chart
11. Identify the methods of communication used during hoisting, lifting, rigging and using access/egress equipment, and describe their associated procedures.
- i) visual
 - hand signals
 - video
 - ii) audible
 - radio
 - mobile phones
12. Describe the procedures used to inspect, store and maintain hoisting, lifting and rigging equipment.
13. Describe the procedures used to inspect, store and maintain access/egress equipment.

14. Describe the procedures used to rig and secure a load (material and/or equipment) for lifting and hoisting.
15. Describe the procedures used to perform a lift.
16. Perform and interpret basic hand signals.

RACM-110 Tools and Equipment

Learning Outcomes:

- Demonstrate knowledge of hand tools, and portable and stationary power tools, their applications, maintenance and procedures for use.
- Demonstrate knowledge of recovery and recycling equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of evacuation and charging tools and equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of diagnostic and measuring tools and equipment.

Objectives and Content:

1. Define terminology associated with tools and equipment.
2. Identify hazards and describe safe work practices pertaining to tools and equipment.
3. Interpret codes, regulations and specifications pertaining to tools and equipment.
 - i) licensing
 - ii) training
4. Identify types of hand tools and describe their applications and procedures for use.
5. Describe the procedures used to care for, store and maintain hand tools.
6. Identify types of portable and stationary power tools, and describe their applications and procedures for use.
 - i) pneumatic
 - ii) electric
 - iii) hydraulic
 - iv) gas
7. Describe the procedures used to care for, store and maintain portable and stationary power tools.

8. Identify types of brazing and soldering equipment, and describe their applications and procedures for use.
9. Describe the procedures used to care for, store and maintain brazing and soldering equipment.
10. Identify types of recovery and recycling equipment, and describe their applications and procedures for use.
11. Describe the procedures used to care for, store and maintain recovery and recycling equipment.
12. Identify types of evacuation and charging tools and equipment, and describe their applications and procedures for use.
13. Describe the procedures used to care for, store and maintain evacuation and charging tools and equipment.
14. Identify types of diagnostic and measuring tools and equipment, and describe their applications and procedures for use.
15. Describe the procedures used to care for, store and maintain diagnostic and measuring tools and equipment.

RACM-115 Refrigeration Fundamentals

Learning Outcomes:

- Demonstrate knowledge of refrigeration fundamentals.
- Demonstrate knowledge of the refrigeration cycle.

Objectives and Content:

1. Define terminology associated with refrigeration.
2. Explain concepts associated with refrigeration.
 - i) temperature
 - ii) heat
 - iii) mass and weight
 - iv) density
 - v) specific gravity
 - vi) specific volume
 - vii) pressure
3. Identify pressure and temperature scales, and describe the procedures used to perform conversion calculations.
4. Explain heat flow and identify methods of heat transfer.
5. Identify states of matter and describe their characteristics.
6. Explain basic gas laws associated with refrigeration, and describe the associated calculations to demonstrate relationships.
7. Explain the effect of pressure on evaporation, condensing, freezing and melting temperatures.
8. Explain the operation of the vapour compression cycle.
9. Identify components of a vapour compression cycle, and describe their purpose and operation.
 - i) evaporator
 - ii) compressor

- iii) condenser
 - iv) accessories
10. Describe the physical changes of the refrigerant as it circulates through the system.
 11. Describe the pressure/temperature chart and its use in determining refrigerant conditions.
 - i) dew point
 - ii) bubble point
 - iii) triple point
 12. Explain superheat and sub-cooling, and their significance in the refrigeration cycle.
 13. Describe the pressure enthalpy diagram and its applications.
 14. Explain how to plot the basic cycle using a pressure enthalpy diagram.
 15. Identify factors that affect system capacity.
 - i) condensing pressure/temperature
 - ii) evaporating pressure/temperature
 - iii) heat of compression
 - iv) sub-cooling
 - v) superheat
 16. Perform calculations to determine refrigeration values using pressure enthalpy diagrams.
 - i) mass flow rate
 - ii) heat of compression
 - iii) net refrigeration effect
 - iv) system capacity
 - v) ton of refrigeration
 - vi) coefficient of performance (COP)
 - vii) horsepower per ton

RACM-120 Refrigerants, Gases and Oils

Learning Outcomes:

- Demonstrate knowledge of refrigerants, gases and oils, their applications and procedures for use.
- Demonstrate knowledge of regulatory requirements pertaining to refrigerants, gases and oils.
- Demonstrate knowledge of the procedures used to recover and recycle refrigerants and oils.

Objectives and Content:

1. Define terminology associated with refrigerants, gases and oils.
2. Identify hazards and safe work practices pertaining to refrigerants, gases and oils.
3. Interpret codes and regulations pertaining to refrigerants, gases and oils.
 - i) environmental certification
 - ii) leak/spill reporting
 - iii) record keeping
4. Identify types of refrigerants and describe their characteristics and applications.
 - i) primary
 - ii) secondary
5. Identify the safety classifications of refrigerants.
 - i) toxicity
 - ii) flammability
6. Identify types of refrigerant containers and colour coding classifications.
7. Identify types of oils and describe their characteristics and applications.
8. Identify types of gases and describe their characteristics and applications.
 - i) nitrogen
 - ii) acetylene

- iii) oxygen
 - iv) carbon dioxide
9. Explain the effects of refrigerants, gases and oils on the environment.
 - i) ozone depletion potential (ODP)
 - ii) global warming potential (GWP)
 - iii) leaks
 - iv) spills
 10. Describe the procedures used to perform refrigerant and oil conversions.
 11. Describe the procedures used to recover and recycle refrigerants and oils.
 12. Describe the procedures used to store and transport refrigerants, gases and oils.

RACM-125 Compressor Fundamentals

Learning Outcomes:

- Demonstrate knowledge of the fundamental principles of compressors.
- Demonstrate knowledge of compressors, their components and operation.

Objectives and Content:

1. Define terminology associated with compressors.
2. Identify hazards and describe safe work practices pertaining to compressors.
3. Interpret codes and regulations pertaining to compressors.
4. Interpret information pertaining to compressors found on drawings and specifications.
5. Explain compressor efficiency.
6. Explain the purpose and operation of compressors and their components.
7. Identify types of compressors, and describe their characteristics and applications.
 - i) reciprocating
 - ii) scroll
 - iii) rotary
 - iv) screw
 - v) centrifugal
 - vi) swing
 - vii) linear
8. Identify compressor components, and describe their characteristics and applications.
9. Identify methods used to lubricate compressors.

10. Identify methods used to cool compressors.
11. Identify common compressor failures and describe their causes and remedies.
 - i) mechanical
 - ii) electrical

RACM-130 Valves and Accessory Devices

Learning Outcomes:

- Demonstrate knowledge of refrigeration valves, their characteristics, applications and operation.
- Demonstrate knowledge of refrigeration accessory devices, their characteristics, applications and operation.

Objectives and Content:

1. Define terminology associated with valves and accessory devices.
2. Identify hazards and describe safe work practices pertaining to valves and accessory devices.
3. Interpret codes and regulations pertaining to valves and accessory devices.
4. Interpret information pertaining to valves and accessory devices found on drawings and specifications.
5. Explain the purpose and operation of valves and accessory devices.
6. Identify types of valves and describe their characteristics and applications.
 - i) safety
 - ii) metering
 - iii) service/access
 - iv) flow controls
7. Identify types of accessory devices and describe their characteristics and applications.
 - i) regulators
 - ii) filters and driers
 - iii) liquid/moisture indicators
 - iv) suction accumulators
 - v) oil separators
 - vi) liquid receivers
 - vii) pressure relief devices
 - viii) heat exchangers

8. Identify common valves and accessory device failures and describe their causes and remedies.

RACM-135 Piping, Tubing, Soldering and Brazing

Learning Outcomes:

- Demonstrate knowledge of refrigeration piping, tubing and fittings, and their applications.
- Demonstrate knowledge of the procedures used to install piping, tubing and their associated components.
- Demonstrate knowledge of the procedures used to solder and braze piping and tubing.

Objectives and Content:

1. Define terminology associated with piping, tubing, soldering and brazing.
2. Identify hazards and describe safe work practices pertaining to piping, tubing, soldering and brazing.
3. Interpret codes and regulations pertaining to piping, tubing, soldering and brazing.
4. Interpret information pertaining to piping, tubing, soldering and brazing found on drawings and specifications.
5. Identify specialized tools and equipment used in piping practices, and describe their applications and procedures for use.
 - i) cutting
 - ii) bending
 - iii) joining
 - flaring
 - swaging
 - brazing
 - soldering
 - threading
6. Identify types of refrigeration piping, tubing and fittings, and describe their characteristics and applications.

7. Identify types of soldering and brazing materials and fillers, and describe their characteristics and applications.
8. Identify types of pipe hangers, brackets and fasteners, and describe their characteristics and applications.
9. Identify types of pipe and tubing insulation, and describe their characteristics and applications.
10. Identify types of sealants and adhesives, and describe their characteristics and applications.
11. Identify the factors to consider when selecting piping system components for installation.
12. Describe the procedures used to install piping systems.
 - i) cutting
 - ii) bending
 - iii) joining
 - flaring
 - swaging
 - brazing
 - soldering
 - threading
 - iv) supporting
 - hangers
 - brackets/fasteners
 - v) insulating
 - vi) applying sealants and adhesives

RACM-140 Leak Testing, Evacuation and Charging

Learning Outcomes:

- Demonstrate knowledge of the procedures used to leak test refrigeration systems.
- Demonstrate knowledge of the procedures used to evacuate refrigeration systems.
- Demonstrate knowledge of the procedures used to charge refrigeration systems.

Objectives and Content:

1. Define terminology associated with leak testing, evacuation and charging of refrigeration systems.
2. Identify hazards and describe safe work practices pertaining to leak testing, evacuation and charging of refrigeration systems.
3. Interpret codes and regulations pertaining to leak testing, evacuation and charging of refrigeration systems.
4. Identify specialized tools and equipment used to leak test, evacuate and charge a refrigeration system, and describe their applications and procedures for use.
5. Describe the procedures used to leak test a refrigeration system.
6. Describe the procedures used to evacuate and dehydrate a refrigeration system.
7. Describe the procedures used to charge a refrigeration system.
 - i) refrigerant
 - liquid
 - vapour
 - ii) oil
 - pumps
 - vacuum

8. Describe the methods used to verify the charge of a refrigeration system.
- i) superheat
 - ii) sub-cooling
 - iii) critical charge
 - iv) charge charts
 - v) sight glass

RACM-145 Electrical Fundamentals

Learning Outcomes:

- Demonstrate knowledge of the fundamental concepts of electricity.
- Demonstrate knowledge of the procedures used to measure voltage, resistance, current and power, and to calculate their interrelationships.
- Demonstrate knowledge of electrical circuits and loads.
- Demonstrate knowledge of conductors, relays, switches, contactors, overloads and transformers, and their operation.
- Demonstrate knowledge of electronic controls and their operation.
- Demonstrate knowledge of electrical wiring diagrams.

Objectives and Content:

1. Define terminology associated with electrical fundamentals.
2. Identify hazards and describe safe work practices pertaining to electricity.
3. Explain current and electron flow in both alternating current (AC) and direct current (DC) circuits.
4. Explain the relationship between voltage, current, resistance and power.
5. Identify units of electrical measurement and symbols.
6. Identify types of conductors and describe their characteristics and applications.
7. Identify the factors used to determine conductor ampacity rating.
8. Identify types of wire insulating materials and describe their characteristics and applications.
9. Identify the factors to consider when selecting resistors using rating and coding information.

10. Identify types of electrical circuits and describe their characteristics and applications.
 - i) series
 - ii) parallel
 - iii) series-parallel
11. Describe an overloaded, grounded, open and short circuit.
12. Identify types of distribution panels and wiring configurations used in single-phase and three-phase systems, and describe their characteristics and applications.
13. Identify types of over-current and overload protection devices, and describe their characteristics, applications and operation.
14. Identify types of relays, switches and contactors, and describe their characteristics, applications and operation.
15. Identify types of transformers and describe their characteristics, applications and operation.
16. Identify types of electronic controls, and explain their purpose and operation.
17. Identify types of electrical wiring diagrams and explain their purpose.
18. Describe the procedures used to troubleshoot basic electrical control circuit systems and components using schematic wiring diagrams.
19. Describe the procedures used to perform a basic diagnosis of electronic controls.
20. Calculate voltage, current and resistance in series, parallel and combination circuits.

RACM-150 Motor Fundamentals

Learning Outcomes:

- Demonstrate knowledge of basic motors, their components and operation.
- Demonstrate knowledge of basic motor controls and their operation.

Objectives and Content:

1. Define terminology associated with basic motors and motor controls.
2. Identify hazards and describe safe work practices pertaining to basic motors and motor controls.
3. Interpret codes and regulations pertaining to basic motors and motor controls.
4. Interpret information pertaining to basic motors and motor controls found on drawings and specifications.
5. Explain the purpose and operation of motors and their components.
6. Identify types of basic motors and describe their characteristics and applications.
 - i) single-phase
 - ii) three-phase
 - iii) electrically commutated motors (ECM)
7. Interpret information found on motor nameplates.
8. Identify types of starting devices for single-phase motors, and describe their characteristics, applications, operation and wiring configurations.
9. Identify types of capacitors and describe their characteristics and applications.
10. Explain the effects of load and voltage changes on motor operation.
11. Describe the procedures used to test capacitors.
12. Describe the procedures used to change rotation of motors.

13. Describe the procedures used to measure voltage, resistance and current in motor circuits.
14. Identify common motor failures and describe their causes and remedies.
 - i) mechanical
 - ii) electrical

RACM-160 Communication and Trade-Related Documentation

Learning Outcomes:

- Demonstrate knowledge of effective communication practices.
- Demonstrate knowledge of trade-related documentation and their use.
- Demonstrate knowledge of the procedures used to complete and interpret trade-related documentation.

Objectives and Content:

1. Define terminology associated with communication and trade-related documentation.
2. Explain the importance of effective verbal and non-verbal communication.
 - i) interpersonal interactions
 - other tradespersons
 - co-workers
 - supervisors
 - clients
 - apprentices
 - ii) conflict resolution
3. Identify types of electronic communication devices, and describe their applications and procedures for use.
 - i) computers
 - ii) smart phones
 - iii) point of sale equipment
 - iv) global positioning system (GPS)
4. Identify types and sources of trade-related documentation, and describe their applications.
 - i) codes and standards
 - ii) energy efficiency guides
 - iii) manuals
 - safety
 - service

- operating
 - iv) permits
 - v) drawings and specifications
 - vi) employer-specific forms and reports
 - vii) preventative/predictive maintenance sheets
 - viii) technical bulletins
 - ix) service records
 - x) warranties
 - xi) estimates
 - xii) refrigerant management records
5. Explain the importance of appropriate and effective use of electronic devices and sources of information.
 6. Describe the procedures used to complete trade-related documentation.
 7. Describe the procedures used to access, interpret and apply information found on trade-related documentation.

RACM-165 Refrigeration and Air Conditioning Installation

Learning Outcomes:

- Demonstrate knowledge of the procedures used to prepare for the installation of refrigeration and air conditioning systems and their components.
- Demonstrate knowledge of the procedures used to install refrigeration and air conditioning systems and their components.
- Demonstrate knowledge of the procedures used to start up and commission refrigeration and air conditioning systems and their components.

Objectives and Content:

1. Define terminology associated with refrigeration and air conditioning installations.
2. Identify hazards and describe safe work practices pertaining to refrigeration and air conditioning installations.
3. Interpret codes and regulations pertaining to refrigeration and air conditioning installations.
4. Interpret information pertaining to refrigeration and air conditioning installations found in drawings, specifications and diagrams.
 - i) electrical diagrams
 - ii) piping schematic diagrams
5. Identify specialized tools and equipment used for refrigeration and air conditioning system installations, and describe their applications and procedures for use.
6. Identify the factors to consider when selecting refrigeration and air conditioning system components for installation.
7. Identify components used in the installation of refrigeration and air conditioning systems, and describe their characteristics and applications.

8. Identify the factors to consider when installing refrigeration and air conditioning systems.
 - i) component placement
 - ii) tool requirements
 - iii) material list
 - iv) scheduling
9. Describe the procedures used to prepare for refrigeration and air conditioning system installations.
10. Describe the procedures used to install refrigeration and air conditioning systems.
11. Identify the factors to consider when performing a system start-up.
 - i) phasing, voltage imbalance and amperage
 - ii) refrigerant charge adjustments
 - iii) oil levels
 - iv) operating pressures and temperatures
 - v) system control adjustments
 - vi) manufacturers' recommendations
 - vii) liquid or air requirements
12. Identify documentation requirements for system installation, start up and commissioning.
13. Identify system problems at start-up and describe their causes and remedies.
14. Describe the procedures used to start up and commission refrigeration and air conditioning systems.

LEVEL 2

RACM-200 Pressure Enthalpy Diagrams and System Analysis

Learning Outcomes:

- Demonstrate knowledge of pressure enthalpy diagrams and their use in troubleshooting refrigeration systems.

Objectives and Content:

1. Define terminology associated with pressure enthalpy diagrams and system analysis.
2. Locate and interpret information found on pressure enthalpy diagrams.
3. Identify the factors affecting system capacity and explain their effect.
 - i) saturated discharge temperature
 - ii) saturated suction temperature
 - iii) liquid sub-cooling
 - iv) suction superheat
 - v) suction to liquid heat exchange
 - vi) high and low side pressure drops
4. Explain theoretical horsepower and brake horsepower.
5. Explain the effects of pressure drop in refrigeration piping.
6. Explain the concept of system equilibrium and the factors that determine system balance.
7. Explain the effects of an unbalanced system on system performance.
8. Plot a refrigeration cycle using a pressure enthalpy diagram and perform associated calculations.
9. Apply cycle diagrams to assist with system troubleshooting.

RACM-205 Evaporators

Learning Outcomes:

- Demonstrate knowledge of evaporators, their components and their operation.
- Demonstrate knowledge of the procedures used to install evaporators and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot evaporators and their components.

Objectives and Content:

1. Define terminology associated with evaporators and their components.
2. Identify hazards and describe safe work practices pertaining to evaporators and their components.
3. Interpret codes and regulations pertaining to evaporators and their components.
4. Interpret information pertaining to evaporators and their components found on drawings and specifications.
5. Identify specialized tools and equipment used with evaporators and their components, and describe their applications and procedures for use.
6. Explain the purpose and operation of evaporators and their components.
7. Identify types of evaporators and describe their characteristics and applications.
 - i) counter, cross and parallel flow
 - ii) direct expansion, flooded and liquid overfeed
 - iii) forced and induced
 - iv) plate or eutectic
 - v) brazed plate/plate and frame
 - vi) primary and secondary surface
 - vii) chiller barrel (fluid cooler)

8. Identify evaporator components, and describe their characteristics and applications.
 - i) drain pan heaters
 - ii) evaporator fans and controls
 - iii) drain lines
 - iv) flow switches
9. Describe defrost methods and identify their associated electrical and piping considerations.
10. Identify the factors and conditions that determine evaporator capacity and efficiency.
11. Describe the procedures used to size evaporators.
12. Identify the factors to consider when selecting evaporators and their components for installation.
13. Describe the procedures used to install evaporators and their components.
14. Describe the procedures used to maintain and troubleshoot evaporators and their components.
15. Identify evaporator and component failures, and describe their causes and repair procedures.

RACM-210 Residential and Commercial Compressors

Learning Outcomes:

- Demonstrate knowledge of the procedures used to install residential and commercial compressors and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot residential and commercial compressors and their components.

Objectives and Content:

1. Define terminology associated with residential and commercial compressors.
2. Identify hazards and describe safe work practices pertaining to residential and commercial compressors.
3. Interpret codes and regulations pertaining to residential and commercial compressors.
4. Interpret information pertaining to residential and commercial compressors found on drawings and specifications.
5. Identify specialized tools and equipment used with residential and commercial compressors, and describe their applications and procedures for use.
6. Explain the purpose and operation of residential and commercial compressors and their components.
7. Identify types of residential and commercial compressors, and describe their characteristics and applications.
 - i) hermetic
 - reciprocating
 - scroll
 - rotary
 - swing
 - ii) semi-hermetic
 - reciprocating

8. Identify residential and commercial compressor components, and describe their characteristics and applications.
9. Describe compressor classifications according to temperature ranges and capacities.
10. Identify the factors that affect compressor efficiency.
 - i) compression ratio
 - ii) clearance volume
 - iii) wear
 - iv) types of valves
11. Identify the factors to consider when selecting residential and commercial compressors and their components for installation.
12. Describe the procedures used to install residential and commercial compressors and their components.
13. Describe the procedures used to maintain and troubleshoot residential and commercial compressors and their components.
14. Describe control strategies for compressor protection.
 - i) solenoid drop
 - ii) pump out cycle
 - iii) pump down cycle
 - iv) pressure controls
15. Identify residential and commercial compressor failures, and describe their causes and procedures for repair.
 - i) mechanical
 - ii) electrical
16. Describe the procedures used to start up, commission and shut down residential and commercial compressors.

RACM-215 Condensers

Learning Outcomes:

- Demonstrate knowledge of condensers, their components and operation.
- Demonstrate knowledge of the procedures used to install condensers and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot condensers and their components.

Objectives and Content:

1. Define terminology associated with condensers.
2. Identify hazards and describe safe work practices pertaining to condensers.
3. Interpret codes and regulations pertaining to condensers.
4. Interpret information pertaining to condensers found on drawings and specifications.
5. Identify specialized tools and equipment used with condensers, and describe their applications and procedures for use.
6. Explain the purpose and operation of condensers and their components.
7. Identify types of condensers and describe their characteristics and applications.
 - i) air-cooled
 - ii) water-cooled
 - iii) evaporative
8. Identify condenser components and describe their characteristics and applications.
9. Describe heat reclaim strategies.
10. Describe head pressure control strategies.

11. Identify the factors and conditions that determine condenser capacity and efficiency.
12. Identify the factors to consider when selecting condensers and their components for installation.
13. Describe the procedures used to size condensers.
14. Describe the procedures used to install condensers and their components.
15. Describe the procedures used to maintain and troubleshoot condensers and their components.
16. Identify condenser failures and describe their causes and procedures for repair.

RACM-220 Metering Devices

Learning Outcomes:

- Demonstrate knowledge of metering devices, their components and operation.
- Demonstrate knowledge of the procedures used to install metering devices and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot metering devices and their components.

Objectives and Content:

1. Define terminology associated with metering devices.
2. Identify hazards and describe safe work practices pertaining to metering devices.
3. Interpret codes and regulations pertaining to metering devices.
4. Interpret information pertaining to metering devices found on drawings and specifications.
5. Identify specialized tools and equipment used with metering devices, and describe their applications and procedures for use.
6. Explain the purpose and operation of metering devices and their components.
7. Identify types of metering devices and describe their characteristics and applications.
8. Identify metering device components and describe their characteristics and applications.
9. Identify the factors to consider when selecting and installing metering devices and their components.
10. Describe the procedures used to install metering devices and their components.

11. Describe the procedures used to maintain and troubleshoot metering devices and their components.
12. Identify metering device and component failures and describe their causes and procedures for repair.

RACM-225 Refrigerant Flow Controls and Accessory Devices

Learning Outcomes:

- Demonstrate knowledge of refrigerant flow controls and accessory devices, and their operation.
- Demonstrate knowledge of the procedures used to install refrigerant flow controls and accessory devices.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot refrigerant flow controls and accessory devices.

Objectives and Content:

1. Define terminology associated with refrigerant flow controls and accessory devices.
2. Identify hazards and describe safe work practices pertaining to refrigerant flow controls and accessory devices.
3. Interpret codes and regulations pertaining to refrigerant flow controls and accessory devices.
4. Interpret information pertaining to refrigerant flow controls and accessory devices found on drawings and specifications.
5. Identify specialized tools and equipment used with refrigerant flow controls and accessory devices, and describe their applications and procedures for use.
6. Explain the purpose and operation of refrigerant flow controls and accessory devices.
7. Identify types of refrigerant flow controls and accessory devices, and describe their characteristics and applications.
 - i) direct-acting
 - ii) pilot-operated
8. Identify the factors to consider when selecting and installing refrigerant flow controls and accessory devices.

9. Describe the procedures used to install refrigerant flow controls and accessory devices.
10. Describe the procedures used to maintain and troubleshoot refrigerant flow controls and accessory devices.
11. Identify refrigerant flow controls and accessory device failures and describe their causes and procedures for repair.

RACM-230 Air Conditioning Fundamentals

Learning Outcomes:

- Demonstrate knowledge of air conditioning fundamentals.
- Demonstrate knowledge of air conditioning systems, their components and operation.
- Demonstrate knowledge of psychrometrics.

Objectives and Content:

1. Define terminology associated with air conditioning and psychrometrics.
2. Explain air quality, air circulation and ventilation.
3. Identify the factors that affect human comfort with respect to air quality.
4. Identify specialized tools and instruments used to determine air quality, air circulation and ventilation.
5. Identify types of air conditioning systems and their components, and describe their characteristics, applications and operation.
6. Explain the fundamentals of psychrometrics
7. Describe psychrometric processes.
 - i) cooling
 - ii) evaporative cooling
 - iii) humidification
 - iv) heating and humidification
 - v) heating
 - vi) heating and dehumidification
 - vii) dehumidification
 - viii) cooling and dehumidification
8. Describe indoor and outdoor design conditions.

RACM-235 Air Movement and Indoor Air Quality

Learning Outcomes:

- Demonstrate knowledge of air movement and indoor air quality components and their operation.
- Demonstrate knowledge of the procedures used to install air movement and indoor air quality components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot air movement and indoor air quality components.

Objectives and Content:

1. Define terminology associated with air movement and indoor air quality.
2. Identify hazards and describe safe work practices pertaining to air movement and indoor air quality components.
3. Interpret codes and regulations pertaining to air movement and indoor air quality components.
4. Interpret information pertaining to air movement and indoor air quality components found on drawings, specifications and curve charts.
5. Identify specialized tools and equipment used with air movement and indoor air quality components, and describe their applications and procedures for use.
6. Explain the purpose and operation of air movement and indoor air quality components.
7. Identify types of air movement components, and describe their characteristics and applications.
 - i) fans
 - axial
 - radial
 - ii) mechanical drives
 - belt
 - direct

8. Identify factors that affect fan performance.
9. Identify types of indoor air quality components, and describe their characteristics and applications.
 - i) filter
 - ii) cleaner
 - iii) purifier
 - iv) humidifier
 - v) exhaust/fresh air
 - vi) dehumidifier
10. Identify the factors to consider when selecting and installing air movement and indoor air quality components.
11. Describe the procedures used to install air movement and indoor air quality components.
12. Describe the procedures used to maintain and troubleshoot air movement and indoor air quality components.
13. Identify air movement and indoor air quality component failures and describe their causes and procedures for repair.
14. Describe the procedures used to start up, commission and shut down air movement and indoor air quality components.

RACM-240 Control Fundamentals

Learning Outcomes:

- Demonstrate knowledge of control fundamentals.
- Demonstrate knowledge of controls, their components, applications and operation.

Objectives and Content:

1. Define terminology associated with controls.
2. Explain closed and open loop control.
3. Explain the purpose and operation of control systems, devices and components.
4. Identify types of control systems and their components, and describe their characteristics and applications.
 - i) electromechanical
 - ii) electronic
 - iii) pneumatic
 - iv) direct digital control (DDC)
5. Identify types of control devices, and describe their characteristics and applications.
 - i) relays
 - ii) switches
 - iii) actuators
6. Identify types of sensing controls, and describe their characteristics and applications.
 - i) flow
 - ii) humidity
 - iii) liquid level
 - iv) pressure
 - v) temperature
7. Describe control and control actions.

RACM-250 Control Circuits and Wiring Diagrams

Learning Outcomes:

- Demonstrate knowledge of the procedures used to install control circuit components.
- Demonstrate knowledge of the procedures used to troubleshoot control circuits.
- Demonstrate knowledge of wiring diagrams and their use.

Objectives and Content:

1. Define terminology associated with control circuits and wiring diagrams.
2. Identify hazards and describe safe work practices pertaining to control circuits.
3. Interpret codes and regulations pertaining to control circuits.
4. Interpret information pertaining to control circuits found in drawings, wiring diagrams, and schematic diagrams.
5. Identify specialized tools and equipment used with control circuits, and describe their applications and procedures for use.
6. Explain the purpose and operation of control circuits and their components.
7. Identify types of control circuits and their components, and describe their characteristics and applications.
 - i) operating
 - ii) safety
8. Identify types of wiring diagrams and describe their characteristics and applications.
 - i) pictorial
 - ii) schematic
 - iii) ladder
 - iv) component location
9. Describe the sequence of operation of a control circuit and explain its relationship to its physical wiring configuration.

10. Identify the factors to consider when selecting and installing control circuit components.
11. Describe the procedures used to install control circuits and their components.
12. Describe the procedures used to troubleshoot control circuits using wiring diagrams.
13. Sketch a schematic wiring diagram based on a written sequence of control events.
14. Sketch a schematic wiring diagram from a pictorial diagram.
15. Sketch a pictorial diagram from a schematic wiring diagram.

RACM-255 Blueprints/Drawings and Specifications

Learning Outcomes:

- Demonstrate knowledge of blueprints/drawings and specifications and their applications.

Objectives and Content:

1. Define terminology associated with blueprints/drawings and specifications.
2. Identify types of specification documents and describe their applications.
 - i) manufacturers'
 - ii) engineers'
 - iii) contractors'
3. Identify types of blueprints/drawings and describe their applications.
 - i) civil/site
 - ii) architectural
 - iii) mechanical
 - iv) structural
 - v) electrical
 - vi) shop drawings
 - vii) sketches
 - viii) as-built
4. Identify views used on blueprints/drawings.
 - i) elevation
 - ii) plan
 - iii) section
 - iv) detail
 - v) 3-D
5. Identify information found on blueprints/drawings.
 - i) lines
 - ii) legend
 - iii) symbols and abbreviations
 - iv) title block
 - v) notes and specifications

- vi) schedules
 - vii) units of measurement (metric/imperial)
6. Explain the use of blueprints/drawings measurement scales.
 7. Describe the procedures used to convert between metric and imperial units of measurement.
 8. Describe the procedures used to interpret and extract information from blueprints/drawings and specifications.
 9. Perform conversions between the metric and imperial systems of measurement.
 10. Perform a basic take-off from a blueprint/drawing.

LEVEL 3

RACM-300 Refrigeration Load Calculations

Learning Outcomes:

- Demonstrate knowledge of refrigeration load calculations.

Objectives and Content:

1. Define terminology associated with refrigeration load calculations.
2. Perform load calculations and determine total loads for refrigeration systems.
 - i) transmission
 - K, C, U and R values
 - solar load
 - ii) air change
 - infiltration
 - ex-filtration
 - usage
 - iii) product
 - sensible heat
 - latent heat
 - heat of respiration
 - iv) miscellaneous
 - fans
 - lighting
 - motors
 - people
 - equipment
 - v) defrost load
 - air
 - electric
 - hot gas
 - vi) Btuh total

RACM-305 Refrigeration System Design

Learning Outcomes:

- Demonstrate knowledge of refrigeration system design principles.
- Demonstrate knowledge of refrigeration system equipment, components and accessory devices, and their selection based on design criteria.
- Demonstrate knowledge of sketching piping schematics.
- Demonstrate knowledge of sketching electrical schematics.

Objectives and Content:

1. Define terminology associated with refrigeration system design.
2. Explain the fundamental principles of refrigeration system design.
3. Interpret codes and regulations pertaining to refrigeration system design.
4. Interpret information pertaining to refrigeration system design found on drawings, specifications, graphs and tables.
5. Identify capacity ratings of refrigeration system components.
6. Identify types of system designs and describe their characteristics and applications.
 - i) high temperature system
 - ii) medium temperature system
 - iii) low temperature system
 - iv) ultra-low temperature system
7. Identify the factors to consider when designing and laying out refrigeration systems.
8. Identify the factors to consider when selecting equipment, components and accessory devices for refrigeration systems based on design criteria.
9. Explain the importance of balancing system capacity with system load.

10. Identify the factors to consider when selecting refrigerant based on design criteria.
11. Identify the factors to consider when sizing pipe for refrigeration piping systems.
12. Describe the procedures used to size pipe for refrigeration piping systems.
13. Sketch piping schematics for refrigeration systems.
14. Sketch electrical schematics for refrigeration systems.

RACM-310 Large Commercial/Industrial Compressors

Learning Outcomes:

- Demonstrate knowledge of the procedures used to install large commercial/industrial compressors and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot large commercial/industrial compressors and their components.
- Demonstrate knowledge of the causes of large commercial/industrial compressor failures and their procedures for repair.

Objectives and Content:

1. Define terminology associated with large commercial/industrial compressors.
2. Identify hazards and describe safe work practices pertaining to large commercial/industrial compressors.
3. Interpret codes and regulations pertaining to large commercial/industrial compressors.
4. Interpret information pertaining to large commercial/industrial compressors found on drawings and specifications.
5. Identify specialized tools and equipment used with large commercial/industrial compressors, and describe their applications and procedures for use.
6. Explain the purpose and operation of large commercial/industrial compressors and their components.
7. Identify types of large commercial/industrial compressors, and describe their characteristics and applications.
 - i) centrifugal
 - ii) rotary screw
 - iii) open drive
 - iv) semi-hermetic
 - v) hermetic
 - vi) magnetic bearing

8. Identify types of large commercial/industrial compressors components, and describe their characteristics and applications.
9. Identify methods used to cool large commercial/industrial compressors.
10. Identify methods used to lubricate large commercial/industrial compressors.
11. Identify methods of large commercial/industrial compressor capacity control.
12. Identify the factors to consider when selecting and installing large commercial/industrial compressors and their components.
13. Describe the procedures used to install large commercial/industrial compressors and their components.
14. Describe the procedures used to maintain and troubleshoot large commercial/industrial compressors and their components.
15. Identify large commercial/industrial compressor failures and describe their causes and procedures for repair.
 - i) mechanical
 - ii) electrical
16. Describe the procedures used to start up, commission and shut down large commercial/industrial compressors.

RACM-315 Heating Systems

Learning Outcomes:

- Demonstrate knowledge of heating systems, their components and operation.
- Demonstrate knowledge of the procedures used to install heating equipment, components and accessories.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot heating systems, and their equipment, components and accessories.

Objectives and Content:

1. Define terminology associated with heating systems.
2. Identify hazards and describe safe work practices pertaining to heating systems.
3. Interpret codes and regulations pertaining to heating systems.
4. Interpret information pertaining to heating systems found on drawings and specifications.
5. Identify specialized tools and equipment used with heating systems, and describe their applications and procedures for use.
6. Explain the purpose and operation of heating systems, equipment, components and accessories.
7. Identify types of energy sources and describe their application.
 - i) natural gas
 - ii) propane
 - iii) electric
 - iv) fossil fuel
 - v) solar
8. Identify types of heating systems and describe their characteristics and applications.
 - i) forced-air
 - ii) radiant

9. Identify types of heating system equipment, components and accessories, and describe their characteristics and applications.
10. Identify the factors to consider when selecting and installing heating system equipment, components and accessories.
11. Describe the procedures used to install heating system equipment, components and accessories.
12. Describe the procedures used to maintain and troubleshoot heating systems and their equipment, components and accessories.
13. Identify heating system failures and describe their causes and procedures for repair.
14. Describe the procedures used to start up, commission and shut down heating systems.

RACM-320 Commercial Refrigeration Systems

Learning Outcomes:

- Demonstrate knowledge of commercial refrigeration systems, their components and operation.
- Demonstrate knowledge of the procedures used to install commercial refrigeration systems and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot commercial refrigeration systems and their components.

Objectives and Content:

1. Define terminology associated with commercial refrigeration systems.
2. Identify hazards and describe safe work practices pertaining to commercial refrigeration systems.
3. Interpret codes and regulations pertaining to commercial refrigeration systems.
4. Interpret information pertaining to commercial refrigeration systems found on drawings and specifications.
5. Identify specialized tools and equipment used with commercial refrigeration systems, and describe their applications and procedures for use.
6. Explain the purpose and operation of commercial refrigeration systems and their components.
7. Identify types of commercial refrigeration systems, and describe their characteristics and applications.
 - i) supermarket/multi-plex
 - ii) walk-in freezers/coolers
 - iii) ice machines
 - iv) food service
 - v) specialty
 - ultra-low
 - cascade
 - cryogenic

8. Identify types of commercial refrigeration system components, and describe their characteristics and applications.
9. Identify types of commercial refrigeration defrost systems, and describe their characteristics and applications.
 - i) hot gas
 - ii) electric
 - iii) latent heat
10. Identify commercial refrigeration defrost system components, and describe their characteristics and applications.
11. Identify the factors that optimize shelf life and quality of refrigerated and frozen products.
12. Identify the factors to consider when selecting and installing commercial refrigeration systems and their components.
13. Describe the procedures used to install commercial refrigeration systems and their components.
14. Describe the procedures used to maintain and troubleshoot commercial refrigeration systems and their components.
15. Identify commercial refrigeration system and component failures, and describe their causes and procedures for repair.
16. Describe the procedures used to start up, commission and shut down commercial refrigeration systems.

RACM-325 Split Air Conditioning Systems

Learning Outcomes:

- Demonstrate knowledge of split air conditioning systems, their components and operation.
- Demonstrate knowledge of the procedures used to install split air conditioning systems and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot split air conditioning systems and their components.

Objectives and Content:

1. Define terminology associated with split air conditioning systems.
2. Identify hazards and describe safe work practices pertaining to split air conditioning systems.
3. Interpret codes and regulations pertaining to split air conditioning systems.
4. Interpret information pertaining to split air conditioning systems found on drawings and specifications.
5. Identify specialized tools and equipment used with split air conditioning systems, and describe their applications and procedures for use.
6. Explain the purpose and operation of split air conditioning systems and their components.
7. Identify types of split air conditioning systems, and describe their characteristics and applications.
 - i) residential
 - ii) commercial
 - iii) industrial
8. Identify types of split air conditioning system components, and describe their characteristics and applications.

9. Identify the factors to consider when selecting and installing split air conditioning systems and components.
10. Describe the procedures used to install split air conditioning systems and their components.
11. Describe the procedures used to maintain and troubleshoot split air conditioning systems and their components.
12. Identify split air conditioning system and component failures, and describe their causes and procedures for repair.
13. Describe the procedures used to start up, commission and shut down split air conditioning systems.

RACM-330 Packaged Air Conditioning Systems

Learning Outcomes:

- Demonstrate knowledge of packaged air conditioning systems, their components and operation.
- Demonstrate knowledge of the procedures used to install packaged air conditioning systems and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot packaged air conditioning systems and their components.

Objectives and Content:

1. Define terminology associated with packaged air conditioning systems.
2. Identify hazards and describe safe work practices pertaining to packaged air conditioning systems.
3. Interpret codes and regulations pertaining to packaged air conditioning systems.
4. Interpret information pertaining to packaged air conditioning systems found on drawings and specifications.
5. Identify specialized tools and equipment used with packaged air conditioning systems, and describe their applications and procedures for use.
6. Explain the purpose and operation of packaged air conditioning systems and their components.
7. Identify types of packaged air conditioning systems and describe their characteristics and applications.
 - i) residential
 - ii) commercial
 - iii) industrial
8. Identify packaged air conditioning system components and describe their characteristics and applications.
 - i) economizer
 - ii) indoor air quality components

9. Identify the factors to consider when selecting and installing packaged air conditioning systems and their components.
10. Describe the procedures used to install packaged air conditioning systems and their components.
11. Describe the procedures used to maintain and troubleshoot packaged air conditioning systems and their components.
12. Identify packaged air conditioning system and component failures, and describe their causes and procedures for repair.
13. Describe the procedures used to start-up, commission and shut-down packaged air conditioning systems.

RACM-335 Heat Pump Systems

Learning Outcomes:

- Demonstrate knowledge of heat pump systems, their components and operation.
- Demonstrate knowledge of the procedures used to install heat pump systems and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot heat pump systems and their components.

Objectives and Content:

1. Define terminology associated with heat pump systems.
2. Identify hazards and describe safe work practices pertaining to heat pump systems.
3. Interpret codes and regulations pertaining to heat pump systems.
4. Interpret information pertaining to heat pump systems found on drawings and specifications.
5. Identify specialized tools and equipment used with heat pump systems and describe their applications and procedures for use.
6. Explain the purpose and operation of heat pump systems and their components.
7. Identify types of heat pump systems and describe their characteristics and applications.
 - i) air to air
 - ii) liquid to air
 - iii) liquid to liquid
 - iv) air to liquid
8. Identify heat pump equipment and components and describe their characteristics and applications.
9. Describe the operation of the defrost cycle as it relates to heat pumps.

10. Explain water quality as it relates to heat pump systems.
11. Explain control sequences for heat pump systems.
12. Identify the factors to consider when selecting and installing heat pumps and components.
 - i) environmental considerations
 - ii) energy efficiency
 - iii) source
 - well
 - loop
 - air
 - iv) ambient conditions
 - v) physical location
13. Identify the environmental considerations when installing heat pumps.
14. Describe the procedures used to install heat pump systems and their components.
15. Describe the procedures used to maintain and troubleshoot heat pumps and their components.
16. Identify heat pump system failures and describe their causes and procedures for repair.
17. Describe the procedures used to start-up, commission and shut-down heat pump systems.

RACM-340 Fluid Dynamics and Pumps

Learning Outcomes:

- Demonstrate knowledge of fluid dynamics within piping systems.
- Demonstrate knowledge of pumps, their components and operation.
- Demonstrate knowledge of the procedures used to install pumps and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot pumps and their components.

Objectives and Content:

1. Define terminology associated with fluid dynamics and pumps.
2. Identify hazards and describe safe work practices pertaining to fluid dynamics and pumps.
3. Interpret codes and regulations pertaining to fluid dynamics and pumps.
4. Interpret information pertaining to fluid dynamics and pumps found on drawings and specifications.
5. Identify specialized tools and equipment used with fluid dynamics and pumps, and describe their applications and procedures for use.
6. Explain the principles of fluid dynamics.
7. Explain the purpose and operation of liquid pumps and their components.
8. Identify types of pumps and describe their characteristics and applications.
9. Identify pump components and describe their characteristics and applications.
10. Identify the factors to consider when selecting and installing pumps and their components.
 - i) system parameters
 - ii) pump curves
 - iii) circuit configurations

11. Describe the procedures used to install pumps and their components.
12. Describe the procedures used to maintain and troubleshoot pumps and their components.
13. Identify pump and component failures and describe their causes and procedures for repair.
14. Describe the procedures used to fill, start up and commission pump systems.
15. Describe the procedures used to purge air from an open or closed pump system.

RACM-345 Control Systems

Learning Outcomes:

- Demonstrate knowledge of control systems, their components and operation.
- Demonstrate knowledge of the procedures used to install control systems and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot control systems and their components.

Objectives and Content:

1. Define terminology associated with control systems.
2. Identify hazards and describe safe work practices pertaining to control systems.
3. Interpret codes and regulations pertaining to control systems.
4. Interpret information pertaining to control systems found on drawings and specifications.
5. Identify specialized tools and equipment used with control systems, and describe their applications and procedures for use.
6. Identify system control strategies and describe their characteristics and applications.
 - i) two position control
 - ii) floating control
 - iii) pulse width modulation
 - iv) proportional (P)
 - v) proportional plus integral (PI)
 - vi) proportional plus integral plus derivative (PID)
7. Explain how to incorporate various control strategies into control systems.
 - i) electric
 - ii) electronic
 - iii) pneumatic
 - iv) direct digital control (DDC)

8. Identify the factors to consider when selecting and installing control systems and their components.
9. Describe the procedures used to install control systems and their components.
10. Describe the procedures used to maintain and troubleshoot control systems and their components.
11. Identify control system failures and describe their causes and procedures for repair.
12. Describe the procedures used to calibrate operating and safety controls.
13. Describe the procedures used to start up and commission control systems.

RACM-350 Troubleshooting Refrigeration and Air Conditioning Electronic Controls

Learning Outcomes:

- Demonstrate knowledge of testing tools and equipment, their applications and procedures for use.
- Demonstrate knowledge of the procedures used to troubleshoot electronic components and control boards.

Objectives and Content:

1. Define terminology associated with refrigeration and air conditioning electronic controls.
2. Identify hazards and describe safe work practices pertaining to refrigeration and air conditioning electronic controls.
3. Interpret codes and regulations pertaining to refrigeration and air conditioning electronic controls.
4. Interpret information pertaining to refrigeration and air conditioning electronic controls found on drawings, specifications and service manuals.
5. Identify specialized tools and equipment used to test and troubleshoot refrigeration and air conditioning electronic components and control boards, and describe their applications and procedures for use.
6. Identify refrigeration and air conditioning electronic components and control boards, and describe their purpose and operation.
7. Describe the procedures used to troubleshoot refrigeration and air conditioning electronic components and control boards.

RACM-355 Advanced Motors

Learning Outcomes:

- Demonstrate knowledge of the procedures used to install complex motors and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot complex motors and their components.
- Demonstrate knowledge of the procedures used to install motor controls.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot motor controls.

Objectives and Content:

1. Define terminology associated with complex motors and motor controls.
2. Identify hazards and describe safe work practices pertaining to complex motors and motor controls.
3. Interpret codes and regulations pertaining to complex motors and motor controls.
4. Interpret information pertaining to complex motors and motor controls found on drawings and specifications.
5. Identify specialized tools and equipment used with complex motors and motor controls, and describe their applications and procedures for use.
6. Explain the purpose and operation of complex motors and motor controls and their components.
7. Identify types of complex motors and their components, and describe their characteristics and applications.
 - i) multi-lead
 - ii) dual-voltage
 - iii) multi-speed
8. Identify types of motor controls for complex motors, and describe their characteristics, applications and wiring configuration.

9. Describe the methods used to change the speed of a motor.
 - i) multi-tap
 - ii) variable frequency drive (VFD)
10. Identify the factors to consider when selecting and installing complex motors, their components and motor controls.
11. Describe the procedures used to install complex motors and their components.
12. Describe the procedures used to maintain and troubleshoot complex motors and their components.
13. Describe the procedures used to install motor controls.
14. Describe the procedures used to maintain and troubleshoot motor controls.
15. Identify complex motor and motor control failures, and describe their causes and procedures for repair.
16. Diagnose single-phase and multi-phase motor failures and describe their causes.

RACM-360 Refrigeration Capacity Control

Learning Outcomes:

- Demonstrate knowledge of refrigeration capacity control.
- Demonstrate knowledge of the procedures used to install refrigeration capacity control components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot refrigeration capacity control components.

Objectives and Content:

1. Define terminology associated with refrigeration capacity control.
2. Identify hazards and describe safe work practices pertaining to refrigeration capacity control.
3. Interpret codes and regulations pertaining to refrigeration capacity control.
4. Interpret information pertaining to refrigeration capacity control found on drawings and specifications.
5. Identify specialized tools and equipment used with refrigeration capacity control, and describe their applications and procedures for use.
6. Explain the purpose and operation of refrigeration capacity controls and their components.
7. Identify types of refrigeration capacity control and describe their characteristics and applications.
 - i) on-off
 - ii) multi-staging
 - iii) cylinder unloading
 - gas-operated
 - hydraulic-operated
 - iv) hot gas bypass
 - v) inlet guide vanes
 - vi) slide valve

- vii) variable frequency drive (VFD)
 - viii) variable refrigerant flow (VRF)/variable refrigerant volume (VRV)
8. Identify refrigeration capacity control components and describe their characteristics and applications.
 9. Identify the factors to consider when selecting and installing refrigeration capacity controls and their components.
 10. Describe the procedures used to install refrigeration capacity controls and their components.
 11. Describe the procedures used to maintain and troubleshoot refrigeration capacity controls and their components.
 12. Identify refrigeration capacity control and component failures and describe their causes and procedures for repair.

LEVEL 4

RACM-400 Air Conditioning Load Calculations

Learning Outcomes:

- Demonstrate knowledge of air conditioning load calculations.

Objectives and Content:

1. Define terminology associated with air conditioning load calculations.
2. Perform heat gain and heat loss calculations for air conditioning systems.
 - i) transmission
 - K, C, U and R values
 - solar load
 - ii) air change
 - infiltration
 - ventilation
 - iii) heat gain/loss
 - sensible
 - latent
 - iv) miscellaneous
 - lighting
 - occupancy
 - ducting
 - equipment
 - v) Btuh total

RACM-405 Air Conditioning System Design

Learning Outcomes:

- Demonstrate knowledge of air conditioning system design principles.
- Demonstrate knowledge of air volume requirements of air conditioning systems.
- Demonstrate knowledge of air conditioning system equipment, components and accessory devices, and their selection based on design criteria.
- Demonstrate knowledge of sketching piping schematics for air conditioning systems.
- Demonstrate knowledge of sketching electrical schematics for air conditioning systems.

Objectives and Content:

1. Define terminology associated with air conditioning system design.
2. Explain the fundamental principles of air conditioning system design.
3. Interpret codes and regulations pertaining to air conditioning system design.
4. Interpret information pertaining to air conditioning system design found on drawings, specifications, graphs and tables.
5. Identify capacity ratings of air conditioning system components.
6. Identify methods of zoning and describe their applications.
7. Identify types of system designs and describe their characteristics and applications.
 - i) constant air volume (CAV)
 - ii) variable air volume (VAV)
 - iii) variable refrigerant flow (VRF)/variable refrigerant volume (VRV)
 - iv) dual duct
8. Identify the factors to consider for the design and layout of air conditioning systems.

9. Identify the factors to consider when selecting equipment, components and accessory devices for air conditioning systems based on design criteria.
10. Explain the importance of balancing system capacity with system load.
11. Identify the factors to consider when sizing pipe for air conditioning systems.
12. Describe the procedures used to size pipe for air conditioning systems.
13. Sketch piping schematics for air conditioning systems.
14. Sketch electrical schematics for air conditioning systems.

RACM-410 Duct Systems and Design

Learning Outcomes:

- Demonstrate knowledge of duct system design.
- Demonstrate knowledge of duct systems, their components and operation.
- Demonstrate knowledge of the procedures to maintain and troubleshoot duct systems and their components.

Objectives and Content:

1. Define terminology associated with duct systems and design.
2. Identify hazards and describe safe work practices pertaining to duct systems.
3. Interpret codes and regulations pertaining to duct systems.
4. Interpret information pertaining to duct systems found on drawings and specifications.
5. Identify specialized tools and equipment used with duct systems and components, and describe their applications and procedures for use.
6. Explain the purpose and operation of duct systems and their components.
7. Identify types of duct systems and describe their characteristics and applications.
8. Identify duct system components and describe their characteristics and applications.
9. Identify the factors affecting duct system sizing, layout and design.
10. Identify the factors to consider when selecting and installing duct system components.
11. Identify methods of duct sizing and describe associated procedures.
12. Identify types of duct insulation and sealants, and describe their characteristics and applications.

13. Describe the procedures used to install duct system components.
14. Describe the procedures used to maintain and troubleshoot duct systems and their components.
15. Identify duct system and component failures, and describe their causes and procedures for repair.

RACM-415 Evaporative Condensers, Cooling Towers and Fluid Coolers

Learning Outcomes:

- Demonstrate knowledge of evaporative condensers, cooling towers and fluid coolers, their components and operation.
- Demonstrate knowledge of the procedures used to install evaporative condensers, cooling towers and fluid coolers, and their associated components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot evaporative condensers, cooling towers and fluid coolers, and their associated components.

Objectives and Content:

1. Define terminology associated with evaporative condensers, cooling towers and fluid coolers.
2. Identify hazards and describe safe work practices pertaining to evaporative condensers, cooling towers and fluid coolers.
3. Interpret codes and regulations pertaining to evaporative condensers, cooling towers and fluid coolers.
4. Interpret information pertaining to evaporative condensers, cooling towers and fluid coolers found in drawings and specifications.
5. Identify specialized tools and equipment used with evaporative condensers, cooling towers and fluid coolers, and describe their applications and procedures for use.
6. Explain the purpose and operation of evaporative condensers, cooling towers and fluid coolers.
7. Identify types of evaporative condensers and their components, and describe their characteristics and applications.
8. Identify types of cooling towers and their components, and describe their characteristics and applications.

9. Identify types of fluid coolers and their components, and describe their characteristics and applications.
10. Identify the factors that influence the effectiveness of evaporative condensers, cooling towers and fluid coolers, based on psychrometric principles.
11. Identify methods to control head pressure and describe their associated procedures.
12. Identify the factors to consider when selecting and installing evaporative condensers, cooling towers and fluid coolers, and their associated components.
13. Describe the procedures used to install evaporative condensers, cooling towers and fluid coolers, and their associated components.
14. Describe the procedures used to maintain and troubleshoot evaporative condensers, cooling towers and fluid coolers, and their associated components.
 - i) water treatment
15. Identify failures in evaporative condensers, cooling towers and fluid coolers, and their associated components, and describe their causes and procedures for repair.
16. Describe the procedures used to start up, commission and shut down evaporative condensers, cooling towers and fluid coolers.

RACM-420 Air Measurement and System Air Balancing

Learning Outcomes:

- Demonstrate knowledge of the principles and procedures for air measurement and system air balancing.
- Demonstrate knowledge of air measuring instruments, their applications and procedures for use.

Objectives and Content:

1. Define terminology associated with air measurement and system air balancing.
2. Identify hazards and describe safe work practices pertaining to air measurement and system air balancing.
3. Interpret codes and regulations pertaining to air measurement and system air balancing.
4. Interpret information pertaining to air measurement and system air balancing found on drawings and specifications.
5. Identify types of air measuring instruments, and describe their applications and procedures for use.
6. Explain the principles of air movement and air balancing.
7. Identify types of charts and tables used to monitor and balance air systems, and describe their applications and procedures for use.
 - i) air velocity chart
 - ii) air volume chart
 - iii) occupancy table
8. Describe the procedures used in system air balancing.
9. Perform calculations for system air balancing.

RACM-425 Chillers and Chiller Systems

Learning Outcomes:

- Demonstrate knowledge of chillers and chiller systems, their associated components and operation.
- Demonstrate knowledge of the procedures used to install chillers, chiller systems and their associated components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot chillers, chiller systems and their associated components.

Objectives and Content:

1. Define terminology associated with chillers and chiller systems.
2. Identify hazards and describe safe work practices pertaining to chillers and chiller systems.
3. Interpret codes and regulations pertaining to chillers and chiller systems.
4. Interpret information pertaining to chillers and chiller systems found on drawings, specifications and schematic diagrams.
5. Identify specialized tools and equipment used with chillers and chiller systems, and describe their applications and procedures for use.
6. Explain the purpose and operation of chillers and chiller systems, and their associated components.
 - i) primary
 - ii) secondary
7. Identify types of chillers and describe their characteristics and applications.
 - i) reciprocating
 - ii) screw
 - iii) scroll
 - iv) rotary
 - v) centrifugal
 - vi) absorption

8. Identify chiller components and describe their characteristics and applications.
 - i) compressor
 - ii) oil pump
 - iii) condenser
 - iv) purge unit
 - v) chiller barrel
9. Identify chiller applications and describe their characteristics.
 - i) air conditioning
 - ii) ice rink/surface
 - iii) process
 - iv) supermarket
10. Identify chiller system components and describe their characteristics and applications.
 - i) pumps
 - ii) cooling coils
 - iii) valves
 - iv) air handlers
11. Identify the methods of chiller capacity control.
12. Identify the factors to consider when selecting and installing chillers, chiller systems and their associated components.
13. Describe the procedures used to install chillers, chiller systems, and their associated components.
14. Describe the procedures used to maintain and troubleshoot chillers, chiller systems and their associated components.
15. Identify chiller and chiller system failures, and describe their causes and procedures for repair.
16. Describe the procedures used to start up, commission and shut down chillers and chiller systems.

RACM-430 Industrial Refrigeration Systems

Learning Outcomes:

- Demonstrate knowledge of industrial refrigeration systems, their components and operation.
- Demonstrate knowledge of the procedures used to install industrial refrigeration systems and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot industrial refrigeration systems and their components.

Objectives and Content:

1. Define terminology associated with industrial refrigeration systems.
2. Identify hazards and safe work practices pertaining to industrial refrigeration systems.
3. Interpret codes and regulations pertaining to industrial refrigeration systems.
4. Interpret information pertaining to industrial refrigeration systems found on drawings and specifications.
5. Identify specialized tools and equipment used with industrial refrigeration systems, and describe their applications and procedures for use.
6. Explain the purpose and operation of industrial refrigeration systems and their components.
7. Identify types of industrial refrigeration systems and describe their characteristics and applications.
 - i) parallel
 - ii) compound
 - iii) cascade
8. Identify industrial refrigeration system components and describe their characteristics and applications.
9. Identify types of liquid recirculation systems and describe their characteristics and applications.

- i) flooded
 - ii) pumped liquid
10. Identify the factors to consider when selecting and installing industrial refrigeration systems and their components.
 11. Describe the procedures used to install industrial refrigeration systems and their components.
 12. Describe the procedures used to maintain and troubleshoot industrial refrigeration systems and their components.
 13. Identify industrial refrigeration system and component failures, and describe their causes and procedures for repair.
 14. Describe the procedures used to start up, commission and shut down industrial refrigeration systems.

RACM-435 Troubleshooting With Schematic Wiring Diagrams

Learning Outcomes:

- Demonstrate knowledge of advanced schematic wiring diagrams and their use in troubleshooting complex systems.

Objectives and Content:

1. Define terminology associated with schematic wiring diagrams.
2. Interpret advanced schematic wiring diagrams for use in troubleshooting complex systems.
 - i) manufacturers' drawings
 - ii) as-built drawings
3. Identify troubleshooting techniques using advanced schematic wiring diagrams and describe their associated procedures.

RACM-440 Job Coordination

Learning Outcomes:

- Demonstrate knowledge of effective job coordinating practices.
- Demonstrate knowledge of equipment and material acquisition.

Objectives and Content:

1. Define terminology associated with job coordination.
2. Interpret codes, regulations, procedures, blueprints and specifications pertaining to job coordination.
3. Identify sources of information relevant to job coordinating.
 - i) trade-related documentation
 - warranties
 - manufacturers' specifications
 - wholesaler catalogues
 - log sheets
 - permits
 - reports
 - ii) related professionals
 - iii) customers
 - iv) co-workers
 - dispatchers
 - sales staff
 - managers
4. Identify information gathering and communication techniques, and describe their associated procedures.
 - i) questioning for clarification
 - ii) relaying technical information
 - iii) using communication equipment
5. Describe the procedures used to coordinate work requirements.
 - i) prepare material list
 - ii) requisition equipment, components and accessories
 - iii) arrange for delivery and storage of equipment/materials

- iv) coordinate access to work site
 - v) conduct work area inspection
 - vi) coordinate activities with customer and other professionals
6. Estimate work requirements.
- i) tools and equipment
 - ii) components and accessories
 - iii) time and costs