Interprovincial Program Guide

Refrigeration and Air Conditioning Mechanic

2008

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The Joint Planning Committee (JPC) recognizes this Interprovincial Program Guide as the national curriculum for the occupation of Refrigeration and Air Conditioning Mechanic.

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Table of Contents

PROGRAM CONTENT

Introduction

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 trades people 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 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 Canadian Council of Directors of Apprenticeship (CCDA) embarked on a process for the development of national Interprovincial Program Guides (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 key activities in moving towards a more cohesive apprenticeship system.

With the support of Human Resources and Social Development Canada (HRSDC), 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.

User Guide

According to the Canadian Apprenticeship Forum, the Interprovincial Program Guide (IPG) is: "a list of validated technical training outcomes, based upon those sub-tasks identified as common core in the National Occupational Analysis, 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 National Occupational Analyses and extensive industry consultation. The IPG is intended to assist program development staff in the design of jurisdictional plans for 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 content of the IPG is divided into units. Unit codes are used as a means of identification and are not intended to convey the order of delivery. Prerequisites have not been detailed. Jurisdictions are free to deliver units one at a time or concurrently provided all outcomes are met.

The IPG does not indicate the amount of time to be spent on a particular unit. The length of time required to deliver an outcome successfully will depend upon the learning activities and teaching methods used. Jurisdictions are encouraged to use practical demonstration and opportunities for hands-on learning whenever possible.

The unit outcomes are the specific performances that must be evaluated. Wording of 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 outcomes are evaluated; theoretically, practically or a combination of both.

Detailed content for each objective has not been developed. Where detail is required for clarity, content has been provided. Content may be added or extended in jurisdictional training plans.

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	v. To subject to a procedure that ascertains effectiveness, value, proper function, or other quality. n. A way of examining something to determine its characteristics or properties, or to determine whether or not it is working correctly.
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 Human Resources and Social Development Canada's Essential Skills website at:

http://srv108.services.gc.ca/english/general/home_e.shtml

Profile Chart

FUNDAMENTAL OCCUPATIONAL SKILLS			
RACM-100 Safety	**RACM-105** Hoisting, Lifting, Rigging and Access/Egress Equipment	**RACM-110** Tools and Equipment	**RACM-115** Refrigeration Fundamentals
RACM-120 Refrigerants and Oils	**RACM-135** Piping, Tubing, Soldering and Brazing	**RACM-140** Leak Testing, Evacuation and Charging	**RACM-145** Electrical Fundamentals
RACM-155 Blueprint Reading	**RACM-160** Trade Documents	**RACM-200** Pressure Enthalpy Diagrams	**RACM-440** Job Coordination
REFRIGERATION AND AIR COOLING SYSTEMS			
RACM-165 Refrigeration and Air Conditioning Installation	**RACM-300** Refrigeration Load Calculations	**RACM-305** Refrigeration System Design	**RACM-320** Commercial Refrigeration Systems
RACM-430 Industrial Refrigeration Systems			
HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS			
RACM-230 Air Conditioning Fundamentals	**RACM-325** Air Conditioning Systems	**RACM-330** Packaged Air Conditioning Units	**RACM-335** Heat Pumps
RACM-400 Air Conditioning Load Calculations	**RACM-405** Air Conditioning System Design	**RACM-410** Duct Systems and Design	**RACM-415** Heating Systems
RACM-420 Air Measuring Instruments and System Air Balancing	**RACM-425** Chillers and Chiller Systems		

Profile Chart *(continued)*

REFRIGERATION, HEATING, VENTILATION AND AIR CONDITIONING SYSTEM COMPONENTS			
RACM-125 Compressors I	**RACM-130** Valves and Accessory Devices	**RACM-150** Motors I	**RACM-205** Evaporators
RACM-210 Compressors II	**RACM-215** Condensers	**RACM-220** Metering Devices	**RACM-225** Refrigerant Flow Controls
RACM-235 Fans, Mechanical Drives, Air Filters and Air Cleaners	**RAMC-245** Motors II	**RACM-310** Compressors III	**RACM-315** Evaporative Condensers and Cooling Towers
RACM-340 Fluid Dynamics and Circulating Pumps			
CONTROL SYSTEMS			
RACM-240 Control Fundamentals	**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			

Recommended Level Structure

Level 1			Level 2		
Unit Code	**Title**	**Page**	**Unit Code**	**Title**	**Page**
RACM-100	Safety	24	RACM-200	Pressure Enthalpy Diagrams	48
RACM-105	Hoisting, Lifting, Rigging and Access/Egress Equipment	25	RACM-205	Evaporators	49
RACM-110	Tools and Equipment	27	RACM-210	Compressors II	51
RACM-115	Refrigeration Fundamentals	29	RACM-215	Condensers	53
RACM-120	Refrigerants and Oils	31	RACM-220	Metering Devices	54
RACM-125	Compressors I	33	RACM-225	Refrigerant Flow Controls	55
RACM-130	Valves and Accessory Devices	34	RACM-230	Air Conditioning Fundamentals	56
RACM-135	Piping, Tubing, Soldering and Brazing	35	RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners	57
RACM-140	Leak Testing, Evacuation and Charging	37	RACM-240	Control Fundamentals	58
RACM-145	Electrical Fundamentals	39	RACM-245	Motors II	59
RACM-150	Motors I	41	RACM-250	Control Circuits and Wiring Diagrams	61
RACM-155	Blueprint Reading	42			
RACM-160	Trade Documents	43			
RACM-165	Refrigeration and Air Conditioning Installation	44			

Level 3			Level 4		
Unit Code	**Title**	**Page**	**Unit Code**	**Title**	**Page**
RACM-300	Refrigeration Load Calculations	64	RACM-400	Air Conditioning Load Calculations	80
RACM-305	Refrigeration System Design	65	RACM-405	Air Conditioning System Design	81
RACM-310	Compressors III	67	RACM-410	Duct Systems and Design	83
RACM-315	Evaporative Condensers and Cooling Towers	69	RACM-415	Heating Systems	84
RACM-320	Commercial Refrigeration Systems	71	RACM-420	Air Measuring Instruments and System Air Balancing	86
RACM-325	Air Conditioning Systems	73	RACM-425	Chillers and Chiller Systems	87
RACM-330	Packaged Air Conditioning Units	74	RACM-430	Industrial Refrigeration Systems	89
RACM-335	Heat Pump Systems	75	RACM-435	Troubleshooting with Schematic Wiring Diagrams	90
RACM-340	Fluid Dynamics and Circulating Pumps	76	RACM-440	Job Coordination	91
RACM-345	Control Systems	77			
RACM-350	Troubleshooting Refrigeration and Air Conditioning Electronics	78			

2004 NOA Sub-task to IPG Unit Comparison

NOA Sub-task		IPG Unit	
Task 1 – Utilizes mechanical and architectural drawings, acts, codes, standards, legislation, and service and operating manuals.			
1.01	Interprets blueprints, drawings and schematics.	RACM-155	Blueprint Reading
1.02	Interprets service and operating manuals, technical bulletins and warranties.	RACM-160	Trade Documents
1.03	Interprets tables, charts and diagrams.	RACM-115	Refrigeration Fundamentals
		RACM-160	Trade Documents
		RACM-200	Pressure Enthalpy Diagrams
1.04	Interprets manufacturer's specifications.	RACM-160	Trade Documents
1.05	Complies with government acts, codes, standards and regulations.	RACM-100	Safety
		RACM-160	Trade Documents
Task 2 – Operates and maintains tools and equipment.			
2.01	Utilizes hand tools.	RACM-110	Tools and Equipment
2.02	Utilizes portable and stationary power tools.	RACM-110	Tools and Equipment
2.03	Utilizes oxy-fuel and air-fuel equipment.	RACM-135	Piping, Tubing, Soldering and Brazing
2.04	Utilizes recovery and recycle equipment.	RACM-140	Leak Testing, Evacuation and Charging
2.05	Utilizes evacuation equipment and tools.	RACM-140	Leak Testing, Evacuation and Charging
2.06	Utilizes charging equipment and tools.	RACM-140	Leak Testing, Evacuation and Charging
2.07	Utilizes access/egress equipment.	RACM-105	Hoisting, Lifting, Rigging and Access/Egress Equipment
2.08	Utilizes hoisting and rigging equipment.	RACM-105	Hoisting, Lifting, Rigging and Access/Egress Equipment
2.09	Utilizes mechanical measuring equipment.	RACM-110	Tools and Equipment
2.10	Utilizes electric and electronic diagnostic tools.	RACM-110	Tools and Equipment
2.11	Utilizes computer equipment to interface with refrigeration and air conditioning systems.	RACM-345	Control Systems
		RACM-350	Troubleshooting Refrigeration and Air Conditioning Electronics
Task 3 – Demonstrates work practices and procedures.			
3.01	Installs fasteners, brackets and hangers.	RACM-135	Piping, Tubing, Soldering and Brazing
3.02	Performs lock-out tagging and isolation procedures.	RACM-100	Safety
3.03	Installs piping and tubing.	RACM-135	Piping, Tubing, Soldering and Brazing
3.04	Applies sealants and adhesives.	RACM-135	Piping, Tubing, Soldering and Brazing

NOA Sub-task		IPG Unit	
3.05	Cleans and lubricates parts and components	RACM-110	Tools and Equipment
3.06	Performs internal electrical wiring of systems.	RACM-145	Electrical Fundamentals
		RACM-250	Control Circuits and Wiring Diagrams
Task 4 – Coordinates refrigeration and air conditioning installation and maintenance.			
4.01	Estimates work requirements.	RACM-440	Job Coordination
4.02	Conducts work area inspection.	RACM-100	Safety
		RACM-440	Job Coordination
4.03	Coordinates work requirements.	RACM-440	Job Coordination
4.04	Maintains customer relations.	RACM-440	Job Coordination
4.05	Clarifies end user problems with refrigeration and air conditioning systems.	RACM-440	Job Coordination
4.06	Completes work-related documentation.	RACM-160	Trade Documents
4.07	Generates maintenance documentation.	RACM-160	Trade Documents
Task 5 – Performs system components, accessories and materials acquisition and handling.			
5.01	Requisitions equipment.	RACM-160	Trade Documents
		RACM-440	Job Coordination
5.02	Receives materials/equipment.	RACM-160	Trade Documents
		RACM-440	Job Coordination
5.03	Transfers equipment to designated location.	RACM-160	Trade Documents
		RACM-440	Job Coordination
Task 6 – Plans installation of refrigeration and air cooling systems.			
6.01	Verifies refrigeration and air conditioning system parameters and requirements.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-300	Refrigeration Load Calculations
		RACM-305	Refrigeration System Design
		RACM-320	Commercial Refrigeration Systems
		RACM-430	Industrial Refrigeration Systems
6.02	Selects refrigeration and air cooling components, equipment and accessories.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps
6.03	Prepares components, equipment and accessories layout.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices

NOA Sub-task		IPG Unit	
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps
6.04	Selects refrigerant.	RACM-120	Refrigerants and Oils
6.05	Sizes pipe.	RACM-135	Piping, Tubing, Soldering and Brazing
6.06	Lays out piping.	RACM-135	Piping, Tubing, Soldering and Brazing
6.07	Selects insulation.	RACM-135	Piping, Tubing, Soldering and Brazing
Task 7 – Installs refrigeration and air cooling systems.			
7.01	Prepares site/location.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-440	Job Coordination
7.02	Assembles refrigeration and air cooling components, equipment and accessories.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps
7.03	Positions and secures refrigeration and air cooling components, equipment and accessories.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps

NOA Sub-task		IPG Unit	
7.04	Routes and connects refrigerant piping.	RACM-135	Piping, Tubing, Soldering and Brazing
7.05	Performs leak test on system.	RACM-140	Leak Testing, Evacuation and Charging
7.06	Evacuates system.	RACM-140	Leak Testing, Evacuation and Charging
7.07	Charges system.	RACM-140	Leak Testing, Evacuation and Charging
Task 8 – Commissions refrigeration and air cooling systems.			
8.01	Performs pre-start-up checks.	RACM-165	Refrigeration and Air Conditioning Installation
8.02	Starts up refrigeration and air conditioning system.	RACM-165	Refrigeration and Air Conditioning Installation
8.03	Completes system charge.	RACM-140	Leak Testing, Evacuation and Charging
8.04	Sets up primary and secondary refrigeration system adjustable switches, valves and regulators.	RACM-130	Valves and Accessory Devices
Task 9 – Maintains refrigeration and air cooling systems.			
9.01	Inspects refrigeration and air cooling systems.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps
9.02	Tests electrical and electronic components.	RACM-110	Tools and Equipment
		RACM-145	Electrical Fundamentals
		RACM-350	Troubleshooting Refrigeration and Air Conditioning Electronics
9.03	Tests mechanical components.	RACM-110	Tools and Equipment
9.04	Recommends corrective action.	RACM-440	Job Coordination
9.05	Selects refrigeration and air cooling equipment and components.	RACM-160	Trade Documents
		RACM-440	Job Coordination
9.06	Replaces defective components and equipment.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners

NOA Sub-task		IPG Unit	
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps
9.07	Repairs/overhauls defective components and equipment.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps
9.08	Verifies refrigeration and air cooling system component function.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps
9.09	Performs predictive maintenance.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps
9.10	Performs preventative maintenance.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I

NOA Sub-task		IPG Unit	
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-225	Refrigerant Flow Controls
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-340	Fluid Dynamics and Circulating Pumps
Task 10 – Plans installation of heating, ventilating and air conditioning systems.			
10.01	Verifies heating, ventilating and air conditioning systems, parameters and requirements.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-230	Air Conditioning Fundamentals
		RACM-325	Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pumps
		RACM-400	Air Conditioning Load Calculations
		RACM-405	Air Conditioning System Design
		RACM-410	Duct Systems Design
		RACM-415	Heating Systems
		RACM-425	Chillers and Chiller Systems
10.02	Selects heating, ventilating and air conditioning components and equipment.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-315	Evaporative Condensers and Cooling Towers
10.03	Confirms heating, ventilating and air conditioning requirements.	RACM-405	Air Conditioning System Design
		RACM-415	Heating Systems
Task 11 – Installs heating, ventilating and air conditioning systems.			
11.01	Prepares heating, ventilating and air conditioning equipment site/location.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-440	Job Coordination
11.02	Assembles heating, ventilating and air conditioning equipment.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators

NOA Sub-task		IPG Unit	
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-315	Evaporative Condensers and Cooling Towers
11.03	Positions and secures heating, ventilating and air conditioning equipment.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-315	Evaporative Condensers and Cooling Towers
Task 12 – Commissions heating, ventilating and air conditioning systems.			
12.01	Performs pre-start-up checks.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-230	Air Conditioning Fundamentals
		RACM-325	Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pumps
		RACM-400	Air Conditioning Load Calculations
		RACM-405	Air Conditioning System Design
		RACM-415	Heating Systems
		RACM-425	Chillers and Chiller Systems
12.02	Starts up heating, ventilating and air conditioning systems.	RACM-165	Refrigeration and Air Conditioning Installation
		RACM-230	Air Conditioning Fundamentals
		RACM-325	Air Conditioning Systems
		RACM-330	Packaged Air Conditioning Units
		RACM-335	Heat Pumps
		RACM-400	Air Conditioning Load Calculations
		RACM-405	Air Conditioning System Design
		RACM-415	Heating Systems
		RACM-425	Chillers and Chiller Systems
Task 13 – Maintains heating, ventilating and air conditioning systems.			
13.01	Inspects heating, ventilating and air	RACM-125	Compressors I

NOA Sub-task		IPG Unit	
	conditioning systems.	RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-315	Evaporative Condensers and Cooling Towers
13.02	Tests electrical/electronic components in heating, ventilating and air conditioning systems.	RACM-110	Tools and Equipment
		RACM-145	Electrical Fundamentals
13.03	Tests mechanical components in heating, ventilating and air conditioning systems.	RACM-110	Tools and Equipment
13.04	Recommends corrective action.	RACM-440	Job Coordination
13.05	Selects heating, ventilating and air conditioning equipment and components.	RACM-160	Trade Documents
		RACM-440	Job Coordination
13.06	Replaces defective heating, ventilating and air conditioning components and equipment.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-315	Evaporative Condensers and Cooling Towers
13.07	Repairs/overhauls defective components and equipment for heating, ventilating and air conditioning systems.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II

NOA Sub-task		IPG Unit	
		RACM-310	Compressors III
		RACM-315	Evaporative Condensers and Cooling Towers
13.08	Verifies heating, ventilating and air conditioning systems and component function.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-315	Evaporative Condensers and Cooling Towers
		RACM-420	Air Measuring Instruments and System Air Balancing
13.09	Performs predictive maintenance on heating system.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-315	Evaporative Condensers and Cooling Towers
13.10	Performs preventative maintenance on heating, ventilating and air conditioning systems.	RACM-125	Compressors I
		RACM-130	Valves and Accessory Devices
		RACM-150	Motors I
		RACM-205	Evaporators
		RACM-210	Compressors II
		RACM-215	Condensers
		RACM-220	Metering Devices
		RACM-235	Fans, Mechanical Drives, Air Filters and Air Cleaners
		RACM-245	Motors II
		RACM-310	Compressors III
		RACM-315	Evaporative Condensers and Cooling Towers

NOA Sub-task		IPG Unit	
Task 14 – Plans installation of control systems.			
14.01	Selects controls.	RACM-240	Control Fundamentals
		RACM-345	Control Systems
14.02	Lays out control system components and wiring.	RACM-250	Control Circuits and Wiring Diagrams
		RACM-345	Control Systems
Task 15 – Installs control systems.			
15.01	Prepares site/location for control system.	RACM-345	Control Systems
15.02	Positions and secures control system components.	RACM-345	Control Systems
15.03	Connects system wiring and tubing.	RACM-135	Tubing, Piping, Soldering and Brazing
		RACM-250	Control Circuits and Wiring Diagrams
Task 16 – Commissions control systems.			
16.01	Performs pre-start-up checks.	RACM-345	Control Systems
16.02	Sets operating parameters.	RACM-345	Control Systems
16.03	Starts up control system.	RACM-345	Control Systems
Task 17 – Maintains control systems.			
17.01	Inspects control system.	RACM-345	Control Systems
17.02	Verifies and resets operating parameters.	RACM-345	Control Systems
17.03	Tests electrical/electronic components in control system.	RACM-145	Electrical Fundamentals
		RACM-350	Troubleshooting Refrigeration and Air Conditioning Electronics
		RACM-435	Troubleshooting with Schematic Wiring Diagrams
17.04	Tests mechanical components in control system.	RACM-345	Control Systems
17.05	Recommends corrective action.	RACM-440	Job Coordination
17.06	Selects control system equipment and components.	RACM-160	Trade Documents
		RACM-440	Job Coordination
17.07	Replaces defective control components and equipment.	RACM-345	Control Systems
17.08	Repairs/overhauls defective components and equipment for control system.	RACM-345	Control Systems
17.09	Verifies control system component function.	RACM-345	Control Systems
17.10	Performs preventative maintenance on control system.	RACM-345	Control Systems
17.11	Calibrates operating and safety controls.	RACM-345	Control Systems

LEVEL 1

RACM-100 Safety

Learning Outcomes:

- Demonstrate knowledge of safety equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of safe work practices.
- Demonstrate knowledge of regulatory requirements pertaining to safety.

Objectives and Content:

1. Identify types of personal protective clothing and equipment (PPE) and describe their applications.

2. Describe the procedures for care and maintenance of PPE.

3. Identify hazards and describe safe work practices and equipment.
   - i) personal
   - ii) workplace
     - electrical
     - confined space
     - fire
     - tag out/lockout
     - fall protection
     - refrigerants
     - pressurized gases
   - iii) environment

4. Identify and describe workplace safety and health regulations.
   - i) federal
     - material safety data sheets (MSDS)
     - workplace hazardous material information system (WHMIS)
     - transportation of dangerous goods (TDG)
   - ii) provincial/territorial
     - occupational health and safety (OHS)
   - iii) municipal

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 and rigging.

2. Identify and interpret regulatory requirements pertaining to hoisting, lifting, rigging and access/egress equipment.

3. 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

4. Identify types of knots and describe their applications.

5. Describe the procedures used to store and maintain rigging equipment.

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. Describe the procedures used to store and maintain hoisting and lifting equipment.

8. Identify types of access/egress equipment and describe their applications, limitations and procedures for use.
   i) ladders
   ii) staging
   iii) scaffolding
   iv) lifts

9. Describe the procedures used to store and maintain access/egress equipment.

10. Identify and interpret basic hand signals used for lifting and hoisting.

RACM-110 Tools and Equipment

Learning Outcomes:

- Demonstrate knowledge of hand and power tools, their applications, maintenance and procedures for use.
- Demonstrate knowledge of measuring and testing devices, their applications, maintenance and procedures for use.
- Demonstrate knowledge of refrigeration tools and equipment, their applications, maintenance and procedures for use.

Objectives and Content:

1. Identify types of hand tools and describe their applications and procedures for use.

2. Describe the procedures used to store and maintain hand tools.

3. Identify types of portable and stationary power tools and describe their applications and procedures for use.
   i) pneumatic
   ii) electric
   iii) hydraulic
   iv) gas

4. Describe the procedures used to store and maintain portable and stationary power tools.

5. Identify types of refrigeration tools and equipment and describe their applications.
   i) recovery and recycle
   ii) evacuation
   iii) charging

6. Identify types of electric and electronic diagnostic tools and describe their applications and procedures for use.

7. Identity types of mechanical measuring equipment and describe their applications and procedures for use.

i) vernier/digital calipers
ii) micrometers
iii) dial indicators

8. Describe the procedures used to store and maintain mechanical measuring equipment.

9. Identify types of monitoring and testing tools and instruments and describe their applications and procedures for use.
   i) acid test kit
   ii) oil test kit
   iii) electrical test meters
   iv) air flow meters
   v) leak detectors

10. Describe the procedures used to store and maintain monitoring and testing tools and instruments.

RACM-115 Refrigeration Fundamentals

Learning Outcomes:

- Demonstrate knowledge of refrigeration and the refrigeration cycle.

Objectives and Content:

1. Define terminology and concepts associated with refrigeration.
   i) temperature
   ii) heat
   iii) mass and weight
   iv) density
   v) specific gravity
   vi) specific volume
   vii) pressure

2. Identify temperature scales and perform conversion calculations.

3. Describe heat flow and identify methods of heat transfer.

4. Identify states of matter and describe their characteristics.

5. Describe basic gas laws associated with refrigeration and perform calculations to demonstrate relationships.

6. Describe the effect of pressure on evaporation, condensing, freezing and melting temperatures.

7. Explain the operation of the vapour compression cycle.

8. Identify components of a vapour compression cycle and describe their purpose and operation.

9. Describe the physical changes of the refrigerant as it circulates through the system.

10. Describe the pressure/temperature chart and its use in determining refrigerant conditions.

11. Describe superheat and sub-cooling and their significance in the refrigeration cycle.

12. Describe the pressure enthalpy diagram and its applications.

13. Explain how to plot the basic cycle using a pressure enthalpy diagram.

14. 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

15. Identify factors that affect capacity.
    i) condensing pressure/temperature
    ii) evaporating pressure/temperature
    iii) heat of compression
    iv) sub-cooling
    v) superheat

RACM-120 Refrigerants and Oils

Learning Outcomes:

- Demonstrate knowledge of refrigerants and oils, their applications and procedures for use.
- Demonstrate knowledge of regulatory requirements pertaining to refrigerants and oils.
- Demonstrate knowledge of recovery and recycling equipment, its maintenance and procedures for use.
- Demonstrate knowledge of the procedures used to recover and recycle refrigerants and oils.

Objectives and Content:

1. Define terminology associated with refrigerants and oils.

2. Identify hazards, health concerns and safe work practices pertaining to the handling, storing, and disposing of refrigerants and oils.

3. Identify types of refrigerants and describe their characteristics and applications.
   i) primary
   ii) secondary

4. Identify refrigerant containers and colour coding classifications.

5. Identify types of oils and describe their characteristics and applications.

6. Identify and interpret codes and regulations pertaining to refrigerants and oils.

7. Describe the environmental effects of refrigerants.
   i) ozone depletion
   ii) global warming

8. Describe the procedures used to perform refrigerant and oil conversions.

9. Identify recovery and recycling equipment and describe procedures for their use and maintenance.

10. Describe the procedures used to recover and recycle refrigerants and oils.

11. Describe the procedures used to transport refrigerants and oils.

RACM-125 Compressors I

Learning Outcomes:

- Demonstrate knowledge of 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. Describe the purpose and operating principles of the compressor in the refrigeration system.

4. Identify types of compressors and describe their characteristics and applications.
   i) reciprocating
   ii) scroll
   iii) rotary
   iv) screw
   v) centrifugal
   vi) swing

5. Identify compressor components and describe their purpose and operation.

6. Identify methods of compressor lubrication.

7. Identify methods used to cool compressors.

8. Explain compressor efficiency and how it is determined.

RACM-130 Valves and Accessory Devices

Learning Outcomes:

- Demonstrate knowledge of refrigeration valves, their applications and procedures for use.
- Demonstrate knowledge of refrigeration accessory devices, their applications and procedures for use.
- Demonstrate knowledge of the procedures used to install valves and accessory devices.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot valves and accessory devices.

Objectives and Content:

1. Define terminology associated with valves and accessory devices.

2. Identity types of valves and describe their applications and procedures for use.

3. Identify types of accessory devices and describe their applications and operations.
   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

4. Describe the procedures used to install valves.

5. Describe the procedures used to maintain and troubleshoot valves.

6. Describe the procedures used to install accessory devices.

7. Describe the procedures used to maintain and troubleshoot accessory devices.

RACM-135 Piping, Tubing, Soldering and Brazing

Learning Outcomes:

- Demonstrate knowledge of refrigeration piping and tubing, their applications and installation.
- Demonstrate knowledge of fittings and their applications.
- Demonstrate knowledge of soldering and brazing equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of fasteners, brackets and hangers and their applications.
- Demonstrate knowledge of pipe insulation, sealants and adhesives, their applications and procedures for use.

Objectives and Content:

1. Define terminology associated with piping, tubing, soldering and brazing.

2. Identify hazards and safe work practices pertaining to piping, tubing, soldering and brazing.

3. Identify types of refrigeration piping and tubing and describe their characteristics and applications.

4. Identify types of fittings and describe their applications and procedures for use.

5. Describe the process for cutting pipe and tubing to proper sizes.

6. Identify types of flaring and swaging tools and describe their applications and procedures for use and maintenance.

7. Describe the procedures used to bend tubing.
   i) piping and offsets
      - rise
      - run

8. Identify types of equipment and accessories used to solder and braze and describe their applications.
   i) oxy-fuel

ii) air-fuel

9. Identify types of soldering and brazing materials and fillers and describe their characteristics and applications.

10. Describe the procedures used to solder and braze tubing.

11. Identify types of threaded pipe and describe their characteristics and applications.

12. Describe the procedures used to install piping and tubing.

13. Identify types of pipe hangers, brackets and fasteners and describe their characteristics and applications.

14. Describe the procedures used to install pipe hangers, brackets and fasteners.

15. Identify types of pipe and tubing insulation and how it is installed.

16. Identify types of sealants and adhesives and describe their applications and procedures for use.

RACM-140 Leak Testing, Evacuation and Charging

Learning Outcomes:

- Demonstrate knowledge of leak test, evacuation and charging tools and equipment, their maintenance and procedures for use.
- 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.

2. Identify and interpret codes and regulations pertaining to leak testing, evacuation and charging.

3. Identify types of leak detection tools and describe their applications and procedures for use.

4. Describe the procedures used to leak test a refrigeration system.

5. Identify types of evacuation tools and equipment and describe their procedures for use and maintenance.

6. Describe the procedures used to evacuate and dehydrate a system.

7. Identify types of charging tools and equipment and describe their procedures for use and maintenance.
   i) charging scales

8. Identify methods to charge oil into a system and describe their associated procedures.

9. Identify methods to charge refrigerant into a system and describe their associated procedures.
   i) superheat

ii) sub-cooling
iii) critical charge
iv) charge charts

RACM-145 Electrical Fundamentals

Learning Outcomes:

- Demonstrate knowledge of fundamental concepts of electricity.
- Demonstrate knowledge of measuring voltage, resistance, current and power, and calculating their interrelationship.
- 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.
- Demonstrate knowledge of interior system electrical wiring.

Objectives and Content:

1. Define terminology associated with electrical fundamentals.

2. Identify hazards and safe work practices pertaining to electricity.

3. Identify units of electrical measurement and symbols.

4. Describe current and electron flow in both direct and alternating current circuits.

5. Identify types of conductors and describe their characteristics and applications.

6. Identify the factors used to determine conductor ampacity rating.

7. Identify types of wire insulating materials and describe their characteristics and applications.

8. Describe the relationship between voltages, current, resistance and power.

9. Calculate voltage, current and resistance in series, parallel, and combination circuits.

10. Describe the selection of resistors using rating and coding information.

11. Identify types of electrical circuits and describe their characteristics.
    i) series
    ii) parallel
    iii) series-parallel

12. Describe an overloaded, grounded, open and short circuit.

13. Identify types of distribution panels and wiring configurations used in single and three-phase systems.

14. Identify types of over-current and overload protection devices and describe their characteristics and applications.

15. Identify types of relays, switches and contactors and describe their characteristics and applications.

16. Identify types of transformers and describe their characteristics and applications.

17. Describe electronic control boards, their purpose and operation.

18. Describe the procedures used to diagnose electronic control boards.

19. Identify types of electrical wiring diagrams and describe their purpose.

RACM-150 Motors I

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with single-phase motors and motor controls.

2. Explain the principles of single-phase motor operation.

3. Identify types of motors and describe their characteristics, components and operation.
   i) single-phase
   ii) three-phase
   iii) electrically commutated motors (ECM)

4. Identify and interpret information found on motor nameplates.

5. Calculate voltage, resistance and current in motor circuits.

6. Identify types of capacitors and describe their characteristics and applications.

7. Describe the procedures used to test capacitors.

8. Identify types of starting devices for single-phase motors and describe their characteristics, wiring configuration and operation.

9. Describe the effects of load and voltage changes on motor operation.

10. Describe methods used to change speed and rotation of single-phase motors.

RACM-155 Blueprint Reading

Learning Outcomes:

- Demonstrate knowledge of blueprints and their applications.

Objectives and Content:

1. Identify the types of drawings and describe their applications.
   - i) civil/site
   - ii) architectural
   - iii) mechanical
   - iv) structural
   - v) electrical
   - vi) shop drawings
   - vii) sketches
   - viii) as-built

2. Identify the views used on blueprints.
   - i) elevation
   - ii) plan
   - iii) section
   - iv) detail
   - v) auxiliary

3. Identify and interpret information found on blueprints.
   - i) lines
   - ii) legend
   - iii) symbols and abbreviations
     - mechanical
     - electrical
     - architectural
   - iv) title block
   - v) notes and specifications
   - vi) schedules

4. Describe the use of blueprint scales.

5. Describe metric and imperial systems of measurement and perform conversions.

RACM-160 Trade Documents

Learning Outcomes:

- Demonstrate knowledge of trade documents and their use.
- Demonstrate knowledge of preparing and interpreting trade documents.

Objectives and Content:

1. Identify and interpret trade-related documentation.
   - i) repair orders
   - ii) purchase orders
   - iii) preventative/predictive maintenance sheets
   - iv) service and operating manuals
   - v) technical bulletins
   - vi) inspection forms
   - vii) service records
   - viii) warranties
   - ix) estimates
   - x) transportation of dangerous goods (TDG) forms
   - xi) refrigerant management records
   - xii) material safety data sheets (MSDS)
   - xiii) time cards/sheets
   - xiv) vehicle inspection reports
   - xv) bill of materials

2. Describe the procedures used to complete trade-related documentation.
   - i) repair orders
   - ii) purchase orders
   - iii) preventative/predictive maintenance sheets
   - iv) inspection forms
   - v) service records
   - vi) refrigerant management records
   - vii) time cards/sheets
   - viii) vehicle inspection reports
   - ix) bill of materials
   - x) site safety survey

RACM-165 Refrigeration and Air Conditioning Installation

Learning Outcomes:

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

Objectives and Content:

1. Identify and interpret codes, regulations and manufacturers' specifications pertaining to refrigeration and air conditioning installations.

2. Describe the procedures used to prepare for refrigeration and air conditioning system installations.
   - i) select tools and equipment
   - ii) select components
   - iii) select piping and fittings
   - iv) select ancillary devices
   - v) use electrical diagrams
   - vi) use piping schematic diagrams

3. Describe the procedures used to install refrigeration and air conditioning systems.
   - i) piping
   - ii) wiring
   - iii) leak testing
   - iv) evacuation
   - v) charging

4. Describe 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

5. Describe documentation requirements for system installation, start-up and commissioning.

LEVEL 2

RACM-200 Pressure Enthalpy Diagrams

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. Describe the factors affecting system capacity.
   i) saturated discharge temperature
   ii) saturated suction temperature
   iii) liquid sub-cooling
   iv) suction superheat
   v) suction to liquid heat exchanger
   vi) high and low side pressure drops

4. Plot a refrigeration cycle using a pressure enthalpy diagram and perform associated calculations.

5. Describe theoretical horsepower and brake horsepower.

6. Describe the effects of pressure loss in refrigeration piping.

7. Describe the concept of system equilibrium and the factors that determine system balance.

8. Describe the effect of an unbalanced system on system performance.

9. Apply cycle diagrams to assist with system troubleshooting.

RACM-205 Evaporators

Learning Outcomes:

- Demonstrate knowledge of evaporators 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.

2. Describe the purpose and operation of evaporators.

3. 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)

4. Identify evaporator system components and describe their purpose and operation.
   i) drain pan heaters
   ii) evaporator fans and controls
   iii) drain lines
   iv) flow switches

5. Identify defrost methods and describe electrical and piping considerations.

6. Describe the factors and conditions that determine evaporator capacity and efficiency.

7. Describe the procedures used to size evaporators.

8. Describe the procedures used to install evaporators and their components.

9. Describe the procedures used to maintain and troubleshoot evaporators and their components.

RACM-210 Compressors II

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with hermetic and semi-hermetic compressors.

2. Identify hazards and describe safe work practices pertaining to hermetic and semi-hermetic compressors.

3. Identify and interpret codes and regulations pertaining to hermetic and semi-hermetic compressors.

4. Describe compressor classifications according to temperature ranges and displacement.

5. Explain compressor efficiency and how it is determined.

6. Describe the procedures used to install hermetic and semi-hermetic compressors and their components.

7. Describe the procedures used to maintain and troubleshoot hermetic and semi-hermetic compressors and their components.

8. Describe control strategies for compressor protection and liquid refrigerant control.
   i) solenoid drop
   ii) pump out cycle
   iii) pump down cycle

9. Identify compressor failures and describe their causes and remedies.
   i) mechanical
   ii) electrical

10. Describe the procedures used to start-up and shut-down hermetic and semi-hermetic compressors.

RACM-215 Condensers

Learning Outcomes:

- Demonstrate knowledge of condensers and their 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. Describe the purpose of condensers.

3. Identify types of condensers and describe their characteristics and applications.
   i) air-cooled
   ii) water-cooled
   iii) evaporative

4. Identify condenser components and describe their purpose and operation.

5. Describe heat reclaim procedures.

6. Describe head pressure control procedures.
   i) air-cooled
   ii) water-cooled
   iii) evaporative

7. Describe the factors and conditions that determine condenser capacity and efficiency.

8. Describe the procedures used to size condensers.

9. Describe the procedures used to install condensers and their components.

10. Describe the procedures used to maintain and troubleshoot condensers and their components.

RACM-220 Metering Devices

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with metering devices.

2. Describe the purpose and operation of metering devices.

3. Identify types of metering devices and describe their characteristics and applications.
   i) dry expansion
   ii) flooded

4. Identify metering device components and describe their purpose and operation.

5. Describe the procedures used to install metering devices.

6. Describe the procedures used to maintain and troubleshoot metering devices.

7. Identify metering device failures and describe their causes and remedies.

RACM-225 Refrigerant Flow Controls

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with refrigerant flow controls.

2. Describe the purpose and operation of refrigerant flow controls.

3. Identify types of refrigerant flow controls and describe their characteristics and applications.
   i) direct acting
   ii) pilot operated

4. Identify refrigerant flow control components and describe their purpose and operation.

5. Describe the procedures used to install refrigerant flow controls.

6. Describe the procedures used to maintain and troubleshoot refrigerant flow controls.

7. Identify refrigerant flow control failures and describe their causes and remedies.

RACM-230 Air Conditioning Fundamentals

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with air conditioning.

2. Identify the factors that affect human comfort with respect to air quality.

3. Identify types of air conditioning systems and describe their components and operation.

4. Explain air circulation and ventilation.

5. Identify tools and instruments used to determine air quality.

6. Describe indoor and outdoor design conditions.

RACM-235 Fans, Mechanical Drives, Air Filters and Air Cleaners

Learning Outcomes:

- Demonstrate knowledge of fans, mechanical drives, air filters and air cleaners, their components and operation.
- Demonstrate knowledge of the procedures used to install fans, mechanical drives, air filters and air cleaners, and their components.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot fans, mechanical drives, air filters and air cleaners, and their components.

Objectives and Content:

1. Define terminology associated with fans, mechanical drives and air filters.

2. Identify types of fans and describe their characteristics and applications.

3. Identify fan components and describe their purpose and operation.

4. Identify and interpret information found on fan performance curve charts.

5. Describe factors that affect fan performance.

6. Identify types of mechanical drives and describe their characteristics and applications.

7. Identify types of mechanical drive components and describe their purpose and operation.

8. Identify types of air filters and air cleaners and describe their characteristics and applications.

9. Describe the procedures used to install fans, mechanical drives, air filters and air cleaners, and their components.

10. Describe the procedures used to maintain and troubleshoot fans, mechanical drives, air filters and air cleaners, and their components.

RACM-240 Control Fundamentals

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with system control.

2. Identify types of control systems and describe their components and operation.

3. Identify types of control circuits and describe their applications, components and operation.

4. Identify types of control devices and describe their applications and operation.

5. Explain open and closed loop control.

6. Describe control and control actions with respect to loads, switches and circuits.

7. Identify types of monitoring controls and describe their applications and operation.
   i) flow
   ii) humidity
   iii) liquid level
   iv) pressure
   v) temperature

RACM-245 Motors II

Learning Outcomes:

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

2. Explain the principles of multi-phase motor operation.

3. Identify types of starting devices for multi-phase motors and describe their characteristics, wiring configuration and operation

4. Identify single and multi-phase motor failures and describe their causes and remedies.
   i) electrical
   ii) mechanical

5. Describe methods used to change speed and rotation of multi-phase motors.
   i) variable frequency drives (VFD)

6. Describe the procedures used to install single and multi-phase motors and their components.
   i) single-phase
   ii) three-phase
   iii) electrically commutated motors (ECM)

7. Describe the procedures used to maintain and troubleshoot single and multi-phase motors and their components.

8. Describe the procedures used to install motor controls.

9. Describe the procedures used to maintain and troubleshoot motor controls.

RACM-250 Control Circuits and Wiring Diagrams

Learning Outcomes:

- Demonstrate knowledge of the procedures used to install control circuits.
- Demonstrate knowledge of the procedures used to maintain and 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. Describe the operating principles of control systems.

3. Describe the operation of a control circuit and its wiring configuration within system design.

4. Identify types of controls and describe their applications.
   i) operating
   ii) safety
   iii) defrost

5. Identify types of wiring diagrams and describe their characteristics and applications.
   i) pictorial
   ii) schematic

6. Identify and interpret information and symbols found on schematic diagrams.

7. Sketch a schematic wiring diagram based on a written sequence of control events.

8. Sketch a schematic wiring diagram from a pictorial diagram.

9. Sketch a pictorial diagram from a schematic wiring diagram.

10. Describe the procedures used to install control circuits.

11. Describe the procedures used to maintain and troubleshoot control circuits.

LEVEL 3

RACM-300 Refrigeration Load Calculations

Learning Outcomes:

- Demonstrate knowledge of performing 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
     - lights
     - motors
     - people
     - equipment
   - v) defrost load
     - air
     - electric
     - hot gas
   - vi) BTU/hr total

RACM-305 Refrigeration System Design

Learning Outcomes:

- Demonstrate knowledge of refrigeration system design principles.
- Demonstrate knowledge of refrigeration system components and their selection based on design criteria.
- Demonstrate knowledge of refrigeration system capacity control.
- Demonstrate knowledge of developing piping schematics.
- Demonstrate knowledge of developing electrical schematics.

Objectives and Content:

1. Define terminology associated with refrigeration system design.

2. Identify and interpret codes and regulations pertaining to refrigeration system design.

3. Explain fundamental principles of refrigeration system design.

4. Interpret graphs and tables for refrigeration system design.

5. Identify capacity ratings of refrigeration system components.

6. Perform calculations for refrigeration system design.
   i) horsepower per ton
      - low temperature system
      - medium temperature system
      - high temperature system

7. Describe the selection of components and ancillary devices for refrigeration systems based on design criteria.

8. Describe the selection of refrigerant based on design criteria.

9. Describe the factors to consider in the design and layout of refrigeration systems.

10. Describe the importance of balancing system capacity with system load.

11. Describe the factors to consider when sizing pipe for refrigeration piping systems.

12. Describe the procedures used to size pipe for refrigeration piping systems.

13. Develop piping schematics for refrigeration systems.

14. Develop electrical schematics for refrigeration systems.

RACM-310 Compressors III

Learning Outcomes:

- Demonstrate knowledge of capacity control.
- 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.

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. Identify and interpret codes and regulations pertaining to large commercial/industrial compressors.

4. Identify specialized tools and equipment and describe their applications and procedures for use.

5. Identify methods used to cool compressors.

6. Identify methods of forced compressor lubrication.

7. Identify methods of compressor capacity control.

8. Describe the procedures used to install large commercial/industrial compressors and their components.

9. Describe procedures used to maintain and troubleshoot large commercial/industrial compressors and their components.

10. Identify compressor failures and describe their causes and remedies.
    i) mechanical
    ii) electrical

11. Describe the procedures used to start-up and shut-down large commercial/industrial compressors.

RACM-315 Evaporative Condensers and Cooling Towers

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with evaporative condensers and cooling towers.

2. Describe the purpose and operating principles of evaporative condensers.

3. Identify types of evaporative condensers and describe their characteristics and applications.

4. Identify evaporative condenser components and describe their purpose and operation.

5. Describe the factors that influence the effectiveness of evaporative condensers.

6. Describe and determine the capacity of an evaporative condenser using psychrometric processes.

7. Identify methods to control head pressure and describe their associated procedures.

8. Identify potential evaporative condenser problems and describe their causes and remedies.

9. Describe the procedures used to install evaporative condensers.

10. Describe the procedures used to maintain and troubleshoot evaporative condensers.

11. Describe the procedures used to start-up, operate and shut-down evaporative condensers.

12. Describe the purpose and operating principles of cooling towers.

13. Identify types of cooling towers and describe their characteristics and applications.

14. Identify cooling tower components and describe their purpose and operation.

15. Describe the factors that influence the effectiveness of cooling towers.

16. Describe and determine the capacity of a cooling tower using psychrometric processes.

17. Identify potential water problems and describe their causes and remedies.

18. Describe the procedures used to install cooling towers.

19. Describe the procedures used to maintain and troubleshoot cooling towers.

20. Describe the procedures used to start-up, operate and shut-down cooling towers.

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.
- Demonstrate knowledge of specialty systems and their applications.

Objectives and Content:

1. Define terminology associated with commercial refrigeration systems.

2. Identify and interpret codes and regulations pertaining to commercial refrigeration systems.

3. Identify types of commercial refrigeration systems and describe their characteristics and applications.

4. Identify types of specialty systems and describe their characteristics and applications.
   i) ultra-low
   ii) cryogenic
   iii) cascade

5. Identify commercial refrigeration system components and describe their purpose and operation.

6. Identify factors that optimize storage of refrigerated and frozen products.

7. Describe the procedures used to install commercial refrigeration systems and their components.

8. Describe the procedures used to maintain and troubleshoot commercial refrigeration systems and their components.

9. Describe the procedures used to start-up and shut-down commercial refrigeration systems.

RACM-325 Air Conditioning Systems

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with residential and commercial air conditioning systems.

2. Identify types of residential and commercial air conditioning systems and describe their characteristics and applications.

3. Identify types of residential and commercial air conditioning system components and describe their purpose and operation.

4. Describe the procedures used to install residential and commercial air conditioning equipment and their components.

5. Describe the procedures used to maintain and troubleshoot residential and commercial air conditioning equipment and their components.

6. Describe potential residential and commercial air conditioning problems and their causes and remedies.

7. Describe the procedures used to calibrate and adjust air conditioning system components.

8. Describe the procedures used to start-up and shut-down air conditioning systems.

RACM-330 Packaged Air Conditioning Units

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with packaged air conditioning units.

2. Identify hazards and describe safe work practices when working with packaged air conditioning units.

3. Identify and interpret codes and regulations pertaining to packaged air conditioning units.

4. Identify types of packaged air conditioning units and describe their characteristics and applications.

5. Identify packaged air conditioning unit components and describe their purpose and operation.

6. Perform calculations for packaged air conditioning units.

7. Identify potential problems and describe their causes and remedies.

8. Describe the procedures used to install packaged air conditioning units and their components.

9. Describe the procedures used to maintain and troubleshoot packaged air conditioning units and their components.

10. Describe the procedures used to start-up and shut-down packaged air conditioning units.

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 and interpret codes and regulations pertaining to heat pump systems.

3. Describe the operating principles of heat pump systems.

4. Identify types of heat pumps and describe their characteristics and applications.

5. Identify heat pump components and describe their purpose and operation.

6. Describe the operation of the defrost cycle as it relates to heat pumps.

7. Describe the environmental considerations when installing heat pumps.

8. Describe water quality as it relates to open loop systems.

9. Perform calculations for heat pump systems.

10. Describe control sequences for heat pumps.

11. Describe the procedures used to install heat pumps and their components.

12. Describe the procedures used to maintain and troubleshoot heat pumps and their components.

RACM-340 Fluid Dynamics and Circulating Pumps

Learning Outcomes:

- Demonstrate knowledge of fluid dynamics within piping systems.
- Demonstrate knowledge of circulating pumps, their components and operation.

Objectives and Content:

1. Define terminology associated with fluid dynamics and circulating pumps.

2. Explain principles of fluid dynamics.

3. Identify types of circulating pumps and describe their characteristics and applications.

4. Identify circulating pump components and describe their purpose and operation.

5. Describe the factors to consider when selecting a circulating pump.
   i) system parameters
   ii) pump curves
   iii) circuit configurations

6. Identify potential problems of air in an open or closed system and their causes and remedies.

7. Describe the procedures to purge air from an open or closed 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 control principles and describe their operation.
   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)

3. Identify types of control systems and describe their characteristics and applications.
   i) electric
   ii) electronic
   iii) pneumatic
   iv) direct digital control (DDC)

4. Identify control system components and describe their purpose and applications.

5. Describe the procedures used to install control systems and their components.

6. Describe the procedures used to maintain and troubleshoot control systems and their components.

7. Describe the procedures used to start-up and commission control systems.

RACM-350 Troubleshooting Refrigeration and Air Conditioning Electronics

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 electronics.

2. Identify electronic components and describe their purpose and operation.

3. Identify tools and equipment used to test and troubleshoot electronic components and describe their applications and procedures for use.

4. Describe the procedures used to troubleshoot electronic components and control boards.

LEVEL 4

RACM-400 Air Conditioning Load Calculations

Learning Outcomes:

- Demonstrate knowledge of performing 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
     - equipment
   - v) BTU/hr 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 components and their selection based on design criteria.
- Demonstrate knowledge of air conditioning system capacity control.
- Demonstrate knowledge of developing piping schematics.
- Demonstrate knowledge of developing electrical schematics.

Objectives and Content:

1. Define terminology associated with air conditioning system design.

2. Identify and interpret codes and regulations pertaining to air conditioning system design.

3. Explain fundamental principles of air conditioning system design.

4. Interpret graphs and tables for air conditioning system design.

5. Identify capacity ratings of air conditioning system components.

6. Perform calculations for air conditioning system design.
   i) air volumes and velocities
   ii) operating capacity
   iii) design capacity
   iv) heating load
   v) cooling load
   vi) peak load
   vii) transfer rates
   viii) sizing of humidity control equipment

7. Identify methods of zoning and describe their applications.

8. Identify types of system design and their applications.
   i) constant air volume
   ii) variable air volume

9. Describe the selection of components and ancillary devices for air conditioning systems based on design criteria.

10. Describe the factors to consider in the design and layout of air conditioning systems.
   i) humidification
   ii) dehumidification
   iii) refrigeration piping
   iv) secondary refrigeration piping
   v) drainage
   vi) condenser water piping

11. Describe the importance of balancing system capacity with system load.

12. Describe the procedures used to size pipe for air conditioning piping systems.

13. Develop piping schematics for air conditioning systems.

14. Develop 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 used to install duct systems and their components.
- 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. Identify and interpret codes and regulations pertaining to duct systems.

4. Identify types of duct systems and describe their characteristics and applications.

5. Identify duct system components and describe their purpose and operation.

6. Describe the factors affecting duct system sizing, layout and design.

7. Identify methods of sizing duct and describe their associated procedures.

8. Identify types of charts used to plan duct systems and describe their applications and procedures for use.

9. Identify types of duct insulation and sealants and describe their applications.

10. Identify potential problems in duct systems and design and describe their causes and remedies.

11. Describe the procedures used to install duct systems and their components.

12. Describe the procedures used to maintain and troubleshoot duct systems and their components.

RACM-415 Heating Systems

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with heating systems.

2. Identify hazards and describe safe work practices when working with heating fuels.

3. Describe the physical and chemical properties of heating fuels.

4. Identify and interpret codes and regulations pertaining to heating systems.
   i) jurisdictional certifications

5. Identify types of heating systems and describe their characteristics and applications.
   i) gas
   ii) oil
   iii) electric

6. Identify types of heating system components and describe their purpose and operation.

7. Perform calculations for heating systems.

8. Identify potential problems and describe their causes and remedies.

9. Identify specialized tools and equipment and describe their applications and procedures for use.

10. Describe the procedures used to install heating systems and their components.

11. Describe the procedures used to maintain and troubleshoot heating systems and their components.

12. Describe the procedures used to start-up and shut-down heating systems.

RACM-420 Air Measuring Instruments and System Air Balancing

Learning Outcomes:

- Demonstrate knowledge of the principles of air measurement and air quality management.
- Demonstrate knowledge of the procedures used to measure air flow quantity.
- Demonstrate knowledge of air measuring instruments, their applications and procedures for use.
- Demonstrate knowledge of system air balancing procedures.

Objectives and Content:

1. Define terminology associated with air measuring instruments and system air balancing.

2. Identify and interpret codes and regulations pertaining to air measurement and system air balancing.

3. Explain fundamental principles of air movement and air quality management.

4. Identify types of air measurement instruments and describe their applications and procedures for use.

5. Identify types of charts used to monitor and balance air systems and describe their applications and procedures for use.

6. Describe conditions affecting air properties.

7. Perform calculations for system air balancing.

8. Describe the procedures used in system air balancing.

RACM-425 Chillers and Chiller Systems

Learning Outcomes:

- Demonstrate knowledge of chillers and chiller systems, their components and operation.
- Demonstrate knowledge of the procedures used to install chillers, chiller systems and their components.
- Demonstrate knowledge of the procedures to maintain and troubleshoot chillers, chiller systems and their 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. Identify and interpret codes and regulations pertaining to chillers and chiller systems.

4. Explain the operating principles of chiller systems.
   i) primary
   ii) secondary

5. Identify chiller applications and describe their characteristics.
   i) air conditioning
   ii) ice rink/surface
   iii) process
   iv) supermarket

6. Identify chiller components and describe their purpose and operation.

7. Identify types of chiller systems and describe their characteristics and applications.
   i) reciprocating
   ii) screw
   iii) scroll
   iv) rotary

v) centrifugal
vi) absorption

8. Identify chiller system components and describe their purpose and operation.

9. Interpret schematic diagrams for chiller systems.

10. Describe the operating cycles of chiller systems.
    i) motor cooling
    ii) lubrication
    iii) refrigeration

11. Describe the methods of chiller capacity control.

12. Describe the procedures used to install chillers and chiller systems and their components.

13. Describe the procedures used to maintain and troubleshoot chillers and chiller systems and their components.

14. Describe the procedures used to start-up and shut-down 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 and interpret codes and regulations pertaining to industrial refrigeration systems.

3. Identify hazards and safe work practices pertaining to industrial refrigeration systems.

4. Identify types of industrial refrigeration systems and describe their characteristics and applications.

5. Identify industrial refrigeration system components and describe their purpose and operation.

6. Describe the procedures used to install industrial refrigeration systems and their components.

7. Describe the procedures used to maintain and troubleshoot industrial refrigeration systems and their components.

8. Describe the procedures used to start-up 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. Interpret advanced schematic wiring diagrams for use in troubleshooting complex systems.
   i) manufacturers' drawings
   ii) as-built drawings

2. 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. Identify sources of information relevant to job coordinating.
   - i) trade-related documentation
   - ii) related professionals
   - iii) customers
   - iv) co-workers

2. Identify information gathering and communication techniques.
   - i) questioning
   - ii) translating technical information
   - iii) using communication equipment

3. Identify and interpret regulatory requirements.
   - i) standards and regulations
   - ii) codes and by-laws
   - iii) permits
   - iv) inspections

4. Estimate work requirements.
   - i) tools and equipment
   - ii) components and accessories
   - iii) time and costs

5. Describe the procedures used to coordinate work requirements.
   - i) conduct work area inspection
   - ii) coordinate work requirements
   - iii) maintain customer relations
   - iv) clarify end user problems and concerns
   - v) complete work-related documentation
   - vi) generate maintenance documentation
   - vii) requisition equipment, components and accessories

viii) receive equipment, components and accessories
ix) transfer equipment to designated location