1. Module details

Module name

REFRIGERATION SCIENCE

Nominal duration

One module
It is anticipated that students will achieve the competencies specified in 35 to 40 hours.

Module codes

EA141

Discipline code

2. Module purpose

To enable students to describe the scientific laws and theories upon which the physics of matter and energy, and the relationships between them, are related to the engineering discipline of Refrigeration and Air Conditioning and to Manipulate formulae relating to Engineering Mechanics to solve a variety of problems.

3. Prerequisites

NBB013 - Engineering Science
NR001 - Refrigeration Fundamentals
NR005 - Introduction to Air Conditioning and
EA002 - Engineering Maths A or
EA145 - Introduction to Refrigeration
EA146 - Introduction to Air Conditioning and
EA002 - Engineering Maths A

4. Relationship to competency standards

TBA

5. Content

1. Engineering mechanics
   - mass/density
   - weight
   - forces
   - specific gravity
   - equilibrium
   - momentum
   - friction loss
   - velocity and speed
   - energy in all forms
   - mechanical advantage
   - efficiency
   - pressure/stress

2. Molecular theory
   - changes of state
   - sublimation
   - expansion and contraction
   - electron flow
   - state of aggregation
   - internal potential energy
   - phase change diagrams

3. Thermodynamics
    - temperature scales
    - conservation of energy
    - specific heat
    - sensible, latent and super heat
    - properties of steam
    - enthalpy
    - heat energy/temperature relationship
    - heat balance on a body
    - heat transfer
    - conductivity
    - calorimetry
    - Peltier effect
    - 1st and 2nd law of thermodynamics

4. Gas laws and liquids
    - pressure
    - Boyles law
    - Charles law
    - Volumetric relationship
    - psychrometrics
    - latent heat of vaporisation
    - relative humidity
    - air conditioning processes
    - dynamic pressure loss
    - velocity and static pressure
    - bourdon tubes
    - density and relative density
    - Archimedes principle
    - Bernoulli's Equation
    - manometers
    - absorption refrigeration
    - centrifugal compression
    - external work of a liquid
    - pressure volume diagrams
    - isothermal and adiabatic processes
    - polytropic processes
    - Dalton's law of partial pressure

5. Vapour compression
    - pressure/enthalpy relationship
    - entropy
    - characteristics of the evaporation, condensation, compression and pressure drop phases
    - co-efficient of performance
    - theoretical/practical cycles
    - characteristics of refrigerants
    - theoretical power input
    - pressure losses
    - heat exchange
    - effects of condensing condition changes
    - sub-cooling and super-heating

6. Learning outcome details

On the completion of this module, the learner will be able to:

Learning outcome 1

Manipulate known formula relating to Engineering Mechanics to solve a variety of problems.

Assessment criteria

Short answer tests.

1.1 State several of the common concepts which relate to Engineering Mechanics.

1.2 Transpose formula relating to Engineering Mechanics to find one unknown quantity given all other values.

1.3 Solve a range of problems involving mass, weight, force, velocity, acceleration, free falling bodies and vectors.

1.4 Solve a range of problems involving momentum, angular motion, centripetal force and related quantities.

Learning outcome 2

Investigate the concept of Molecular Theory and demonstrate its relationship to refrigeration and air conditioning.

Assessment criteria

Short answer tests.
Project.

2.1 Identify the various elementary substances which combine to form several of the most common molecules.

2.2 State the atomic structure and characteristics of common elementary substances.

2.3 Describe the movement of electrons which causes electro-motive force.

2.4 Analyse the effect the addition of heat energy has on the physical state of matter.

Learning outcome 3

Research the scientific laws of thermodynamics and demonstrate their relevance to refrigeration and air conditioning.

Assessment criteria

Short answer test.
Project.

3.1 Compare the saturation properties of several ozone benign refrigerants, with CFC 12 and HCFC 22.

3.2 Calculate the specific entropy of steam at a variety of conditions.

3.3 Investigate the factors that relate to heat gain/rejection using a range of mediums in passive, parallel and contra flow.

3.4 Analyse the performance of an ‘ideal’ reversed Carnot cycle.

Learning outcome 4	Establish how the gas laws and characteristics of liquids provide the scientific basis for the engineering discipline of refrigeration and air conditioning.
Assessment criteria	Short answer tests. Project. 4.1 Solve theoretical laboratory problems using Boyles and Charles laws. 4.2 Produce pressure-volume diagrams for several refrigerants. 4.3 Compare an actual evaporative cooling process with an 'ideal' adiabatic process. 4.4 Mathematically show theoretical isothermal and polytropic processes. 4.5 Analyse reversible and irreversible thermodynamic processes. 4.6 Plot the thermal changes that a quantity of air undergoes as it travels through a refrigerated air conditioning system.
Learning outcome 5	Compare theoretical vapour compression cycles with actual cycles using information collected from operating units.
Assessment criteria	Practical report. 5.1 Produce a plot of the saturated vapour and liquid curves for several refrigerants. 5.2 Plot a theoretical pressure enthalpy diagram for single and multiple stage vapour compression refrigeration cycles. 5.3 Plot pressure enthalpy diagrams for operating single stage vapour compression refrigeration systems. 5.4 Calculate the heat gain, heat rejected and work input of theoretical and actual single and multiple stage vapour compression refrigeration systems.
7. Assessment Strategies	See Assessment Criteria.
8. Module Delivery Strategies	Alternative assessment procedures will need to be considered to provide for special needs of students in a flexible delivery mode.

9. Resource Requirements

All references used should be up to date and relevant for Australian conditions.

Australian refrigeration and Air Conditioning Volumes I & II A CR & D Project Trust Publication.

Dossat, R.J., Principles of Refrigeration, Second Edition, SI Version, John Wiley and Sons, New York. Latest Edition.

ASHRAE Handbook, Refrigeration Systems and Applications, SI Version, ASHRAE, Atlanta., Latest Edition.