1. Module details

Module name

Electrical Installations - Design and Equipment Selection 3

Module duration

40 hours

Module code

NUE405

Discipline code

2. Module purpose

This module is intended to bridge the gap between installation tradesperson and the architect/design engineer. The module provides information about cable systems, protection schemes and basic energy control and management systems.
This module also includes an overview of handover testing procedures.

3. Prerequisites

Nil

4. Relationship to competency standards

This module provides some of the knowledge ans skills underpinning competence in the National Electrotechnology Competency (UTE) units: NES207bA, NES302bA, NES403bA, NES502bA, NES703bA and the equivalent unit/s in the Federal Metals Industry Award Standards.

5. Content

1. Performance limitations of cables used in industrial and commercial installations.
   - Voltage drop
   - Temperature rise
   - Magnetic performance
   - EMI effects and support
2. Installation methods for cables in excess of 400 A / phase.
   - Cable selection based on physical conditions
   - Cable support systems considering flexibility and cable mass
   - Work clearances and mechanical protection
   - Parallel groups of cables
3. Power distribution within buildings
   - Earth sheath return
   - Rising mains and submains
   - Power reticulation design for reliability
   - Back up power supplies
   - Uninteruptable power supplies
4. Access requirements for risers and switchrooms
   - Switchboard size
   - Metering system
   - Access for supply authority and other authorised persons
5. Determination of electrical load

- Calculation of maximum demand
- Assessment of maximum demand
- Use of limitation and assessment methods of maximum demand

6. Cable selection and protection
   - Select cables based on current carrying capacity
   - Select cables based on short circuit performance and temperature rise
   - Cable voltage drop based on cable impedance, power factor and cable temperature
7. Selection of circuit protection schemes
   - Short circuit performance of protection devices
   - Cascading and fault current limiters
   - Manufacturers recommendations for the use of circuit protection schemes
8. Building safety systems
   - Types of safety and emergency systems
   - Cabling systems and control arrangements for various building emergency and safety systems
9. Energy control systems
   - Power factor detection and correction systems
   - Power factor measurement and calculation
   - Light and energy management systems
   - Building management systems
10. Installation handover testing
    - Electrical testing to AS/NZS standards
    - EM radiation testing
    - Test and maintenance procedures

6. Assessment strategy

Assessment methods

Assessment should be progressive reflecting a holistic approach to ensure the module purpose is met. To assist in ensuring validity, reliability and fairness, assessment instruments should include practical exercises, assignments and written tests consisting of a variety of item types such as multiple choice, short answer and problem solving. Part of this assessment should consist of project work completed outside college hours.

Conditions of assessment

Normally learning and assessment will take place in a classroom / laboratory environment.

7. Learning outcome details

Learning outcome 1

Outline factors that limit the performance of electrical installations that must be overcome by circuit design

Assessment criteria

1.1 Outline factors that contribute to voltage drop.

1.2 List factors that restrict cable performance such as temperature rise, magnetic forces and electromagnetic interference.

1.3 Detail the effects of the performance limiting factors on the operation of the cable and the installation as a whole.

Learning outcome 2

Detail installation methods that may be used in electrical installation where the current carrying capacity of cables will exceed 200 A per phase.

Assessment criteria

2.1 Select cables given installation conditions and load current.

2.2 Select cable support for given cables using manufacturers data and methods of installation allowing for cable flexibility and mass.

2.3 Determine minimum mechanical protection or clearance required for a given installation.

2.4 Outline situations where parallel cables might be preferred and determine suitable cable sizes for parallel grouped cables.

Learning outcome 3

Describe power reticulation methods that may be used in installations that use distribution boards.

Assessment criteria

3.1 List types of reticulation systems including earth sheath return, rising mains and dedicated submains.

3.2 Outline limitations and precautions required with ESR and rising mains.

	3.3 Describe reticulation systems designed for maximum reliability and minimum outage time.
	3.4 Outline operation of back up power supplies and un-interruptable power supplies including requirements to restrict power feed into normal building supply.
	3.5 Describe differences between back up power supplies and UPS systems.
Learning outcome 4	Determine requirements for space and access associated with cable ways, switchboards and substations
Assessment criteria	4.1 List characteristics of installations that may require the inclusion of a substation and outline requirements for rooms that house main switchboards and substations.
	4.2 Design a main switchboard for a commercial/ industrial application that has emergency switching and back up power supply.
	4.3 Describe metering options including remote meter supervision and reading.
	4.4 Layout main and distribution boards for an installation that has metering systems used for the resale of power to tenants.
Learning outcome 5	Determine the magnitude of a prospective electrical load on a switchboard.
Assessment criteria	5.1 Calculate the maximum demand on and installation that contains a variety of devices that may be found in industrial and commercial installations.
	5.2 Describe other methods that may be used to determine the maximum current rating of consumers mains or submains existing or otherwise.
	5.3 Outline situations that may be suitable for assessment or limitation as a means of determining the maximum demand of an installation.
Learning outcome 6	Select equipment for circuit protection and appropriate cables sizes for installation.
Assessment criteria	6.1 Determine cable sizes for installation based on current carrying capacity and circuit protection rating.
	6.2 Determine the suitability of a cable the supply of a given load taking into account short circuit performance.
	6.3 Describe the effect on cable and installation performance caused by variations in power factor.

	6.4 Calculate the voltage drop on industrial / commercial installations having mains and submains including methods based on cable impedance power factor and cable temperature.
Learning outcome 7	Select maximum rating for circuit protection
Assessment criteria	7.1 Use appropriate standards to determine the maximum current rating of circuit protection associated with final subcircuits, submains and mains including circuits with transients.
	7.2 Determine minimum short circuit performance rating needed by circuit protection for final subcircuits mains and submains.
	7.3 Explain methods that are used to minimise cost of circuit protection where high fault currents are expected including fault current limiters and cascade protection methods.
	7.4 Explain discrimination and the effect on cascaded circuit protection systems.
Learning outcome 8	Outline building requirements for safety or emergency equipment
Assessment criteria	8.1 List and describe types of safety and emergency systems that are necessary in industrial / commercial installations.
	8.2 Select cable types and control systems that are suitable for the supply of emergency or fire systems including installations in fire stairs.
	8.3 Describe mandatory and recommended test and maintenance procedures for emergency systems including emergency lighting and fire systems.
Learning outcome 9	Describe building control systems that minimise energy costs
Assessment criteria	9.1 Explain power factor correction systems that are used in commercial and industrial situations and show how to calculate or otherwise determine power factor.
	9.2 Outline features of PF correction systems including the effects on signaling and control systems that use mains cable as a pathway.
	9.3 Describe various types of building management systems that are designed to reduce or offset energy demands including heat recovery systems.
Learning outcome 10	Outline completion and handover testing requirements for electrical installations

Assessment criteria	10.1 List and describe suitable test procedures for electrical tests recommended by AS/NZS 3000. 10.2 Outline tests and recommended maximum levels for electromagnetic interference caused by the electrical installation. 10.3 Recommend maintenance schedules and procedures that should be followed to maintain the minimum operational standards of equipment and lighting.

8. Delivery of the module

Delivery strategy	Delivery strategies must be suitable for learning both theoretical and practical aspects described in the module purpose. It is considered that the most effective way to achieve this is by the integration of theory and practice where students learn by experimentation, research and reports. It is recommended that the learning and assessment be facilitated in a holistic manner, which may require a learning outcome sequence other than that indicated in the module.
Resource requirements	Resources should be sufficient for students to carry out exercises individually. Useful resources include: *Standards Australia, Standards New Zealand,* Australian/ New Zealand Wiring Rules AS/NZS 3000:2000. *Standards Australia, Standards New Zealand,* Electrical installations. Selection of cables. Part 1.1 Cables for alternating voltages up to and including 0.6/1kV Typical Australian installation conditions Australian standards for interior lighting and emergency lighting Petherbridge, K., Neeson,I. 1998 *Electrical Wiring Practice*. 5th Ed. McGraw Hill Sydney. Manufacturers information such as CBUS manual. Supply Authority service rules
Occupational health and safety requirements	A safe and healthy environment will be provided for students and teachers as well as safety procedure with regard to learning / teaching activity