

MODULE TITLE	ELECTRICAL DISTRIBUTION 1
Nominal Duration	One Module
Module Code	EA153
Module Purpose	<p>The purpose of the module is to provide the knowledge and skills of basic concepts, principles and operation for the following:</p> <ul style="list-style-type: none">(i) Distribution of electricity to consumers by Supply Authorities.(ii) Distribution of electrical energy in the supply authorities' distribution network to the consumers.
Prerequisites	NE09 Single and Three Phase Principles
Summary of Content	<p>1. <u>Distribution System</u></p> <p>Systems of distribution used, (primary and secondary) Voltage levels Supply quality Load curve profiles (residential/industrial/commercial) Types of feeders Distribution systems (urban, rural single-phase systems, SWER etc.)</p> <p>2. <u>Overhead Lines and Installation</u></p> <ul style="list-style-type: none">• Industry and Safety regulations <p>Overhead Conductors:</p> <ul style="list-style-type: none">• conductor material• current rating factors (heating, voltage drops, power losses)• aerial bundled cables (HV. and LV.)• covered conductors

Overhead Line Poles

- types (wood, concrete and steel)
- installation of poles (tooling, rake, life, labelling, sinking)
- maintenance of poles - above & below ground
- pole strength and loads

Crossarms

- types and standard sizes

Insulators

- insulation types
- types (pin, suspension or disc, shackle)
- creepage, necessary clearances
- acring horns, insulator mounting

Structure Types

- mechanical properties (working strength, maximum tension, limiting size)

Stringing Charts (use of)

- sag (calculations, measurement and tension measurement)
- sight and wave sagging, sag correction

Stays

- components, anchorage

Use of Design Schedules

Sample Design Problems

- examples of common design practice line, voltage, structure types used, line deviation, span sag, crossarms, insulators and stays wind loading and line deviation loading Basic Surveying
- measurement of levels, deviation angle and compass bearings
- perform survey of short distribution line extension of produce field notes

3. Underground Cables

Cables types, ratings, core material, design considerations, cable dielectrics, insulating materials and abbreviations, electric stress, cable volt drop and volt drop calculations, cable termination, joints and installation.

Induction and eddy currents

Cable testing, cable fault location

Cable drawing

4. Voltage Regulations of Feeders and Associated Equipment

Terminology used: distribution system, service line, customer's terminals, customer voltage, utilisation voltage, base voltage, voltage variation and bandwidth

Voltage limits and effects of voltage variation

Causes of variation: inductance, capacitance and reactance of distribution lines, transformers

Methods of voltage control: off-load, on- load tap changers, voltage regulating relays, line drop compensation, different types of voltage regulators

Voltage profiles: principles, effect on voltage profiles, limits of voltage, voltage drops due to LV mains transformers, tapsettings feeder and service lines.

Practical examples: sketch/draw voltage profiles, calculate the volt drops for components within the profile.

Delivery

These learning outcomes will require the application of theory and practice. The resources required will need to facilitate both classroom and demonstrations. Plant visits demonstrating the equipment in use would be advantageous.

Strategies should be selected to reflect the nature of the learning outcomes in relation to the electrical power industry context.

Learning outcomes	On completion of this module the learner will be able to:
<i>Learning Outcome 1</i>	Outline the basic concepts of distribution systems in relation to voltage levels, supply quality and load curve profiles.
Assessment criteria	<ol style="list-style-type: none">1.1 Describe the common systems used for electrical distribution.1.2 State their relative merit and voltage levels.1.3 Interpret diagrams of distribution systems, including relationships of sub-stations, feeders and distribution transformers.1.4 Recall terminologies pertaining to distribution systems.
Conditions	<p>Normally learning will take place in the classroom or other appropriate environments.</p> <p>Relevant standards or specification (or extracts) will be made available to students for reference during lessons.</p>
Assessment methods	Multiple choice/short answer questions
<i>Learning Outcome 2</i>	Describe the components, and determine the relevant factors, such as: mechanical limitations, physical dimensions of lines, loading limitations and pole/line installation techniques, using common configurations in relation to overhead line design.
Assessment criteria	<ol style="list-style-type: none">2.1 Identify relevant components used in overhead line design.2.2 Outline relevant factors related to installation, maintenance, crossarms, stays, pole types and choice of conductor size, for commonly used configurations.2.3 Determine mechanical limitations and physical dimensions of lines.2.4 Determine loading limitation using design schedules and calculations.

- 2.5 State pole and line installation techniques.
- 2.6 Recall regulations pertaining to overhead lines.
- 2.7 Measure ground levels, deviation angles and compass bearings.
- 2.8 Perform basic survey of short distribution line extension to produce field notes.

Conditions

Relevant standards or specifications, and design schedules (or extracts) will be made available to students for reference during lessons.

Relevant instrumentation and equipment to be able to record results for surveying will be supplied during lessons.

Normally learning will take place in the classroom, field work for survey and other appropriate environments.

Assessment methods

Short answer question
 Practical survey assessment
 Overhead line design assignment

Learning Outcome 3

Identify the constructional features of underground power cables, their uses, rating factors, associated equipment and techniques used for cable installations.

Assessment criteria

- 3.1 Describe the construction features and insulation abbreviations of underground power cables.
- 3.2 Calculate cable volt drop in relation to length of cable run.
- 3.3 Recall techniques used to reduce electrical stress on cables.
- 3.4 Recall cable rating factors, methods of joining and terminations.
- 3.5 Apply cable schedules for underground reticulation schemes.
- 3.6 Describe techniques used to install cable/associated equipment.
- 3.7 Recall cable testing techniques and methods used to find the location of cable faults.

Conditions	Normally learning will take place in the classroom, laboratory and other appropriate environments.
Assessment methods	Multiple choice questions Short answer questions Practical testing of cables
<i>Learning Outcome 4</i>	Analyse the techniques available for voltage control, the effects and limitations of voltage variation and their application to distribution feeders.
Assessment criteria	4.1 Recall the terminology used in relation to voltage profiles. 4.2 Describe the reasons, effects and limitations of voltage variation. 4.3 Recall methods used in controlling voltage levels. 4.4 Draw voltage profiles using calculations to determine percentage voltage drop for components within the distribution feeder.
Conditions	Normally learning will take place in the classroom and other appropriate environments. Relevant standards or specifications (or extracts) will be made available to students for reference during lessons.
Assessment methods	Short answer questions Multiple choice questions Voltage profile design assignment
Suggested Learning Resources	Text/references Relevant supply authority regulations and standards. Electricity Supply Association of Australia (ESAA) Code of Practice C(b)1-1991 Relevant State Regulations

Overhead Line Design Manuals

Overhead Line Manuals

Aerial Bundled Cable Manuals

Underground Cable Design Manuals

Relevant SAA Standards

P.J Freeman Harrap: *Electric Power Transmission and Distribution*, London, 1974.

A.T. Starr: *Generation Transmission and Utilisation of Electric Power*, Pitman, London, 1957

H. Waddicor Chapman & Hull: *Principles of Electric Power Distribution*, London

B.M. Weedy: *Electrical Power Systems*, J. Wiley & Sons, London, 1967

Westinghouse: *Electrical Transmission and Distribution Reference Book*

A. Symonds, *Electric Power Equipment*, McGraw Hill, UK, 1980