

MODULE TITLE	FAULT CALCULATIONS
Nominal Duration	One Module
Module Code or Number	EA 155
Module Purpose	<p>The purpose of this module is to give students:</p> <ul style="list-style-type: none"> (i) An understanding of the importance of fault current magnitudes and (ii) The basic skills to calculate their magnitude for various supply configurations and locations.
Relationship to Competency Standards	<p>This module contains the knowledge and skills identified and agreed by all States and Territories. It has been developed on the basis that these will be reflected in the competency standards.</p>
Pre-requisites	EA153 Electrical Distribution 1
Summary of Content	<p>1. Basic Skills Review the following:</p> <p>Norton's and (particularly) Thevenin's theorems and their application to AC circuits.</p> <p>"J" notation and conversion between rectangular and polar. The conjugate complex form for maximum power transfer.</p> <p>Current and voltage divider rules and their application in AC circuits.</p> <p>The theory and application of the "per unit" system.</p> <p>Currents and voltages in 3 phase (balanced and unbalanced) circuits.</p>

Representation of unbalanced currents and voltages using the method of symmetrical components.

Phasor diagrams for 3 phase circuits.

Power (P), VARS. (Q), Apparent Power (S) and power factor and their measurement.

Factors influencing the impedance of system components, (cables, lines, buses and transformers).

2. The Calculation of Fault Currents

The calculation/determination of positive, negative and zero sequence impedances.

Determination of fault current breaking and let-through energy capacities of circuit breakers, fuses etc.

The importance of fault/arc impedances.

The impedances operative for phase-to-phase and phase-to-earth faults.

Calculation of fault currents for phase-to-phase and phase-to-earth faults.

"Quick" (approximate) calculations by selecting the components with the major impedance.

Delivery

A large part of this module should be delivered in a classroom situation. The availability of the means to demonstrate the principles involved, using proprietary demonstration electrical machines of adequate rating, is highly desirable. Excursions/tours to appropriate industrial locations is extremely important.

Suggested Duration for Learning Outcomes

Learning Outcome 1 15 hrs
Learning Outcome 2 15 hrs
Learning Outcome 3 10 hrs

Learning Outcomes	On completion of this module the learner will be able to:
<i>Learning Outcome 1</i>	Calculate the values of, and then sketch the relationship between, complex electrical quantities.
Assessment criteria	<p>Given circuit component parameters, solve practically based problems using: The equivalent circuits of transformers, lines and loads.</p> <p>The component values using rectangular and polar notation. The current divider and potential divider rules using complex impedances. The "per unit" values of voltage, current, VA and impedance to a common VA base.</p>
Conditions	<p>Normally learning will take place in the class-room and other appropriate environments.</p> <p>Relevant standards or specifications (or extracts) will be made available to students for reference during lessons.</p> <p>Access to simulators or other demonstration equipment for student is highly desirable.</p> <p>These conditions apply to Learning Outcome 1-3.</p>
Assessment Method	<p>There must be some descriptive questions requiring a written answer.</p> <p>Calculation questions must be included and should predominate. Where they are used, the response should have an accuracy of 0.1 pu.</p> <p>The above assessment methods apply to Learning Outcome 1-3.</p>

Learning Outcome 2

2.1 Represent currents and voltages as complex phasors for 3 phase and 3 phase and neutral quantities.

2.2 Represent unbalanced voltages or currents as symmetrical components.

Assessment criteria

- 2.1 (a) Calculate the values of and draw labelled phasor diagrams, not to scale, to represent complex values of current and voltage:
- for balanced and unbalanced loads.
 - for star and delta systems.
- b) Calculate values of P, Q and S for balanced and unbalanced systems.
- c) Draw and label single phase diagrams to represent 1 phase of a complex 3 phase system.
- 2.2 Identify the operative symmetrical component values, in a balanced 3 phase system of voltages, for:
- Phase to phase currents
 - Phase to neutral/earth currents

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.

Access to simulators or other demonstration equipment for student is highly desirable.

These conditions apply to Learning Outcome 1-3.

Assessment Method

There must be some descriptive questions requiring a written answer.

Calculation questions must be included and should predominate. Where they are used, the response should have an accuracy of 0.1 pu.

The above assessment methods apply to Learning Outcome 1-3.

Learning Outcome 3

3.1 Calculate steady state values of fault current for various configurations.

3.2 Estimate peak values using accepted multipliers

Assessment criteria

3.1 a) Evaluate the symmetrical component impedances for the various distribution system components.

- Transformers (earthed neutral case)
- Generators (high impedance earth)
- Lines and
- Cables

b) Calculate values of fault currents using the pu. systems.

c) Calculate "worst case" values based on transformer impedance only (ie., a close in fault).

3.2 Description of the effects of the DC component on the instantaneous magnitudes of fault currents in transformers and generators.

Conditions

Normally learning will take place in the class-room and other appropriate environments.

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

Access to simulators or other demonstration equipment for student is highly desirable.

These conditions apply to Learning Outcome 1-3.

Assessment Method

There must be some descriptive questions requiring a written answer.

Calculation questions must be included and should predominate. Where they are used, the response should have an accuracy of 0.1 pu.

The above assessment methods apply to Learning Outcome 1-3.

Suggested Learning Resources

No one text covers all the facets of the module but the following texts do give some coverage.

"Electric Power Systems" (3rd. Ed) by B M Weedy (pub. by Wiley).

"Electrical Power Transmission and Distribution" (2nd. Ed.) by P J Freeman (pub. by Harrow).

"Modern Power Station Practice". pub. by the Central Electricity Generating Board, (mid 60's technology).