1. Module details

Module name

Formed Coil Rewind AC Stators

Module duration

It is expected that students with the appropriate entry knowledge and skills will successfully complete this module in 36 - 40 hours.

Module code

NUE134

Discipline code

0703105

2. Module purpose

This module will provide the learner with the knowledge required to strip a formed wound stator up to 11kV rating, record all the relevant data required to manufacture new coils, rewind the stator with the new coils and then static test the complete motor.

3. Prerequisites

NE150 Stator winding.

4. Relationship to competency standards

This module provides part of the underpinning knowledge and skills in the 'Evidence Guide' of specific units of competency in the National Electrotechnology Training Package and provides similar support, where mapped, to equivalent units in the National Metals and Engineering Competency Standards. For details refer to the module to unit maps, available from NUEITAB.

5. Content

Stripping the stator core of the existing winding, recording winding data

Prepare stator for rewinding, inserting slot insulation

Fitting of the new coils into the stator core, wedging, bracing, and connecting winding

Impregnating materials
Procedures
Testing
Precautions

Static electrical
Procedures
Testing
Precautions

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 number of item types, such as multiple choice, short answer and problem solving.

Conditions of assessment

Learning and assessment will take place in an environment that is conducive to a learner's development.

7. Learning outcome details

Learning outcome 1

Accurately record all winding details and core dimensions when stripping the stator.

Assessment criteria

1.1 Prepare a table featuring all the measurements, description of winding materials, and any additional information considered necessary for the following stators:
- Hairpin wound stator
- Lap wound stator.

1.2 Draw a winding diagram of a hairpin wound stator.

1.3 Draw a winding diagram of a lap wound stator.

1.4 Explain why the wedges of a radial ventilated machine should be closely examined.

1.5 List factors to be considered when selecting connection cables for a stator winding.

Learning outcome 2	**Outline the procedures for checking the condition of a stripped stator core and preparing the stator for rewinding with reference to the manufacturers' specifications.**	
Assessment criteria	2.1	Describe the sequence of events between the removal of the original winding and the commencement of starting the new rewind.
	2.2	Describe how to carry out a core loss test, the effect this test may have on the core and the expected test results.
	2.3	Describe how to remove hot spots in a faulty stator core.
	2.4	State the level of insulation required to insulate the steel bracing rings that support the coil overhang.
	2.5	Describe the difference between the slot liners and packing required for 3.3kV and 6.6kV windings.
Learning outcome 3	**Outline the procedures for the fitting of coils to the core, wedging and bracing.**	
Assessment criteria	3.1	Explain why the slot portion of the coils should not be handled on machines above 3.3kV.
	3.2	Explain the method used to insert ribbon windings into the stator slots.
	3.3	Explain why undue mechanical stress should be avoided when using B stage insulated coils.
	3.4	Explain the term slot pitch and why is it important to the winding.
	3.5	Explain the sequents of events in fitting: - The first pole pitch coil group of coils in a lap winding - The coils of a concentric winding.
	3.6	Specify where and why the excess packing should be placed in a slot.
	3.7	Explain the essential difference between the wedges for a lap and a hairpin winding.
	3.8	Explain why some windings have magnetic wedges.
	3.9	Describe the method of fitting wedges.

	3.10 Explain the difference that may be encountered between the wedges of a radial ventilated machine and the wedges of an axial ventilated machine.
	3.11 Describe the methods used to brace and strengthen the coil overhang for: - Lap windings - Hairpin windings.
Learning outcome 4	**Describe the correct procedures for making inter-turn and inter-coil winding connections.**
Assessment criteria	4.1 Draw the winding diagram for each of the following windings: - Six pole 60-slot double layer lap winding - Four pole 48-slot double layer lap winding - Six pole 72 slot hairpin winding.
	4.2 Describe the sequence of events in making turn to turn connections, and insulating the turns of a lap winding for the following methods: - Silver solder - Tig welding - Soft solder.
	4.3 Describe the sequence of events for a hairpin winding, from the hand forming of the coils to when they are finally insulated, then joining the turn to turn by welding.
	4.4 Describe the sequence of events in making the coil to coil connections in a bar winding.
	4.5 Name the tests to be carried out after all coil to coil connections are made on: - 3.3kV B stage insulated windings - 6.6kV insulated windings - VPI windings.

Learning outcome 5	**Describe impregnating materials used, procedures, tests and precautions required after the impregnation of a completed winding.**
Assessment criteria	5.1 List relevant Australian, IEC and British Standards for impregnation of winding. 5.2 List the safety precautions to be taken when handling and using varnishes and resins. 5.3 List the important features of an oven used to cure impregnated windings of a large machine. 5.4 Describe the following impregnating materials, their advantages and disadvantages and where they would be use: - 100 % solid resin - Xylol based resin - Water based varnish. 5.5 Describe the method of conducting the following tests: - Gel test on a resin - Viscosity test on a varnish. 5.6 Describe other relevant quality procedures that should be carried out on an impregnating varnish. 5.6 Describe the procedure and precautions for carrying out the following impregnations: - Hot dip - Flood coat - VPI. 5.7 Name the tests to be carried out after the impregnation on baking of: - A 3.3 kV B stage insulated winding - A 6.6 kV stage B insulated winding - A VPI winding.

Learning outcome 6	**Describe how to insulate winding to terminal connections according to Australian, IEC and British standards.**	
Assessment criteria	6.1	Select correct cable taking into account the voltage, full load current and fault capacity of the machine.
	6.2	Describe in brief the following terminal boxes and their purpose: - Phase insulated - Phase separated - Phase segregated.
	6.3	Describe a method of making a joint between the winding and the terminal cables and how to insulate the joint.
	6.4	Describe an Elastimold connection and its attributes.
Learning outcome 7	**Determine procedures and precautions to be followed when performing static electrical testing of a complete stator rewind according to Australian, British and IEC standards.**	
Assessment criteria	7.1	Describe how to carry out a polarisation index (PI) test including the following: - Test procedures and precautions - Expected values for a new winding.
	7.2	Calculate the resistance cold of a complete winding using a winding data.
	7.3	Describe the method of measuring the resistance cold of a complete rewind, using both the duct and the low volt ammeter methods.
	7.4	Calculate the phase resistance from the line resistance at the terminal block for Star and Delta connected machines.

	7.5 Explain how to carry out a polarity test check on a stator.
	7.6 Describe how to carry out the loss tangent test including appropriate precautions.
	7.7 Explain why the results from a loss tangent test on a complete Stator will be different from those measured on individual coils.
	7.8 Describe how to carry out a high voltage test including the test procedure and precautions, when it should be conducted and the required voltage.
	7.9 Describe how to carry out a repetitive surge test including the test procedure and precautions, when it should be conducted and common indications from the test results.

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 method to achieve this is by integration of theory and practice where students learn by experimentation, research and reports. It is recommended that learning and assessment be facilitated in a holistic manner that may require learning outcome sequence other than that indicated in the module.

Resource requirements

Physical resources:

The off the job facilities should include but not be limited to:
A regular class room
Audiovisual equipment such as an overhead projector and screen, video player and monitor.

Human resources:

Minimum qualification must be relevant to the subject together with (5) years industrial experience and the completion of an accredited instructional course.

	Learning resources: AS 1359.60: Rotating electrical machines: Tests. AS2768: Electrical insulating materials - evaluation and classification based on thermal endurance. BS 4999: Part 71: Winding terminations. BS 4999: Part 144: Specifications for the insulation of bars and coils of high voltage machines, including test methods. Current manufacturers' trade catalogues. EITB, Rotating Electrical Equipment, Winding and Building, Module G2, vol 1 & 2, Watford, U.K 1990. IEC 34-15: Impulse voltage withstands levels of rotating AC machines with form wound stator coils. The Performance and Design of Alternating Current Machines. By M.G. SAY Pitman Press.
Occupational health and safety requirements	A safe and healthy environment will be provided for students and teachers as well as the particular safety procedures followed as part of the learning / teaching activity and content.