

1. Module details**Module name****Electrical Machine Bearings****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

NUE133

Discipline code

0703105

2. Module purpose

This module will provide the learner with the knowledge and skill to select, handle, store, lubricate, calculate bearing life expectancy, remove and fit a range of bearings for electrical motors in a variety of practical situations. Identify signs and causes of bearing failure as well as the appropriate remedial action to be taken.

3. Prerequisites

NE21 Rotating Electrical Machines - Maintenance and Repair.

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**Types of bearings used in electrical machines**

Rolling bearings ball: deep groove, maximum capacity, angular contact, self-aligning, special thrust

Rolling bearings roller: cylindrical, tapered, spherical, special thrust

Plain bearings: (full sleeve, split sleeves, thrust-fixed and self-centring, carbon and sintered)

Bearing clearances

Fitting bearings to shafts: induction heating, hot oil baths, oven heating, hydraulic, mechanical, cold shrink, adaptor sleeves

Fitting of bearings into housing: pressing, heating, shrinking

Removal of bearings from shafts (mechanical, hydraulic, heating) and housings (pressing, heating, and shrinking)

Handling and storage of bearings

Methods of lubrication: grease, oil bath, oil circulation systems, throw away systems, oil mist

Calculation of bearing life

Seals: oil seals, carbon seals, ceramic seals, labyrinth, V rings, oil grooves, mechanical devices

Identifying bearing failure damage and remedial action: overload, corrosion, brinelling, false brinelling, electric currents, foreign materials

Practical: fitting and removal of the bearings from shafts and housings

Note: In this module, the term “rolling bearings” includes both ball and roller bearings.

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

Identify the types of rolling and plain bearings currently used in electric motors and generators.

Assessment criteria

- 1.1 List six of the most common type bearings used in electric motors.
- 1.2 Sketch and label a cross sectional view for bearing listed in 1.1.
- 1.3 List the types of plain bearings commonly used in electric motors.
- 1.4 Give examples where each of the above bearings in 1.1 and 1.3 would be used.
- 1.5 Describe the purpose of a bearing cage and the different types of materials used in its manufacture for different motor speed ranges.

Learning outcome 2

Determine when a particular rolling bearing clearance is used with reference to manufacturer's catalogues.

Assessment criteria

- 2.1 Detail the condition that determines a rolling bearing clearance after fitting.
- 2.2 List conditions that would require a reduced clearance in rolling bearings.
- 2.3 List conditions that would require a greater than normal clearance in rolling bearings.
- 2.4 Compare the clearance between a C2 and a C4 bearing.

Learning outcome 3

Outline the methods of fitting rolling bearings and white metal split sleeve bearings to shafts.

Assessment criteria

- 3.1 List the methods used for the fitting of rolling bearings to shafts.
- 3.2 List the advantages and disadvantages of methods listed in 3.1.
- 3.3 Describe one procedure for fitting rolling bearings to shafts.
- 3.4 Describe the procedure for fitting a split sleeve, white metal bearing to a shaft.
- 3.5 List the safety requirements of the procedures in 3.3 and 3.4.

Learning outcome 4

Outline the methods of fitting rolling, carbon and sintered bearings into housings.

Assessment criteria

- 4.1 List the methods used to fit rolling bearings into housings.
- 4.2 Provide examples where each method in 4.1 would most likely be used.
- 4.3 Detail one procedure and its safety requirements for fitting rolling bearings into housings.
- 4.4 Detail the method of fitting a sintered bearing into housing and the safety requirements for this method.
- 4.5 Detail the method of fitting a carbon bearing into housing and the safety requirements for this method.

Learning outcome 5

Outline the methods used to remove rolling bearings from shafts.

Assessment criteria

- 5.1 List methods used to remove rolling bearings from shafts.
- 5.2 Provide examples where each of these removal methods in 5.1 is used.
- 5.3 Detail one procedure for removing rolling bearings from a shaft and the safety requirements for this procedure.
- 5.4 List the methods used to remove rolling bearings from housings.
- 5.5 Detail one procedure for removing a rolling bearing from the housing and the safety requirements for this procedure.

Learning outcome 6

Outline various methods of handling, lubricating and sealing bearings with reference to bearing manufacturers' recommendations.

Assessment criteria

- 6.1 List the correct and incorrect methods of handling and storing bearings whether packaged or machine mounted.
- 6.2 List the methods used to lubricate bearings.
- 6.3 List types of sealing devices and method of fitting including metallic (NILOS) plates.
- 6.4 List the advantage and disadvantage for each of the lubricating and sealing methods in 6.2 and 6.3.
- 6.5 Nominate one application for each lubricating and sealing method.
- 6.6 List the effect of different lubricants and sealing methods on temperature rise of the bearing and the efficiency of the machine.
- 6.7 Detail the method of relubricating a sintered metal bearing.
- 6.8 List the precautions to be taken when transporting bearings over long distances, either packed or mounted within the machine.

Learning outcome 7

Determine the life expectancy for specific types of loads with reference to manufacturer recommendations.

Assessment criteria

- 7.1 Calculate the life expectancy for a cylindrical ball bearing with radial load only.
- 7.2 Calculate the life expectancy of a roller bearing with radial load only.
- 7.3 Calculate the life expectancy for a cylindrical roller thrust bearing with axial load only.
- 7.4 Calculate the life expectancy for a ball bearing with both axial and radial load only:
 - Angular contact
 - Single row tapered
 - Double row tapered
 - Spherical.

Learning outcome 8

Calculate shaft and housing dimensions of nominated bearings for given electric motor specification.

Assessment criteria

- 8.1 Calculate the shaft and housing dimensions with acceptable tolerances for a given electric motor.
- 8.2 Calculate the shaft and housing dimensions for a roller bearing for a given electric motor.

Learning outcome 9

Determine the most likely cause of failure for given bearings which have failed under given conditions.

Assessment criteria

- 9.1 List the most common causes of bearing failure.
- 9.2 Prepare a report identifying the specific signs of wear and imminent failure and the most likely cause of the damage given a bearing in the early stages of failure.

Learning outcome 10	Perform the fitting and removal of bearings from shafts and housings.
Assessment criteria	<p>10.1 Fit a bearing to a shaft.</p> <p>10.2 Remove a ball bearing from a shaft.</p> <p>10.3 Remove a roller bearing from a shaft.</p> <p>10.4 Remove a bearing from a housing.</p> <p>10.5 Assemble a machine with rolling bearings, without shields or built in seals.</p> <p>10.6 Re-lubricate a sintered metal bearing and fit into a housing.</p>
8. Delivery of the module	
Delivery strategy	<p>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.</p>
Resource requirements	<p><i>Physical resources:</i></p> <p>The off-job facilities should include but not be limited to:</p> <ul style="list-style-type: none"> • A regular class room. • Audiovisual equipment such as overhead projector and screen, video recorder and monitor. • Workshop tools and equipment for the removal and fitting of bearings. • Electric machines and failed bearings. • Safety equipment. <p><i>Learning resources:</i></p> <p>Metallic seals for Bearings, Catalogue Z143e, KROLL & ZILLER</p> <p>AS1654 Limits and fits for engineering</p>

Ball and roller bearings, Catalogue 2010, NTN Toyo bearing Co, Japan 1981

Ball and roller bearings, Catalogue 2010, NTN Toyo bearing Co, Japan 1981

Rolling Bearings in Electrical Machines and Office Technology, Publication. No. WL01201 EF, FAG Australia

Current catalogues and other publications from bearing and lubricant manufacturers

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.