COURSE OUTLINE

Electric Machines — Course Title

ET 121 — Dept & Course No.

I. COURSE DESCRIPTION

This course provides technical knowledge and skills necessary in dealing with electric machines. It consists of theories and operating principles of transformers, motors and generators. Specifically, it deals with connecting, installing, troubleshooting and repair of transformers, motors and generators. Appropriate CAI will be used.

III. SEMESTER CREDIT: 4

IV. CONTAC HOURS PER WEEK: 2 Lecture | 6 Lab | 8 Total

V. PREREQUISITE: ET 111

VI. STUDENT LEARNING OUTCOMES:

Upon completion of the course, the students will be able to, with 65% accuracy to:

1. Rewind transformer
2. Perform Transformer banking
3. Troubleshoot and repair capacitor motor

VII. COURSE CONTENT

A. Static machine and Dynamic machine
   1. Concepts and principles of transformer
   2. Induction type transformer
   3. Autotype transformer
   4. Three phase transformer
   1. Single phase transformer

B. Transformer connections
   1. Connections
   2. Transformer configuration
   3. Transformer banking
   4. Transformer polarities
   5. Open delta transformer connection
   6. Delta-wye
   7. Wye-delta
   8. Delta-delta
   9. Wye-wye

C. Capacitor Motors
   1. Main parts of capacitor motor
   2. Operation of capacitor motor
   3. Understanding nameplate data
   4. Motor efficiency
   5. Capacitor start induction run motor
   6. Capacitor start capacitor run motor
   7. Permanent split capacitor motor
   8. Terminal markings for capacitor motor
   9. Connecting capacitor motor
      a. Schematic diagrams of motors
      b. Single voltage capacitor motor
      c. Single voltage capacitor

motor
   d. Dual voltage capacitor motor
   e. Dual voltage split phase motor
10. Repairing capacitor motor
   a. Procedure for analyzing single phase motor troubles
   b. How to recognize connections
   c. Common troubles and remedies for capacitor motors.
   d. Replacing centrifugal switch
   e. Replacing bearing/bushing
   f. Reconnecting capacitor motor for a change in voltage
   g. Rewinding single phase motor
   h. Rewinding capacitor motor for a change in voltage
   i. Rewinding for a change in speed
   j. Performing test run
   k. Insulation resistance testing

4. Troubleshoot and repair three-phase motors

D. Three-phase motors
1. Connecting three-phase motor
   a. Main parts of three-phase motor
   b. Operation of three-phase motor
   c. Terminal markings for three-phase motor
   d. Understanding nameplate data
2. Troubleshooting and repair of three phase motor
   a. Three leads out three phase motor
   b. Six leads out three phase motor
   c. Nine leads out three phase motor
   d. Twelve leads out three phase motor
   e. Wye connection
   f. Delta connection
   g. Single voltage three phase motor
   h. Dual voltage three phase motor
   i. Dual speed motor
   j. Troubleshooting procedures
   k. Common troubles and remedies for three-phase motors
   l. Recording data
   m. Identifying nine-leads of untagged three phase motor

n. Reconnecting three phase motor
o. Rewinding three-phase motor
p. Performing test run
q. Insulation resistance testing

5. Troubleshoot and repair generator

E. Generator
1. Operation of generator
2. Separately excited generator
3. Self excited generator
4. Direct current generators
5. Single phase generator
6. Three-phase generator
7. Troubleshooting and repairing generator
8. Performing test run
9. Insulation resistance testing

6. Perform corrective and preventive maintenance of electric machines

F. Preventive maintenance
1. Lubricating bearing and bushing
2. Cleaning contacts of auxiliary parts
3. Re-baking and re-varnishing winding

G. Corrective Maintenance
1. Replacing bearing/bushing
2. Replacing auxiliary parts

VIII. MATERIALS AND EQUIPMENT

A. Basic electrical hand tools
B. Multimeter
C. Clamp ammeter
D. Magnet wires
E. Transformer rewinding machine
F. Motor rewinding machine
G. Coil formers
H. Fish paper
I. Mylar insulator
J. Electrical insulating varnish
K. Transformers
1. single phase transformer
2. three-phase transformer
L. Generator
M. Motors
1. capacitor motor
2. three-phase motor
3. dc motors
4. three phase motor

IX. TEXT AND REFERENCES

A. Required Text
Rosenberg, Robert and Hand, August. ***ELECTRIC MOTOR REPAIR,*** Delmar Publishers Inc.

B. Supplementary Reference
Alerich, Walter N and Jeff Keljik. ***ELECTRICTY 3***, USA: Delmar Publishers Inc; 1991.
Alerich, Walter N and Jeff Keljik. ***ELECTRICTY 4***, USA: Delmar Publishers Inc; 1991.

X. METHOD OF INSTRUCTION

A. Lecture-discussion
B. Demonstration
C. Video Presentation
D. Self-pace learning
E. Laboratory Performance

XI. METHOD OF EVALUATION

A. Knowledge will be evaluated using the following methods:
   1. Written test
   2. Graded recitation/Oral presentation
   3. Instructor's Interview

B. Skills will be evaluated using the following criteria:
   1. Accuracy
   2. Quality of work
   3. Safety
   4. Time lines/Completion

C. Final grade is computed and weighted using the following criteria:

Class participation.....		15%
Quizzes/Short Tests.....		20%
Midterm/Final Exams.....		25%
Performance.....		40%
	TOTAL	100%

D. Transmutation of total percent to letter grade:

90-100%.....	A
80-89%.....	B
70-79%.....	C
65-69%.....	D
00-64%.....	F

TASK LISTING

ET 121	Credits:	2	6	8
Course No. Title		Lec	Lab	Total Hrs

COURSE LEARNING OUTCOMES	Allotted Hours
1. Rewind transformer a. Rewind transformer. 1. Induction type transformer 2. Auto-type transformer 3. Three-phase transformer	20
2. Perform Transformer banking a. Identify transformer polarity b. Bank two transformer using open delta configuration c. Bank transformer using different configuration 1. Delta-wye 2. Wye-delta 3. Delta-delta 4. Wye-wye	20
3. Troubleshoot and repair capacitor motor a. and remedies for capacitor motors. b. Replace centrifugal switch c. Replace bearing/bushing d. Lubricate bearing/bushing e. Reconnect capacitor motor to suite for a change in voltage f. Rewind single phase motor g. Rewind capacitor motor for a change in voltage h. Rewind capacitor motor for a change in speed i. Rewind capacitor motor for a change in frequency.	28
4. Troubleshoot and repair three phase motor a. Identify main parts of three-phase motor b. Describe the operation of three-phase motor c. Mark terminal of three-phase motor d. Take nameplate data Connect three leads out three phase motor e. Connect six leads out three phase motor f. Connect nine leads out three phase motor g. Connect twelve leads out three phase motor h. Connect wye connection i. Connect delta connection j. Connect single voltage three phase motor k. Connect dual voltage three phase motor l. Connect dual speed motor m. Connect nine leads out three phase motor n. Identify common troubles and remedies for three-phase motors o. Troubleshoot and repair three-phase motor p. Record data q. Identify nine-leads of untagged three phase motor r. Reconnect three phase motor to suite for a change in voltage s. Rewind three-phase motor t. Rewind three phase motor to suite for a change in voltage u. Rewind three phase motor to suite for a change in speed v. Rewind three phase motor to suite for a change in frequency w. Perform insulation test x. Test run the motor y. Repair mechanical components of three phase motor z. Lubricate mechanical parts of three phase motor	28
5. Troubleshoot and repair generator	20

a. Discuss operation of generator b. Identify characteristic of self excited generator and separately excited generator c. Connect direct current generator d. Connect single phase generator e. Connect three-phase generator in parallel f. Troubleshoot and repair generator g. Perform insulation testing h. Test run the generator	
6. Perform corrective and preventive maintenance of electric machines a. Lubricate bearing and bushing b. Clean contacts of auxiliary parts c. Re-bake and re-varnish winding d. Replace bearing/bushing e. Replace auxiliary parts	12
	128

Palau Community College
ET 121 Electric Machines
Course Learning Outcomes

During the course experience, the ***course learning outcomes*** (CLOs) will be assessed through the use of signature assignments. A rating scale will be used to determine the students' proficiency level of each CLO using specifically aligned assignments. The numerical ratings of 3, 2, and 1 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on the level of student performance of each of the course learning outcomes listed below:

Rating Scale:

5	Excellent
4	Above average
3	Average
2	Below Average
1	Unacceptable

CLO 1: Rewind transformer

5	The student is able to rewind transformer without any supervision and instruction.
4	The student is able to rewind transformer banking with limited supervision but no instruction.
3	The student is able to rewind transformer with limited supervision and limited instruction.
2	The student has difficulty to rewind transformer and requires considerable supervision and instruction.
1	The student is unable to rewind transformer even with supervision and instruction.

CLO 2: Perform Transformer banking

5	The student is able to perform transformer banking without any supervision and instruction.
4	The student is able to perform transformer banking with limited supervision but no instruction.
3	The student is able to perform transformer banking with limited supervision and limited instruction.
2	The student has difficulty to perform transformer banking and requires considerable supervision and instruction.
1	The student is unable to perform transformer banking even with supervision and instruction.

CLO 3: Troubleshoot and repair capacitor motor

5	The student is able to troubleshoot and repair capacitor motor without any supervision and instruction.
4	The student is able to troubleshoot and repair capacitor motor with limited supervision but no instruction.
3	The student is able to troubleshoot and repair capacitor motor with limited supervision and limited instruction.
2	The student has difficulty to troubleshoot and repair capacitor motor and requires considerable supervision and instruction.
1	The student is unable to troubleshoot and repair capacitor motor even with supervision and instruction.

CLO 4: Troubleshoot and repair three-phase motors.

5	The student is able to troubleshoot and repair three-phase motors without any supervision and instruction.
4	The student is able to troubleshoot and repair three-phase motors with limited supervision but no instruction.
3	The student is able to troubleshoot and repair three-phase motors with limited supervision and limited instruction.
2	The student has difficulty to troubleshoot and repair three-phase motors and requires considerable supervision and instruction.
1	The student is unable to troubleshoot and repair three-phase motors even with supervision and instruction.

CLO 5: Troubleshoot and repair generator

5	The student is able to troubleshoot and repair generator without any supervision and instruction.
4	The student is able to troubleshoot and repair generator with limited supervision but no instruction.
3	The student is able to troubleshoot and repair generator with limited supervision and limited instruction.
2	The student has difficulty to troubleshoot and repair generator and requires considerable supervision and instruction.
1	The student is unable to troubleshoot and repair generator even with supervision and instruction.

CLO 6: Perform corrective and preventive maintenance of electric machines

5	The student is able to perform corrective and preventive maintenance of electric machines without any supervision and instruction.
4	The student is able to perform corrective and preventive maintenance of electric machines with limited supervision but no instruction.
3	The student is able to perform corrective and preventive maintenance of electric machines with limited supervision and limited instruction.
2	The student has difficulty to perform corrective and preventive maintenance of electric machines and requires considerable supervision and instruction.
1	The student is unable to perform corrective and preventive maintenance of electric machines even with supervision and instruction.

MARKING SHEET
ET 121 – Electric Machines

Name of student: _____ Instructor: _____

CLO1 –REWIND TRANSFORMER

CRITERIA	ALLOTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	**10 or 1**		**35%**
1. Transformer primary winding are connected according to connection configuration required to suit supply voltage.	10 or 1		Average of gained points X 10 X 35%
2. Appropriate supply voltage that suits the configuration is impressed primary winding.	10 or 1		
3. Expected amount of voltage on the secondary side of the transformer is obtained when the transformer bank is energized.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			**25%**
1. Data is gathered while stripping the transformer.	10		Average of gained points X 10 X 25%
2. Transformer terminals are connected using NEC approved type of electrical materials			
3. Live conductors are covered with appropriate type of materials according to NEC standards.	10		
4. Every layer of the winding is separated by insulator according to best practices.	10		
5. Transformer terminals are connected tight enough not to create sparks/loose connections that will eventually lead to burnt terminals.	10		
6. Transformer is baked and varnished according to manufacturer's specifications.	10		
SAFETY, PROPER USED OF TOOLS, MATERIALS AND EQUIPMENT			**20%**
1. Area is cleaned every after each session	10		Average of gained points X 10 X 20%
2. Tools and equipment are used properly.	10		
3. Materials are used properly	10		
4. Safety procedure is strictly observed within the duration of work	10		
TIMELINESS/COMPLETION			**20%**
1. Work is submitted one or more days ahead of due date	10		Average of gained points X 10 X 20%
2. Work submitted on due date	8		
3. Work submitted a day after due date	4		
4. Work submitted more than two days after due date	0		
TOTAL			

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Assessor

MARKING SHEET
ET 121 – Electric Machines

Name of student: _____ Instructor: _____

CLO2 – PERFORM TRANSFORMER BANKING

CRITERIA	ALLOTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	**10 or 1**		**35%**
1. Transformer primary winding are connected according to connection configuration required to suit supply voltage.	10 or 1		Average of gained points X 10 X 35%
2. Appropriate supply voltage that suits the configuration is impressed primary winding.	10 or 1		
3. Expected amount of voltage on the secondary side of the transformer is measured when the transformer bank is energized.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			**25%**
1. Transformer terminals are connected using NEC approved type of electrical materials	10		Average of gained points X 10 X 25%
2. Live conductors are covered with appropriate type of materials according to NEC standards.	10		
3. Transformer terminals are connected tight enough not to create sparks/loose connections that will eventually lead to burnt terminals.	10		
SAFETY, PROPER USED OF TOOLS, MATERIALS AND EQUIPMENT			**20%**
1. Area is cleaned every after each session	10		Average of gained points X 10 X 20%
2. Tools and equipment are used properly.	10		
3. Materials are used properly	10		
4. Safety procedure is strictly observed within the duration of work	10		
TIMELINESS/COMPLETION			**20%**
1. Work is submitted one or more days ahead of due date	10		Average of gained points X 10 X 20%
2. Work submitted on due date	8		
3. Work submitted a day after due date	4		
4. Work submitted more than two days after due date	0		
TOTAL			

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Assessor

MARKING SHEET
ET 121 — Electric Machines

Name of student: _____ Instructor: _____

CLO3 — CONNECT MOTOR TO SUITE OPERATIONAL REQUIREMENTS

CRITERIA	ALLOTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	**10 or 1**		**35%**
1. Motor runs when connected at low voltage	10 or 1		Average of gained points X 10 X 35%
2. Motor runs when connected at high voltage	10 or 1		
3. Current measured is not more than the specified nameplate current when the motor is run at low voltage operation.	10 or 1		
4. Current measured is not more than the specified nameplate current when the motor is run at high voltage operation.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			**25%**
1. Motor terminals are connected using NEC approved type of electrical materials.	10		Average of gained points X 10 X 25%
2. Live conductors are covered with appropriate type of materials according to NEC standards.	10		
3. Motor terminals are connected tight enough not to create sparks/loose connections that will eventually lead to burnt terminals.	10		
SAFETY, PROPER USED OF TOOLS, MATERIALS AND EQUIPMENT			**20%**
1. Area is cleaned every after each session	10		Average of gained points X 10 X 20%
2. Tools and equipment are used properly.	10		
3. Materials are used properly	10		
4. Safety procedure is strictly observed within the duration of work	10		
TIMELINESS/COMPLETION			**20%**
1. Work is submitted one or more days ahead of due date	10		Average of gained points X 10 X 20%
2. Work submitted on due date	8		
3. Work submitted a day after due date	4		
4. Work submitted more than two days after due date	0		
TOTAL			

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Assessor

MARKING SHEET
ET 121 – Electric Machines

Name of student: _____ Instructor: _____

CLO4 – TROUBLESHOOT AND REPAIR CAPACITOR MOTOR

CRITERIA	ALLOTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	**10 or 1**		**35%**
1. Causes of trouble are identified using appropriate measuring and testing device according to best practices.	10 or 1		Average of gained points X 10 X 35%
2. Defective part/s of capacitor motor is removed according to manufacturer's specifications.	10 or 1		
3. Defective part/s of capacitor motor is replaced according to manufacturer's specifications.	10 or 1		
4. Repaired capacitor motor is inspected and tested for further anomalies before performing test run.	10 or 1		
5. Repaired capacitor motor operates properly during test run.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			**25%**
1. Punch mark is made before dismantling the motor.	10		Average of gained points X 10 X 25%
2. Defective component/s is removed without damaging other parts of the motor.	10		
3. Data is gathered while stripping the stator	10		
4. Coils are formed according to best practices.	10		
5. Coils are inserted on the slots according to best practices.	10		
6. Wedges are provided according to best practices.	10		
7. Windings are connected according the original configuration of the motor.	10		
8. Terminal wires are connected to the winding properly	10		
9. Winding is laced according to best practices.	10		
10. Motor is reassembled properly	10		
SAFETY, PROPER USED OF TOOLS, MATERIALS AND EQUIPMENT			**20%**
1. Area is cleaned every after each session	10		Average of gained points X 10 X 20%
2. Tools and equipment properly used.	10		
3. Materials are used properly	10		
4. Motor components are secured to facilitate easy retrieval during assembly.	10		
5. Safety procedure is strictly observed within the duration of work	10		
TIMELINESS/COMPLETION			**20%**
1. Work is submitted one or more days ahead of due date	10		Average of gained points X 10 X 20%
2. Work submitted on due date	8		
3. Work submitted a day after due date	4		
4. Work submitted more than two days after due date	0		
TOTAL			

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Assessor

MARKING SHEET
ET 121 — Electric Machines

Name of student: _____ Instructor: _____

CLO5 — TROUBLESHOOT AND REPAIR THREE-PHASE MOTORS

CRITERIA	ALLOTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	**10 or 1**		**35%**
1. Causes of trouble are identified using appropriate measuring and testing device according to best practices.	10 or 1		Average of gained points X 10 X 35%
2. Defective part/s of three phase motor is removed according to manufacturer's specifications.	10 or 1		
3. Defective part/s of three phase motor is replaced according to manufacturer's specifications.	10 or 1		
4. Repaired three phase motor is inspected and tested for further anomalies before performing test run.	10 or 1		
5. Repaired three-phase operates properly during test run.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			**25%**
1. Punch mark is made before dismantling the motor.	10		Average of gained points X 10 X 25%
2. Defective component/s is removed without damaging other parts of the motor.	10		
3. Data is gathered while stripping the stator	10		
4. Coils are formed according to best practices.	10		
5. Coils are inserted on the slots according to best practices.	10		
6. Wedges are provided according to best practices.	10		
7. Windings are connected according the original configuration of the motor.	10		
8. Terminal wires are connected to the winding properly	10		
9. Winding is laced accordingly	10		
10. Motor is assembled properly	10		
SAFETY, PROPER USED OF TOOLS, MATERIALS AND EQUIPMENT			**20%**
1. Area is cleaned every after each session	10		Average of gained points X 10 X 20%
2. Tools and equipment properly used.	10		
3. Materials are used properly	10		
4. Motor components are secured to facilitate easy retrieval during assembly.	10		
5. Safety procedure is strictly observed within the duration of work	10		
TIMELINESS/COMPLETION			**20%**
1. Work is submitted one or more days ahead of due date	10		Average of gained points X 10 X 20%
2. Work submitted on due date	8		
3. Work submitted a day after due date	4		
4. Work submitted more than two days after due date	0		
TOTAL			

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Assessor

MARKING SHEET
ET 121 — Electric Machines

Name of student: _____ Instructor: _____

CLO6 — TROUBLESHOOT AND REPAIR GENERATOR

CRITERIA	ALLOTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	**10 or 1**		**35%**
1. Causes of trouble are identified using appropriate measuring and testing device according to best practices.	10 or 1		Average of gained points X 10 X 35%
2. Defective part/s of generator is removed according to manufacturer's specifications.	10 or 1		
3. Defective part/s of generator is replaced according to manufacturer's specifications.	10 or 1		
4. Repaired generator is inspected and tested for further anomalies before performing test run.	10 or 1		
5. Repaired generator operates properly during test run.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			**25%**
1. Punch mark is made before dismantling the generator.	10		Average of gained points X 10 X 25%
2. Defective component/s is removed without damaging other parts of the generator.	10		
3. Data is gathered while stripping the stator	10		
4. Coils are formed according to best practices.	10		
5. Coils are inserted on the slots according to best practices.	10		
6. Wedges are provided according to best practices.	10		
7. Windings are connected according the original configuration of the generator.	10		
8. Terminal wires are connected to the winding properly	10		
9. Winding is laced accordingly	10		
10. Generator is assembled properly	10		
SAFETY, PROPER USED OF TOOLS, MATERIALS AND EQUIPMENT			**20%**
1. Area is cleaned every after each session	10		Average of gained points X 10 X 20%
2. Tools and equipment properly used.	10		
3. Materials are used properly	10		
4. Motor components are secured to facilitate easy retrieval during assembly.	10		
5. Safety procedure is strictly observed within the duration of work	10		
TIMELINESS/COMPLETION			**20%**
1. Work is submitted one or more days ahead of due date	10		Average of gained points X 10 X 20%
2. Work submitted on due date	8		
3. Work submitted a day after due date	4		
4. Work submitted more than two days after due date	0		
TOTAL			

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Assessor

MARKING SHEET
ET 121 — Electric Machines

Name of student: _____ Instructor: _____

CLO7 — PERFORM CORRECTIVE AND PREVENTIVE MAINTENANCE OF ELECTRIC MACHINES.

CRITERIA	ALLOTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	**10 or 1**		**35%**
1. Bearing/bushing is lubricated according to manufacturer's specifications.	10 or 1		Average of gained points X 10 X 35%
2. Bearing/bushing is inspected for any defects according to manufacturer's specifications.	10 or 1		
3. Defective bearing/bushing is replaced according to manufacturer's specifications.	10 or 1		
4. Winding is re-baked and re-varnished according manufacturer's specifications.	10 or 1		
5. Repaired electric machine is inspected and tested for further anomalies before performing test run.	10 or 1		
6. Repaired electric machine operates properly during test run.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			**25%**
1. Punch mark is made before dismantling the machine.	10		Average of gained points X 10 X 25%
2. Defective component/s is removed without damaging other parts of the machine.	10		
3. Terminal wires are connected to the winding properly	10		
4. Winding is laced accordingly	10		
5. Machine is re-assembled properly	10		
SAFETY, PROPER USED OF TOOLS, MATERIALS AND EQUIPMENT			**20%**
1. Area is cleaned every after each session	10		Average of gained points X 10 X 20%
2. Tools and equipment properly used.	10		
3. Materials are used properly	10		
4. Components are secured to facilitate easy retrieval during assembly.	10		
5. Safety procedure is strictly observed within the duration of work	10		
TIMELINESS/COMPLETION			**20%**
1. Work is submitted one or more days ahead of due date	10		Average of gained points X 10 X 20%
2. Work submitted on due date	8		
3. Work submitted a day after due date	4		
4. Work submitted more than two days after due date	0		
TOTAL			

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Assessor

MARKING GUIDE

ET 121 ELECTRIC MACHINES

CRITERIA
ACCURACY
CLO1 – Rewind Transformer
CLO2 – Perform transformer banking
CLO3 – Connect motor to suite operational requirements
CLO4 – Troubleshoot and repair capacitor motor
CLO5 – Troubleshoot and repair three-phase motors
CLO6 – Troubleshoot and repair generator
CLO7 – Perform corrective and preventive maintenance of electric machines
• *10 points will be awarded if the criteria on each CLO are met, 1 point if the criteria are not met.*
QUALITY OF WORK (WORKMANSHIP)
CLO1 – REWIND TRANSFORMER
1. Data is gathered while stripping the transformer. • 2 points deduction for every important data missed. 2. Transformer terminals are connected using NEC approved type of electrical materials • 2 points deduction for every terminal used not in accordance with NEC standards. 3. Live conductors are covered with appropriate type of materials according to NEC standards. • 2 points deduction for every exposed live conductor. 4. Every layer of the winding is separated by insulator according to best practices. • 2 points deduction for every layer not separated by insulator. 5. Transformer terminals are connected tight enough not to create sparks/loose connections that will eventually lead to burnt terminals. • 2 points deduction for every loose terminal connection. 6. Transformer is baked and varnished according to manufacturer's specifications. • 2 points deduction for every violation of the manufacturer's specification in baking and varnishing the transformer.
CLO2 – PERFORM TRANSFORMER BANKING
1. Transformer terminals are connected using NEC approved type of electrical materials • 2 points deduction for every terminal used not in accordance with NEC standards. 2. Live conductors are covered with appropriate type of materials according to NEC standards. • 2 points deduction for every exposed live conductor. 3. Transformer terminals are connected tight enough not to create sparks/loose connections that will eventually lead to burnt terminals. • 2 points deduction for every loose terminal connection.
CLO3 – CONNECT MOTOR TO SUITE OPERATIONAL REQUIREMENTS
1. Motor terminals are connected using NEC approved type of electrical materials. • 2 points deduction for every terminal used not in accordance with NEC standards. 2. Live conductors are covered with appropriate type of materials according to NEC standards. • 2 points deduction for every exposed live conductor. 3. Motor terminals are connected tight enough not to create sparks/loose connections that will eventually lead to burnt terminals. • 2 points deduction for every loose terminal connection.
CLO4 – TROUBLESHOOT AND REPAIR CAPACITOR MOTOR
1. Punch mark is made before dismantling the motor. • 2 points deduction for every for incorrect punch mark made. 2. Defective component/s is removed without damaging other parts of the motor. • 2 points deduction for every damage made to other components of the motor. 3. Data is gathered while stripping the stator • 2 points deduction for every important data missed. 4. Coils are formed according to best practices. • 2 points deduction for every coil improperly formed (uneven sizes of coils) 5. Coils are inserted on the slots according to best practices. • 2 points deduction for every scratched made on the coil insulation due to improper way of

insertion to the slots.

6. Wedges are provided according to best practices.
   - 2 points deduction for every slot without wedge.
7. Windings are connected according the original configuration of the motor.
   - 2 point deduction for every improper winding connection.
8. Terminal wires are connected to the winding properly
   - 2 points deduction for every terminal improperly connected to the windings
9. Winding is laced according to best practices.
   - 2 points deduction for every coil not laced properly.
10. Motor is reassembled properly
    - 2 points deduction for every

CLO5 – TROUBLESHOOT AND REPAIR THREE-PHASE MOTORS

1. Punch mark is made before dismantling the motor.
   - 2 points deduction for every for incorrect punch mark made.
2. Defective component/s is removed without damaging other parts of the motor.
   - 2 points deduction for every damage made to other components of the motor.
3. Data is gathered while stripping the stator
   - 2 points deduction for every important data missed.
4. Coils are formed according to best practices.
   - 2 points deduction for every coil improperly formed (uneven sizes of coils)
5. Coils are inserted on the slots according to best practices.
   - 2 points deduction for every scratched made on the coil insulation due to improper way of insertion to the slots.
6. Wedges are provided according to best practices.
   - 2 points deduction for every slot without wedge.
7. Windings are connected according the original configuration of the motor.
   - 2 point deduction for every improper winding connection.
8. Terminal wires are connected to the winding properly
   - 2 points deduction for every terminal improperly connected to the windings
9. Winding is laced according to best practices.
   - 2 points deduction for every coil not laced properly.
10. Motor is reassembled properly
    - 2 points deduction for every

CLO6 – TROUBLESHOOT AND REPAIR GENERATOR

1. Punch mark is made before dismantling the generator.
   - 2 points deduction for every for incorrect punch mark made.
2. Defective component/s is removed without damaging other parts of the generator.
   - 2 points deduction for every damage made to other components of the generator.
3. Data is gathered while stripping the stator
   - 2 points deduction for every important data missed.
4. Coils are formed according to best practices.
   - 2 points deduction for every coil improperly formed (uneven sizes of coils)
5. Coils are inserted on the slots according to best practices.
   - 2 points deduction for every scratched made on the coil insulation due to improper way of insertion to the slots.
6. Wedges are provided according to best practices.
   - 2 points deduction for every slot without wedge.
7. Windings are connected according the original configuration of the generator.
   - 2 point deduction for every improper winding connection.
8. Terminal wires are connected to the winding properly
   - 2 points deduction for every terminal improperly connected to the windings
9. Winding is laced according to best practices.
   - 2 points deduction for every coil not laced properly.
10. Generator is reassembled properly
    - 2 points deduction for every

CLO7 – PERFORM CORRECTIVE AND PREVENTIVE MAINTENANCE OF ELECTRIC MACHINES

1. Punch mark is made before dismantling the electric machine.
   - 2 points deduction for every for incorrect punch mark made.

2. Defective component/s is removed without damaging other parts of the generator.
   - 2 points deduction for every damage made to other components of the generator.
3. Terminal wires are connected to the winding properly
   - 2 points deduction for every terminal improperly connected to the windings
4. Winding is laced according to best practices.
   - 2 points deduction for every coil not laced properly.
5. Machine is reassembled properly
   - 2 points deduction for every

SAFETY, PROPER USED OF TOOLS, MATERIALS AND EQUIPMENT

1. Area is cleaned upon completion of the job
   - 10 points is awarded to properly cleans area
   - 6 points is awarded for slightly cleaned area
   - No point is awarded if the area is unclean.
2. Tools and equipment properly used.
   - 2 points deduction for every improper use of tools and/or equipment
3. Materials are used properly
   - 2 points deduction for every improper use of materials
4. Safety procedure is strictly observed within the duration of work
   - 2 points deduction for every violation of safety rules.

TIMELINESS/COMPLETION

1. 10 points is awarded if work is submitted one or more days ahead of due date
2. 8 points is awarded if work submitted on due date
3. 4 points is awarded if work submitted a day after due date
4. Zero for the work submitted more than two days after due date