

COURSE OUTLINE

Motor Controls and Sequential Controllers

ET 210

Course Title

Dept & Course No.

I. COURSE DESCRIPTION

This course provides technical knowledge and skills relevant to industrial applications. It applies real world step-by-step approach to all aspect of motor controls and sequential controls, which includes basic control circuits, sensing devices and other control devices commonly used in industrial controls and installations. It also enables the students to learn to draw and interpret schematic/ladder and wiring diagrams, connect, install, troubleshoot, repair and maintain motor controls and sequential controllers. Appropriate CAI will be used.

II. SEMESTER CREDIT 5

III. CONTACT HOURS PER WEEK:

<u>3</u>	<u>6</u>	<u>9</u>
Lecture	Lab	Total

IV. PREREQUISITE: ET 121

V. COURSE LEARNING OUTCOME:

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

1. Install magnetic full-voltage starter
2. Install reduce voltage starters
3. Install wye-delta starters
4. Install sequential/compelling controls

VI. COURSE CONTENT

- A. Basic motor control circuit
 1. Basic motor control symbols
 - a Ladder diagrams
 - b Wiring diagrams
 - c Pilot devices
 - d Different parts of motor starter
 - e Manual controller for single phase motor
 - f Two-wire and three-wire control circuits
 - g Jogging and reversing controls
 - h Drum switches
 2. Overload protection
 3. Overcurrent protection
 4. Full voltage starting
 - a Magnetic full voltage starter
 - b Magnetic full voltage reversing starter
- B. Reduce voltage starter
 1. Primary resistance starters
 2. Auto-transformer
 3. Part-winding starters
- C. Wye-delta starters
 1. Open transition
 2. Close transition
- D. Sequential/Compelling controls
 1. Electromechanical relays
 2. Electromechanical timers
 3. Electronic timers
 4. Proximity sensors
 5. Limit switches
 6. Pressure switches
 7. Level switches
 8. Photo electric sensors
 9. Programmable logic controller

5. Apply typical approaches in troubleshooting, repairing and maintenance of motor control circuits

- E. Troubleshooting and repair of motor controls
- F. Troubleshooting procedures
- G. Testing control and power circuits
- H. Repairing magnetic contactors and other control devices
- I. Maintaining motor controls
- J. Contactor maintenance

VII. MATERIALS AND EQUIPMENT

- A. Basic electrical hand tools
- B. Multimeter
- C. Clamp ammeter
- D. Control devices
 - 1. push button switches
 - 2. limit switches
 - 3. float switches
 - 4. pressure switches
 - 5. level switches
 - 6. pilot lights
- E. Magnetic contactors
- F. Overload relays
- G. Control Relays
- H. Transformers
- I. Motors
 - 1. single phase motor
 - 2. three-phase motor
 - 3. dc motors
- J. Solenoids
- K. Magnets
- L. Programmable Logic Controllers

VIII. 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. **ELECTRICITY 3**, USA: Delmar Publishers Inc; 1991.
Alerich, Walter N and Jeff Keljik. **ELECTRICITY 4**, USA: Delmar Publishers Inc; 1991.
Jeff Keljik. **ELECTRIC MOTORS AND MOTOR CONTROLS**, USA: Delmar Publishers Inc; 1995.

IX. METHOD OF INSTRUCTION

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

X. 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 210 MOTOR CONTROLS AND SEQUENTIAL
CONTROLLERS

Course No. & Title

Credit: 2
Lec

3
Lab

9
Total Lab Hrs

COURSE LEARNING OUTCOMES	Allotted Hours
<p>1. Install magnetic full-voltage starter</p> <p>1.1. Draw wiring/ladder diagram 1.2. Identify different kinds of pilot devices used in basic motor control circuit 1.3. Connect manual controller for single phase motor 1.4. Install two-wire and three-wire control circuit 1.5. Install jogging and reversing control 1.6. Install motor control using drum switch 1.7. Identify different components of magnetic full voltage starter 1.8. Connect magnetic full voltage starter 1.9. Install magnetic full voltage reversing starter</p>	35
<p>2. Install reduce voltage starter.</p> <p>2.1. Install reduce voltage starter using primary resistance 2.2. Install reduce voltage starter using auto transformer 2.3. Install part winding starter</p>	15
<p>3. Install wye-delta starter</p> <p>3.1. Install open transition wye-delta starter 3.2. Install closed transition wye-delta starter</p>	10
<p>4. Install sequential/compelling controls</p> <p>4.1. Install sequential control using electromagnetic relays and timers 4.2. Install sequential control using different kinds of control devices. 4.3. Program logic controller</p>	15
<p>5. Apply typical approaches in troubleshooting, repair and maintenance of motor control circuits</p> <p>5.1. Troubleshoot motor control 5.2. Repair and maintain motor control 5.3. Repair and maintain magnetic contactors</p>	5

Palau Community College
ET 210 Motor Controls and Sequential Controllers
 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: Install magnetic full-voltage starter.

5	The student is able to install magnetic full-voltage starter without any supervision and instruction.
4	The student is able to install magnetic full-voltage starter with limited supervision but no instruction.
3	The student is able to install magnetic full-voltage starter with limited supervision and limited instruction.
2	The student has difficulty to install magnetic full-voltage starter and requires considerable supervision and instruction.
1	The student is unable to install magnetic full-voltage starter even with supervision and instruction.

CLO 2: Install reduce voltage starter.

5	The student is able to install reduce voltage starter without any supervision and instruction.
4	The student is able to install reduce voltage starter with limited supervision but no instruction.
3	The student is able to install reduce voltage starter with limited supervision and limited instruction.
2	The student has difficulty to install reduce voltage starter and requires considerable supervision and instruction.
1	The student is unable to install reduce voltage starter even with supervision and instruction.

CLO 3: Install wye-delta starter.

5	The student is able to install wye-delta starter without any supervision and instruction.
4	The student is able to install wye-delta starter with limited supervision but no instruction.
3	The student is able to install wye-delta starter with limited supervision and limited instruction.
2	The student has difficulty to install wye-delta starter and requires considerable supervision and instruction.
1	The student is unable to install wye-delta starter even with supervision and instruction.

CLO 4: Install sequential/compelling controls.

5	The student is able to install sequential/compelling controls without any supervision and instruction.
4	The student is able to install sequential/compelling controls with limited supervision but no instruction.
3	The student is able to install sequential/compelling controls with limited supervision and limited instruction.
2	The student has difficulty to troubleshoot and repair electric motors and requires considerable supervision and instruction.
1	The student is unable to install sequential/compelling controls even with supervision and instruction.

CLO 5: Apply typical approaches in troubleshooting, repair and maintenance motor control circuits.

5	The student is able to apply typical approaches in troubleshooting repair and maintenance of motor control circuits without any supervision and instruction.
4	The student is able to apply typical approaches in troubleshooting, repair and maintenance of motor control circuits with limited supervision but no instruction.
3	The student is able to apply typical approaches in troubleshooting, repair and maintenance of motor control circuits with limited supervision and limited instruction
2	The student has difficulty to apply typical approaches in troubleshooting, repair and maintenance of motor control circuits and requires considerable supervision and instruction.
1	The student is unable to apply typical approaches in troubleshooting, repair and maintenance of motor control circuits even with supervision and instruction.

MARKING SHEET

ET 210 – Motor Controls and Sequential Controllers

Name of student: _____

Date: _____

CLO1 – INSTALL MAGNETIC FULL-VOLTAGE STARTER

CRITERIA	ALLOTTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	10 or 1		35%
1. Pump motor runs when selector switch HOA is turned to "HAND" position and "START" pushbutton is depressed.	10 or 1		Average of gained points X 10 X 35%
2. Pump motor stops when selector switch HOA is turned to "OFF" position.	10 or 1		
3. Pump motor runs when the selector switch HOA is in "AUTO" position and the water level in the tank falls sufficiently enough to close "ON" float switch.	10 or 1		
4. Pump motor stops when the selector switch HOA is in "AUTO" position and the water level in the tank rise sufficiently enough to open "OFF" float switch.	10 or 1		
5. Pump motor stops upon tripping the motor overload protector "OLP".	10 or 1		
6. The size of wire used in motor power circuit is #12 AWG	10 or 1		
7. The size of wire used in motor control circuit is #16 AWG	10 or 1		
8. 25A circuit protection is installed in motor power circuit.	10 or 1		
9. 10A circuit protection is installed in motor control circuit.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			25%
1. Control panel box is leveled from the side and securely mounted on the wiring board.	10		Average of gained points X 10 X 25%
2. Entry points are secured with appropriate fittings.	10		
3. Magnetic contactors, relays, timers and other components are properly secured inside electrical boxes.	10		
4. Wires are properly terminated on terminal lugs and other electrical components	10		
5. Wires are properly arranged and harnessed inside electrical boxes	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. 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			

MARKING SHEET

ET 210 – Motor Controls and Sequential Controllers

Name of student: _____

Date: _____

CLO2 – INSTALL REDUCE VOLTAGE STARTER

CRITERIA	ALLOTTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	10 or 1		35%
1. Toggling the selector switch HOA to "HAND" and depressing the "START" pushbutton, pump motor runs at 75% of the voltage supply. After 5 seconds, pump motor runs on full-voltage.	10 or 1		Average of gained points X 10 X 35%
2. Pump motor stops when selector switch HOA is turned to "OFF" position.	10 or 1		
3. Toggling the selector switch HOA is in "AUTO" position and the water level in the tank falls sufficiently enough to close "ON" float switch, pump motor runs at 75% of the voltage supply. After 5 seconds, pump motor runs on full-voltage.	10 or 1		
4. Pump motor stops when the selector switch HOA is in "AUTO" position and the water level in the tank rose sufficiently enough to open "OFF" float switch.	10 or 1		
5. Pump motor stops upon tripping the motor overload protector "OLP".	10 or 1		
6. The size of wire used in motor power circuit is #12 AWG	10 or 1		
7. The size of wire used in motor control circuit is #16 AWG	10 or 1		
8. 25A circuit protection is installed in motor power circuit.	10 or 1		
9. 10A circuit protection is installed in motor control circuit.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			25%
1. Control panel box is leveled from the side and securely mounted on the wiring board.	10		Average of gained points X 10 X 25%
2. Entry points are secured with appropriate fittings.	10		
3. Magnetic contactors, relays, timers and other components are properly secured inside electrical boxes.	10		
4. Wires are properly terminated on terminal lugs and other electrical components	10		
5. Wires are properly arranged and harnessed inside electrical boxes	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. 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			

MARKING SHEET

ET 210 – Motor Controls and Sequential Controllers

Name of student: _____

Date: _____

CLO3 – INSTALL WYE-DELTA STARTER

CRITERIA	ALLOTTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	10 or 1		35%
1. Depressing the "START" pushbutton, pump motor runs in WYE connection. After 5 seconds, pump motor runs on DELTA connection.	10 or 1		Average of gained points X 10 X 35%
2. Pump motor stops when selector switch HOA is turned to "OFF" position.	10 or 1		
3. Toggling the selector switch HOA is in "AUTO" position and the water level in the tank falls sufficiently enough to close "ON" float switch, pump motor runs at 75% of the voltage supply. After 5 seconds, pump motor runs in WYE connection. After 5 seconds, pump motor runs on DELTA.	10 or 1		
4. Pump motor stops when the selector switch HOA is in "AUTO" position and the water level in the tank rose sufficiently enough to open "OFF" float switch.	10 or 1		
5. Pump motor stops upon tripping the motor overload protector "OLP".	10 or 1		
6. The size of wire used in motor power circuit is #12 AWG	10 or 1		
7. The size of wire used in motor control circuit is #16 AWG	10 or 1		
8. 25A circuit protection is installed in motor power circuit.	10 or 1		
9. 10A circuit protection is installed in motor control circuit.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			25%
1. Control panel box is leveled from the side and securely mounted on the wiring board.	10		Average of gained points X 10 X 25%
2. Entry points are secured with appropriate fittings.	10		
3. Magnetic contactors, relays, timers and other components are properly secured inside electrical boxes.	10		
4. Wires are properly terminated on terminal lugs and other electrical components	10		
5. Wires are properly arranged and harnessed inside electrical boxes	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. 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			

MARKING SHEET

ET 210 – Motor Controls and Sequential Controllers

Name of student: _____

Date: _____

CLO4 – INSTALL SEQUENTIAL/COMPELLING CONTROLS

CRITERIA	ALLOTTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	10 or 1		35%
1. Pump 1 runs when selector switch HOA 1 is turned to "HAND" position.	10 or 1		Average of gained points X 10 X 35%
2. Pump 2 runs when selector switch HOA 2 is turned to "HAND" position.	10 or 1		
3. Pump 1 runs when the selector switch HOA 1 is in "AUTO" position provided the water level falls sufficiently enough to close "OFF" and "LEAD" float switches.	10 or 1		
4. While pump 1 is running and HOA 2 selector switch is in "AUTO" position, pump 2 will run if the water falls sufficiently enough to close "LAG" float switch	10 or 1		
5. Pump 2 turns off when the water rises to a level sufficiently opening the "LAG" float switch.	10 or 1		
6. Pump 1 turns off when the water rises to a level sufficiently opening the "OFF" float switch.	10 or 1		
7. Pump 1 stop upon tripping the motor overload protector "OLP1".	10 or 1		
8. Pump 2 stop upon tripping the motor overload protector "OLP2".	10 or 1		
9. The size of wire used in motor power circuit is #12 AWG	10 or 1		
10. The size of wire used in motor control circuit is #16 AWG	10 or 1		
11. The size of circuit protection for motor power circuit is 25A	10 or 1		
12. The size of circuit protection for motor control circuit is 10A	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			25%
1. Control panel box is leveled from the side and securely mounted on the wiring board.	10		Average of gained points X 10 X 25%
2. Entry points are secured with appropriate fittings.	10		
3. Magnetic contactors, relays, timers and other components are properly secured inside electrical boxes.	10		
4. Wires are properly terminated on terminal lugs and other electrical components	10		
5. Wires are properly arranged and harnessed inside electrical boxes	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. 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			

MARKING SHEET
ET 210 – Motor Controls and Sequential Controllers

Name of student: _____

Date: _____

CLO5 – APPLY TYPICAL APPROACHES IN TROUBLESHOOTING AND REPAIRING MOTOR CONTROL CIRCUITS

CRITERIA	ALLOTTED POINTS	GAINED POINTS	FINAL GRADE
ACCURACY	10 or 1		35%
1. Troubles are analyzed with the aid of blueprints and schematic diagrams.	10 or 1		Average of gained points X 10 X 35%
2. Defective components identified to be the cause of trouble is tested and confirmed to be defective using appropriate testing and measuring instruments.	10 or 1		
3. Ground fault on the circuit is located and rectified according to best practices	10 or 1		
4. Short circuit is located and corrected in accordance with the best practices	10 or 1		
5. Rectified circuit is tested using appropriate testing and measuring instrument before re-energizing.	10 or 1		
6. Circuit worked the way it used to be after necessary rectification is done.	10 or 1		
QUALITY OF WORK (WORKMANSHIP)			25%
1. Defective components are taken out of the circuit without making any further damage to other components	10		Average of gained points X 10 X 25%
2. Defective components are replaced and re-mounted in place according.	10		
3. Wires/Conductors are re-harnessed after replacing defective components.	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. 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			

Assessor

MARKING GUIDE

CRITERIA	
ACCURACY	
CLO1	– Install magnetic full-voltage starter
CLO2	– Install reduce voltage starter.
CLO3	– Install wye-delta starter
CLO4	– Install sequential/compelling controls
CLO5	– Apply typical approaches in troubleshooting and repairing motor control circuits
	• 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)	
1.	Control panel box is leveled from the side and securely mounted on the wiring board.
	• 5 points deduction if the box is not leveled.
	• 5 points deduction if the box is not securely mounted.
2.	Entry points are secured with appropriate fittings.
	• 2 points deduction for every entry point not secured with appropriate fittings.
3.	Magnetic contactors, relays, timers and other components are properly secured inside electrical boxes.
	• 2 points deduction for every component not properly secured.
4.	Wires are properly terminated on terminal lugs and other electrical components
	• 2 points deduction for every wire not properly terminated.
5.	Wires are properly arranged and harnessed inside electrical boxes
	• 2 points deduction for every wirings not secured by tie wires/clamps
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