

**SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY**  
**SAULT STE. MARIE, ON**

**COURSE OUTLINE**  
**ELECTRICAL APPRENTICESHIP**  
**ELECTRONIC CONTROLS**

**COURSE TITLE: ELECTRONIC LAB**

**CODE NO.: ELT 902**

**SEMESTER: \_\_\_\_\_**

**PROGRAM: ELECTRICAL APPRENTICESHIP**

**AUTHOR: RON CHARTRAND**

**DATE: DEC. 1, 1994**

**PREVIOUS OUTLINE DATED: \_\_\_\_\_**

*W Filipowich Dec 15/94*

**APPROVED: J.P. Choquette**  
**DEAN**

**DATE 94-12-19**

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# DC DRIVE SYSTEMS

DC DRIVE SYSTEMS  
COURSE NAME

ELT 902  
CODE NO.

TOTAL CREDITS 5 5HR / WEEK FOR 8 WEEKS TOTAL 40 HRS

PREREQUISITE(S): COMPLETION OF ADVANCE ELECTRICAL APPRENTICESHIP COURSE

**I. PHILOSOPHY/GOALS:** This course is a study of the principles and techniques of modern DC DRIVE SYSTEMS. The student will gain an understanding of functions, power components and circuits related to DC DRIVES.

## **II. STUDENT PERFORMANCE OBJECTIVES (OUTCOMES):**

Upon successful completion of this course the student will:

- 1) Distinguish between AC and DC Drive systems
- 2) Identify different DC Drive System components and circuits
- 3) Identify and understand the function of power semiconductor devices
- 4) Identify protection components and circuits
- 5) Test and Troubleshoot power semiconductors and DC Drive power circuits
- 6) Understand proper preventive maintenance procedures and programs
- 7) Understand the basic operation of single phase converter drives
- 8) Understand the basic operation of three phase semi-converters, full converters, and dual converters
- 9) Understand the principles of regenerative brake control and rheostatic brake control
- 10) Understand the basic operation chopper control
- 11) Understand the operation of phase locked loops
- 12) Identify and describe the difference between a DC Drive that uses open-loop control and one that uses close-loop control
- 13) Identify the differences of analog DC drive and Microcomputer Control of DC Drives
- 14) Understand the basic functions of three phase firing circuits
- 15) Understand operational amplifier control circuits such as Integrators, Differentiators, Summing Amplifiers, Speed Error Amplifiers, Oscillators, Comparators
- 16) Understand the limitations and applications of DC Drive Systems.

**III. TOPICS TO BE COVERED: approximate Time (include lab or demonstration time)**

1) Review of DC Motors and their characteristics	2 hr
2) Introduction to DC Motor control	1 hr
3) Introduction to DC Drive Systems	1 hr
4) Introduction to power semiconductors	2 hr
5) Power semiconductor and DC drive power circuit testing and troubleshooting	2 hr
6) Introduction to protective devices and circuitry for DC Drives	1 hr
7) Single phase converters	2 hr
8) Three phase converters	2 hr
9) Regenerative Braking and Rheostatic Braking	1 hr
10) Chopper Control	2 hr
11) Phase locked loops operation	2 hr
12) Open-loop control	2 hr
13) Close-loop control	2 hr
14) Microcomputer control of DC Drives	2 hr
15) Three phase firing circuits	2 hr
16) Types of operational amplifier control	2 hr
17) Limitations applications programming of DC Drives	<u>12 hr</u>

**TOTAL 40 hr**

**NOTE:**

**These times include theory, lab and tests for this course.**

**DC DRIVE SYSTEMS**  
COURSE NAME

**ELT 902**  
CODE NO.

**IV. LEARNING ACTIVITIES/REQUIRED RESOURCES**

**Topic/Unit -1) Review of DC Motors and their Characteristics**

**Learning Activities:**

**Listen to presentation on DC Motors and specifications.**

**Also discuss DC Motor characteristics**

**Participate in question / answer time for this topic**

**Participate in DC motor lab**

**Resources:**

**Overheads, handouts, and VHS tape.**

**Lab equipment and material**

**Topic/Unit: 2) Introduction to DC Motor Control**

**Learning Activities:**

**Listen to presentation on basic DC solid state Motor control**

**Participate in solving solid state DC motor control lab**

**Participate in question / answer time for this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Lab equipment and material**

**Topic/Unit: 3) Introduction to DC Drive Systems**

**Learning Activities:**

**Listen to presentation on DC Drive Systems**

**Participate in question / answer time for this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Topic/Unit: 4) Introduction to power semiconductors**

**Learning Activities:**

**Listen to presentation on power semiconductor identification and operation**

**Practice using cross referencing catalogue**

**Participate in question / answer time for this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Cross referencing catalogues**

**Topic/Unit: 5) Testing Power Semiconductors**

**Learning Activities:**

**Listen to presentation on proper procedures for testing power semiconductors**

**Participate in question / answer time for this topic**

**Participate in lab activities related to this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Lab equipment and material**

**Topic/Unit: 6) Introduction to protection devices and circuits for DC Drives**

**Learning Activities:**

**Listen to presentation on protection devices and circuits for DC Drives**

**Participate in question / answer time for this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Topic/Unit: 7) Single Phase Converters**

**Learning Activities:**

Listen to presentation on single phase converters.  
Participate in question / answer time for this topic

**Resources:**

Chalkboard, overheads and handouts.

**Topic/Unit: 8) Three Phase Converters**

**Learning Activities:**

Listen to presentation on three phase converters.  
Participate in question / answer time for this topic

**Resources:**

Chalkboard, overheads and handouts.

**Topic/Unit: 9) Braking methods**

**Learning Activities:**

Listen to presentation on regenerative and rheostatic breaking methods  
Participate in question / answer time for this topic

**Resources:**

Chalkboard, overheads and handouts.

**Topic/Unit: 10) Chopper Control**

**Learning Activities:**

Listen to presentation on chopper control  
Participate in question / answer time for this topic

**Resources:**

Chalkboard, overheads and handouts.

**Topic/Unit: 11) Phase locked loops operation**

**Learning Activities:**

**Listen to presentation on phase locked loop operation and use.**

**Participate in question / answer time for this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Topic/Unit: 12) Open-Loop Control**

**Learning Activities:**

**Listen to presentation on open-loop control**

**Participate in question / answer time for this topic**

**Participate in lab activities related to this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Lab equipment and material**

**Topic/Unit: 13) Close-Loop Control**

**Learning Activities:**

**Listen to presentation on close-loop control**

**Participate in question / answer time for this topic**

**Participate in lab activities related to this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Lab equipment and material.**

**Topic/Unit: 14) Microcomputer Control of DC Drives**

**Learning Activities:**

**Listen to presentation on microcomputer control of DC Drives**

**Participate in question / answer time for this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Topic/Unit: 15) Three Phase Firing Circuits**

**Learning Activities:**

**Listen to presentation on three phase firing circuits**

**Participate in question / answer time for this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Topic/Unit: 16) Types of Operational Amplifiers**

**Learning Activities:**

**Listen to presentation on different types of operational amplifiers**

**Participate in question / answer time for this topic**

**Resources:**

**Chalkboard, overheads and handouts.**

**Topic/Unit: 17) Limitations Applications and Programming of DC Drives**

**Learning Activities:**

**Listen to presentation on limitations and applications of DC Drives**

**Participate in question / answer time for this topic**

**Participate in labs related to operation of DC Drives**

**Resources:**

**Chalkboard, overheads and handouts.**

**Lab equipment and material**

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**DC DRIVE SYSTEMS**  
**COURSE NAME**

**ELT 902**  
**CODE NO.**

**V. EVALUATION METHODS:**

**MAY INCLUDE WRITTEN TESTS, PRACTICAL TESTS, ASSIGNMENTS, QUIZZES, ATTENDANCE REQUIREMENTS, ETC.) Your instructor reserves the right to use all, or a selection of the above mentioned evaluation methods.**

**A final grade will be derived as follows:**

<b>All written tests for theory portion of course May include quizzes or oral testing at the discretion of the instructor.</b>	<b>20%</b>
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<b>All assignments, lab written assignments, lab projects and practical tests. Your instructor reserves the right to use all, or a selection of the above mentioned evaluation methods.</b>	<b>80%</b>
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**TOTAL 100%**

**The number and types of written tests and other forms of evaluation will be set by the instructor at the beginning of the Electronic Control Course.**

**VI. REQUIRED STUDENT RESOURCES:** Will be indicated by the instructor at the beginning of the course if he/she deems one necessary.

**VII. ADDITIONAL RESOURCE MATERIALS AVAILABLE IN THE COLLEGE LIBRARY:**

**Book Section (TITLE, PUBLISHER, EDITION, DATE, LIBRARY CALL NUMBER IF APPLICABLE) Will be indicated by the instructor at the beginning of the course if he/she deems it necessary.**

**VIII. SPECIAL NOTES**

**Students with special needs (eg. physical limitations, visual impairments, hearing impairments, learning disabilities) are encouraged to discuss required accommodations confidentially with the instructor.**

**If a student is absent or misses a test of any kind, he / she will receive a mark of zero ( 0 ) for that particular test, unless he / she has made prior arrangements and agreement with the instructor , or the student has a doctor slip indicating that he /she was unable to attend the testing time due to illness.**

**Your instructor reserves the right to issue a make up test if he / she feels that the situation warrants a make up test, other wise no make up tests will be issued.**

**Lab attendance is compulsory and is included in the evaluation process.**

**Your instructor reserves the right to modify the course or change resource presentation material as he/she deems necessary to meet the needs of students.**

**X. COURSE ANALYSIS SHEET (see attached)**

**COURSE ANALYSIS FORM**

**ELECTRICAL APPRENTICESHIP**

**ELECTRONIC CONTROL**

<b>COURSE TITLE AND NO.</b>		
<b>ELECTRONIC THEORY ELT 902 DC DRIVE SYSTEMS</b>		
<b>LEARNING OUTCOMES</b>	<b>BROAD AREAS OF CONTENT</b>	<b>INDICATORS OF SUCCESS</b>
<p>1. Explain the operation of a DC motor.</p> <p>2. Calculate the speed of a DC motor.</p> <p>3. Explain the effect of armature reaction.</p> <p>4. Calculate the induced EMF of a DC motor.</p> <p>5. Explain the effect of field weakening.</p> <p>6. Calculate the speed of a DC motor with field weakening.</p> <p>7. Explain the operation of a DC generator.</p> <p>8. Calculate the induced EMF of a DC generator.</p> <p>9. Explain the effect of armature reaction.</p> <p>10. Calculate the induced EMF of a DC generator with field weakening.</p>	<p>1. DC Motor</p> <p>2. DC Generator</p> <p>3. Armature Reaction</p> <p>4. Field Weakening</p>	<p>1. Explain the operation of a DC motor.</p> <p>2. Calculate the speed of a DC motor.</p> <p>3. Explain the effect of armature reaction.</p> <p>4. Calculate the induced EMF of a DC motor.</p> <p>5. Explain the effect of field weakening.</p> <p>6. Calculate the speed of a DC motor with field weakening.</p> <p>7. Explain the operation of a DC generator.</p> <p>8. Calculate the induced EMF of a DC generator.</p> <p>9. Explain the effect of armature reaction.</p> <p>10. Calculate the induced EMF of a DC generator with field weakening.</p>

**ASSESSMENT PROCESS**

**ASSESSMENT TOOLS**

**SUPPORTS**

**REQUIREMENTS FOR SUCCESSFUL COMPLETION**

**SIGNATURES:**

**PROFESSOR** \_\_\_\_\_

**PROGRAM COORDINATOR OR DEAN** \_\_\_\_\_

**DATE** \_\_\_\_\_

**DATE** \_\_\_\_\_

## AC DRIVE SYSTEMS

AC DRIVE SYSTEMS  
COURSE NAME

ELT 902  
CODE NO.

TOTAL CREDITS 5 5HR / WEEK FOR 8 WEEKS TOTAL 40 HRS

PREREQUISITE(S): COMPLETION OF ADVANCE ELECTRICAL APPRENTICESHIP COURSE

**I. PHILOSOPHY/GOALS:** This course is a study of the principles and techniques of modern AC DRIVE SYSTEMS. The student will gain an understanding of basic operation and applications.

### II. STUDENT PERFORMANCE OBJECTIVES (OUTCOMES):

Upon successful completion of this course the student will:

- 1) Distinguish between AC and DC Drive systems
- 2) Identify different AC Drive System components and circuits
- 3) Identify and understand the function of power semiconductor devices used in AC Drives
- 4) Identify protection components and circuits used in AC Drives such as  $dv / dt$  and  $di /dt$  circuits
- 5) Test and Troubleshoot power semiconductors and AC Drive power circuits
- 6) Understand proper preventive maintenance procedures and programs
- 7) Understand the basic operation of AC Drives
- 8) Understand the basic operation of three phase converters, and inverters
- 11) Understand the principles of Voltage Control and Variable Frequency Control
- 12) Understand the basic operation Six Step Inverters ( VVI )
- 13) Understand the operation of Current Source Inverter ( CSI )
- 14) Understand the operation of Pulse-Width Modulation Inverter ( PWM )
- 15) Identify and describe the difference between a AC Drives types mentioned above
- 16) Connect and program selected AC drives in the lab using hand held programmers and PC based software programs
- 17) Understand the basic functions of AC Drive control circuits
- 18) Understand VCO, VFC and Counter Circuits
- 19) Understand the limitations and applications of AC Drive Systems.

**III. TOPICS TO BE COVERED: ( approximate Time (include lab or demonstration time)**

1) Review of AC Motors and their characteristics	2 hr
2) Introduction to AC Motor control	1 hr
3) Introduction to AC Drive Systems Block Diagram	1 hr
4) Introduction to AC Drive power semiconductors	1 hr
5) Power semiconductor and AC drive power circuit testing and troubleshooting	1 hr
6) Basic operation of AC Drives	2 hr
7) Three phase converters and inverter basic function	1 hr
8) Solid State Voltage control of AC Motors	1 hr
9) Basic operation of Six Step Inverters	3 hr
10) Basic operation of Current Source Inverters	3 hr
11) Basic operation of Pulse Width Modulation Inverters	3 hr
12) Basic operation AC Drive control circuits	1hr
13) Basic operation of VOC and VFC	1 hr
14) Basic operation of counter circuit	1 hr
15) Limitations applications programming of AC Drives	<u>18 hr</u>
<b>TOTAL</b>	<b>40 hr</b>

**NOTE:**

**These times include theory, lab and tests for this course.**

**Topic/Unit 1) Review of AC Motors and their characteristics****Learning Activities:**

**Listen to presentation on AC Motors and their characteristics**

**Discuss the use of AC motors**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit -2) Introduction to AC Motor control****Learning Activities:**

**Listen to presentation on basic AC Motor control**

**Discuss the use of AC Motor control systems**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit - 3) Introduction to AC Drive Systems****Learning Activities:**

**Listen to presentation on AC Drive Systems block functions**

**Draw AC Drive Block Diagrams**

**Discuss the functions of each block**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit - 4) Introduction to AC Drive power semiconductors**

**Learning Activities:**

- Listen to presentation on AC Drive power semiconductors**
- Discuss the use of these components and how they relate to the AC Drive**
- Participate in questions / answer time for the topic**
- Participate in lab activities related to this topic**

**Resources:**

- Handouts, Overheads, Chalkboard**
- Lab Equipment and Material**

**Topic/Unit - 5) Power semiconductor and AC drive power circuit testing and troubleshooting**

**Learning Activities:**

- Listen to presentation on testing and troubleshooting power semiconductor and AC drive power circuit**
- Discuss the use of testing equipment**
- Participate in questions / answer time for the topic**
- Participate in lab activities related to this topic**

**Resources:**

- Handouts, Overheads, Chalkboard**
- Lab Equipment and Material**

**Topic/Unit -6) Basic operation of AC Drives**

**Learning Activities:**

- Listen to presentation on basic operation of AC Drives**
- Participate in questions / answer time for the topic**

**Resources:**

- Handouts, Overheads, Chalkboard**

**Topic/Unit -7) Three phase converters and inverter basic function**

**Learning Activities:**

**Listen to presentation on three phase converters and inverter basic function**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit - 8) Solid State Voltage control of AC Motors**

**Learning Activities:**

**Listen to presentation on Solid State Voltage control of AC Motors**

**Participate in lab activities related to this topic**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Lab Equipment and Material**

**Topic/Unit -9) Basic operation of Six Step Inverters**

**Learning Activities:**

**Listen to presentation on the basic operation of Six Step Inverter**

**Discuss the use of the Six Step Inverter**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit -10) Basic operation of Current Source Inverters**

**Learning Activities:**

**Listen to presentation on the basic operation of Current Source Inverters**

**Discuss the use of Current Source Inverters**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit -11) Basic operation of Pulse Width Modulation Inverters**

**Learning Activities:**

**Listen to presentation on the basic operation of Pulse Width Modulation Inverters**

**Discuss the use of Pulse Width Modulation Inverters**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit -12) Basic operation AC Drive control circuits**

**Learning Activities:**

**Listen to presentation on the basic operation AC Drive control circuits**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit -13) Basic operation of VOC and VFC**

**Learning Activities:**

**Listen to presentation on the basic operation of VOC and VFC**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit -14) Basic operation of counter circuit**

**Learning Activities:**

**Listen to presentation on the basic operation of Counter circuit**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit -15) Limitations, applications and programming of AC Drives**

**Learning Activities:**

**Listen to presentation on the Limitations, applications and programming of AC Drives**

**Participate in labs that relate to programming of AC Drives**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Lab Equipment and Material**

**AC DRIVE SYSTEMS**  
**COURSE NAME**

**ELT 902**  
**CODE NO.**

**V. EVALUATION METHODS:**

**MAY INCLUDE WRITTEN TESTS, PRACTICAL TESTS, ASSIGNMENTS, QUIZZES, ATTENDANCE REQUIREMENTS, ETC.) Your instructor reserves the right to use all, or a selection of the above mentioned evaluation methods.**

**A final grade will be derived as follows:**

<b>All written tests for theory portion of course May include quizzes or oral testing at the discretion of the instructor.</b>	<b>10%</b>
<b>All assignments, lab written assignments, lab projects and practical tests. Your instructor reserves the right to use all, or a selection of the above mentioned evaluation methods.</b>	<b>90%</b>

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**TOTAL 100%**

**The number and types of written tests and other forms of evaluation will be set by the instructor at the beginning of the Electronic Control Course.**

**VI. REQUIRED STUDENT RESOURCES: Will be indicated by the instructor at the beginning of the course if he/she deems one necessary.**

**VII. ADDITIONAL RESOURCE MATERIALS AVAILABLE IN THE COLLEGE LIBRARY:**

**Book Section (TITLE, PUBLISHER, EDITION, DATE, LIBRARY CALL NUMBER IF APPLICABLE) Will be indicated by the instructor at the beginning of the course if he/she deems it necessary.**

**VIII. SPECIAL NOTES**

**Students with special needs (eg. physical limitations, visual impairments, hearing impairments, learning disabilities) are encouraged to discuss required accommodations confidentially with the instructor.**

**Lab attendance is compulsory and is included in the evaluation process.**

**Your instructor reserves the right to modify the course as he/she deems necessary to meet the needs of students.**

**IX. COURSE ANALYSIS SHEET (see attached)**

COURSE ANALYSIS FORM

ELECTRICAL APPRENTICESHIP

ELECTRONIC CONTROLS

COURSE TITLE AND NO. ELECTRONIC THEORY ELT 902 AC DRIVE SYSTEMS		
LEARNING OUTCOMES	BROAD AREAS OF CONTENT	INDICATORS OF SUCCESS
<p>1. Explain the operation of a three-phase induction motor.</p> <p>2. Calculate the synchronous speed of a three-phase induction motor.</p> <p>3. Explain the effect of slip on the speed of a three-phase induction motor.</p> <p>4. Calculate the torque of a three-phase induction motor.</p> <p>5. Explain the effect of rotor resistance on the torque of a three-phase induction motor.</p> <p>6. Calculate the maximum torque of a three-phase induction motor.</p> <p>7. Explain the effect of rotor reactance on the maximum torque of a three-phase induction motor.</p> <p>8. Calculate the starting current of a three-phase induction motor.</p> <p>9. Explain the effect of starting current on the starting torque of a three-phase induction motor.</p> <p>10. Calculate the starting torque of a three-phase induction motor.</p> <p>11. Explain the effect of starting torque on the starting current of a three-phase induction motor.</p> <p>12. Calculate the maximum starting current of a three-phase induction motor.</p> <p>13. Explain the effect of maximum starting current on the maximum starting torque of a three-phase induction motor.</p> <p>14. Calculate the maximum starting torque of a three-phase induction motor.</p> <p>15. Explain the effect of maximum starting torque on the maximum starting current of a three-phase induction motor.</p> <p>16. Calculate the maximum starting current of a three-phase induction motor.</p> <p>17. Explain the effect of maximum starting current on the maximum starting torque of a three-phase induction motor.</p> <p>18. Calculate the maximum starting torque of a three-phase induction motor.</p> <p>19. Explain the effect of maximum starting torque on the maximum starting current of a three-phase induction motor.</p> <p>20. Calculate the maximum starting current of a three-phase induction motor.</p>	<p>1. Induction Motor</p> <p>2. Synchronous Speed</p> <p>3. Slip</p> <p>4. Torque</p> <p>5. Rotor Resistance</p> <p>6. Maximum Torque</p> <p>7. Rotor Reactance</p> <p>8. Starting Current</p> <p>9. Starting Torque</p> <p>10. Maximum Starting Current</p> <p>11. Maximum Starting Torque</p> <p>12. Maximum Starting Current</p> <p>13. Maximum Starting Torque</p> <p>14. Maximum Starting Current</p> <p>15. Maximum Starting Torque</p> <p>16. Maximum Starting Current</p> <p>17. Maximum Starting Torque</p> <p>18. Maximum Starting Current</p> <p>19. Maximum Starting Torque</p> <p>20. Maximum Starting Current</p>	<p>1. Explain the operation of a three-phase induction motor.</p> <p>2. Calculate the synchronous speed of a three-phase induction motor.</p> <p>3. Explain the effect of slip on the speed of a three-phase induction motor.</p> <p>4. Calculate the torque of a three-phase induction motor.</p> <p>5. Explain the effect of rotor resistance on the torque of a three-phase induction motor.</p> <p>6. Calculate the maximum torque of a three-phase induction motor.</p> <p>7. Explain the effect of rotor reactance on the maximum torque of a three-phase induction motor.</p> <p>8. Calculate the starting current of a three-phase induction motor.</p> <p>9. Explain the effect of starting current on the starting torque of a three-phase induction motor.</p> <p>10. Calculate the starting torque of a three-phase induction motor.</p> <p>11. Explain the effect of starting torque on the starting current of a three-phase induction motor.</p> <p>12. Calculate the maximum starting current of a three-phase induction motor.</p> <p>13. Explain the effect of maximum starting current on the maximum starting torque of a three-phase induction motor.</p> <p>14. Calculate the maximum starting torque of a three-phase induction motor.</p> <p>15. Explain the effect of maximum starting torque on the maximum starting current of a three-phase induction motor.</p> <p>16. Calculate the maximum starting current of a three-phase induction motor.</p> <p>17. Explain the effect of maximum starting current on the maximum starting torque of a three-phase induction motor.</p> <p>18. Calculate the maximum starting torque of a three-phase induction motor.</p> <p>19. Explain the effect of maximum starting torque on the maximum starting current of a three-phase induction motor.</p> <p>20. Calculate the maximum starting current of a three-phase induction motor.</p>

**ASSESSMENT PROCESS**

**ASSESSMENT TOOLS**

**SUPPORTS**

**REQUIREMENTS FOR SUCCESSFUL COMPLETION**

**SIGNATURES:**

\_\_\_\_\_  
**PROFESSOR**

\_\_\_\_\_  
**PROGRAM COORDINATOR OR DEAN**

\_\_\_\_\_  
**DATE**

\_\_\_\_\_  
**DATE**

## PLC CONTROL SYSTEMS

PLC CONTROL SYSTEMS  
COURSE NAME

ELT 902  
CODE NO.

TOTAL CREDITS 5 5HR / WEEK FOR 8 WEEKS TOTAL 40 HRS

PREREQUISITE(S): COMPLETION OF ADVANCE ELECTRICAL APPRENTICESHIP COURSE

**I. PHILOSOPHY/GOALS:** This course is a study of the principles and techniques of modern PLC CONTROL SYSTEMS. The student will gain an understanding of basic operation and applications.

### II. STUDENT PERFORMANCE OBJECTIVES (OUTCOMES):

Upon successful completion of this course the student will:

- 1) Identify PLC SYSTEMS components
- 2) Understand the function and the electrical connection of PLC System components
- 3) Select and install PLC's
- 4) Determine power and I/O requirements
- 5) Understand Peer to Peer communication
- 6) Understand DCS as it relates to PLC systems
- 7) Demonstrate programming of selected PLCs through selected software run PCs
- 8) Understand Analog In and Analog Out cards as it relates to PLCs
- 9) Understand Timers, Counters, Sequencers, Limit Test, Compare Function, Move Function, Data manipulation, Math Functions and PID Functions
- 10) Understand instrumentation interfacing and scaling
- 11) Understand proper installation and troubleshooting procedures
- 12) Demonstrate Troubleshooting techniques in PLC based software

**III. TOPICS TO BE COVERED:** approximate Time (include lab or demonstration time)

- |   |             |
|---|-------------|
| 1) PLC SYSTEMS components   | 1 hr        |
| 2) Select and install PLC's components  | 1 hr        |
| 3) Determine power and I/O requirements   | 1/2 hr      |
| 4) Programming PLCs using AB 6200 software for PLC-5/25s  | 12 hr       |
| 5) Peer to Peer communication, and DCS Systems for PLCs   | 1/2 hr      |
| 6) Timers, Counters, Sequencers, Limit Test,<br>Compare Function, Move Function, Data manipulation,<br>Math Functions and PID Functions | 10 hr       |
| 7) Slick 500 series software  | 2 hr        |
| 8) Analog In and Analog Out cards for PLCs 503 series   | 6 hr        |
| 9) Instrumentation interfacing and scaling using the 503 series PLCs  | 6 hr        |
| 10) Proper installation and troubleshooting procedures  | <u>2 hr</u> |

**TOTAL 40 hr**

**NOTE:**

**These times include theory, lab and tests for this course.**

**PLC CONTROL SYSTEMS**  
**COURSE NAME**

**ELT 902**  
**CODE NO.**

**IV. LEARNING ACTIVITIES/REQUIRED RESOURCES**

**Topic/Unit - 1) PLC SYSTEMS components**

**Learning Activities:**

**Listen to presentation on PLC System Components**

**Discuss the use of PLCs and how they relate to the electrical trade**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit: 2) Select and install PLC's components**

**Learning Activities:**

**Listen to presentation on how to select and install PLCs**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit - 3) Determine power and I/O requirements**

**Learning Activities:**

**Listen to presentation on how to determine power and I/O requirements**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit -4) Programming PLCs using AB 6200 software for PLC-5/25s**

**Learning Activities:**

**Listen to presentation on how to use AB 6200 software with PLC 5/25**

**Discus different software packages available**

**Participate in lab activities related to this topic**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Lab Equipment and Material**

**Topic/Unit -5) Peer to Peer communication, and DCS Systems for PLCs**

**Learning Activities:**

**Listen to presentation on Distributed Control Systems and Peer to Peer communication**

**Discus the use of distributed control systems and Peer to Peer communication systems.**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Topic/Unit -6) Understand Timers, Counters, Sequencers, Limit Test, Compare Function, Move Function, Data manipulation, Math Functions and PID Functions**

**Learning Activities:**

**Listen to presentation on Timers, Counters, Sequencers, Limit Test, Compare, Move, Math, PID Function, and Data Manipulation.**

**Participate in questions / answer time for the topic**

**Participate in lab activities related to this topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Lab Equipment and Material**

**Topic/Unit - 7) Slick 500 series software**

**Learning Activities:**

**Listen to presentation on AB Slick 500 series software and hardware**

**Participate in questions / answer time for the topic**

**Participate in lab activities related to this topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Lab Equipment and Material**

**Topic/Unit - 8) Analog In and Analog Out cards for PLCs 503 series**

**Learning Activities:**

**Listen to presentation on Analog In and Analog Out cards for PLCs 503 series**

**Discuss the use of these cards and how they relate to the electrical trade**

**Participate in questions / answer time for the topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Lab Equipment and Material**

**Topic/Unit - 9) Instrumentation interfacing and scaling using the 503 series PLCs**

**Learning Activities:**

**Listen to presentation on Instrumentation interfacing and scaling using the 503 series PLCs**

**Participate in questions / answer time for the topic**

**Participate in lab activities related to this topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Lab Equipment and Material**

**Topic/Unit - 10) Proper installation and troubleshooting procedures**

**Learning Activities:**

**Participate in lab activities related to this topic**

**Resources:**

**Handouts, Overheads, Chalkboard**

**Lab Equipment and Material**

**PLC CONTROL SYSTEMS**  
**COURSE NAME.**

**ELT 902**  
**CODE NO.**

**V. EVALUATION METHODS:**

**MAY INCLUDE WRITTEN TESTS, PRACTICAL TESTS, ASSIGNMENTS, QUIZZES, ATTENDANCE REQUIREMENTS, ETC.) Your instructor reserves the right to use all, or a selection of the above mentioned evaluation methods.**

**A final grade will be derived as follows:**

<b>All written tests for theory portion of course May include quizzes or oral testing at the discretion of the instructor.</b>	<b>10%</b>
<b>All assignments, lab written assignments, lab projects and practical tests. Your instructor reserves the right to use all, or a selection of the above mentioned evaluation methods.</b>	<b>90%</b>

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**TOTAL 100%**

**The number and types of written tests and other forms of evaluation will be set by the instructor at the beginning of the Electronic Control Course.**

**ELECTRICAL APPRENTICESHIP GRADING:**

**A---85 TO 100%**  
**B---75 TO 84%**  
**C---60 TO 74%**  
**D---55 TO 59%**  
**F--- UNDER 55% FAIL**

**ELECTRONIC CONTROLS IS AN EIGHT WEEK COURSE WITH 30 HOURS PER WEEK INSTRUCTION.**

**THEIR ARE TWO REPORTABLE SUBJECT WHICH CONTAIN ALL THE AREAS OF INSTRUCTION AS OUTLINED BELOW AND THEIR OVERALL MARK %.**

**REPORTABLE COURSE #ELT 901 COMMUNICATION & COMPUTERS SYSTEMS**

<b>CONTAINS :</b>	<b>(1) DIGITAL ELECTRONICS THEORY AND LAB</b>	<b>5HRS</b>	<b>33%</b>
	<b>(2) FIBRE OPTICS THEORY AND LAB</b>	<b>3HRS</b>	<b>20%</b>
	<b>(3) DATA COMMUNICATIONS</b>	<b>1HRS</b>	<b>7%</b>
	<b>(4) LASERS</b>	<b>1HRS</b>	<b>7%</b>
	<b>(5) INDUSTRIAL COMPUTER CONTROLS</b>	<b>5HRS</b>	<b>33%</b>
	<b>TOTAL</b>	<b>15HRS</b>	<b>100%</b>

**REPORTABLE COURSE # ELT 902 CONTROL & POWER ELECTRONICS**

<b>CONTAINS :</b>	<b>(1) DC DRIVES THEORY AND LAB</b>	<b>5HRS</b>	<b>33%</b>
	<b>(2) AC DRIVES THEORY AND LAB</b>	<b>5HRS</b>	<b>33%</b>
	<b>(3) PLC CONTROL THEORY AND LAB</b>	<b>5HRS</b>	<b>34%</b>
	<b>TOTAL</b>	<b>15HRS</b>	<b>100%</b>

**VI. REQUIRED STUDENT RESOURCES:** Will be indicated by the instructor at the beginning of the course if he/she deems one necessary.

**VII. ADDITIONAL RESOURCE MATERIALS AVAILABLE IN THE COLLEGE LIBRARY:**

**Book Section (TITLE, PUBLISHER, EDITION, DATE, LIBRARY CALL NUMBER IF APPLICABLE)** Will be indicated by the instructor at the beginning of the course if he/she deems it necessary.

**VIII. SPECIAL NOTES**

**Students with special needs (eg. physical limitations, visual impairments, hearing impairments, learning disabilities) are encouraged to discuss required accommodations confidentially with the instructor.**

**Lab attendance is compulsory and is included in the evaluation process.**

**Your instructor reserves the right to modify the course as he/she deems necessary to meet the needs of students.**

**IX. COURSE ANALYSIS SHEET (see attached)**

**COURSE ANALYSIS FORM**

**ELECTRICAL APPRENTICESHIP**

**ELECTRONIC CONTROLS**

COURSE TITLE AND NO.      ELECTRONIC THEORY    ELT 902    PLC CONTROL SYSTEMS		
LEARNING OUTCOMES	BROAD AREAS OF CONTENT	INDICATORS OF SUCCESS

**ASSESSMENT PROCESS**

**ASSESSMENT TOOLS**

**SUPPORTS**

**REQUIREMENTS FOR SUCCESSFUL COMPLETION**

**SIGNATURES:**

**PROFESSOR** \_\_\_\_\_

**PROGRAM COORDINATOR OR DEAN** \_\_\_\_\_

**DATE** \_\_\_\_\_

**DATE** \_\_\_\_\_

ELECTRICAL APPRENTICESHIP ELECTRONIC CONTROLS

MARK SHEET FOR ELECTRONIC THEORY ELT 902

	STUDENT'S NAME	DC DRIVE MARK OUT OF 33	AC DRIVE MARK OUT OF 33	PLC MARK OUT OF 34	TOTAL MARK OUT OF 100	FINAL GRADE LETTER
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
	<b>AVERAGES</b>					

COULD IN...



