A) COURSE

Course Id:	Course
5702	Circuits and Electric Motors

Class Hours per Week	Lab hours per week	Complementary practices	Credits	Total hour course
3	2	2	8	48

B) GENERAL COURSE INFORMATION:

	EE (IEA)	ME (IM)	MME (IMA)	EME (IME)	MTE (IMT)
Level:					V
Course Type (Required/Elective)					Required
Prerequisite Course:					Electrical Circuits A (5517)
CACEI Classification:					CI

C) COURSE OBJECTIVE

At the end of the course, the student will be capable of:
Apply the principles of operation of single phase and three phase circuits AC, the single phase transformers and of electrical motors DC, the induction motors, the single phase motors, the stepper motors, and the servomotors, in the selection of motors for specific applications.

D) TOPICS (CONTENTS AND METHODOLOGY)

1. ANALYSIS OF SINGLE PHASE POWER IN AC		**8 Hours**
Specific Objective:	**The student will understand the concepts of instantaneous power, average, reactive, apparent and power factor in single phase circuits.**	
1.1 Single phase power. 1.1.1 Average and effective values of a sinusoidal. 1.1.2 Instantaneous power and average power. 1.2 Complex power. 1.2.1 Representation of the complex power. 1.2.2 The power triangle. 1.2.3 Theorem of maximum power transfer. 1.3 Power factor and correction of the power factor		
Readings and other resources	To read the topics of the bibliography is recommended To solve problems suggested by the teacher.	
Teaching Methodologies	Collaborative Learning Problem-based learning	

Learning Activities	Projects To solve problems in the class. Homework Mandatory to make practices in the Lab

2.- THREE PHASE CIRCUITS		**9 Hours**
Specific Objective:	**The student will analyze and apply the concepts related with three phase circuits: the phasor representation, solution methods, transformations and power calculations in balanced conditions.**	
2.1 Balanced three phase systems. 2.1.1 Introduction to the three phase systems 2.1.2 Y-connection. 2.1.3 -connection. 2.1.4 Transformations: Y- , Y- . 2.2 The power triangle and power factor in systems.		
Readings and other resources	To read the topics of the bibliography is recommended To solve problems suggested by the teacher.	
Teaching Methodologies	Collaborative Learning Problem-based learning	
Learning Activities	Projects To solve problems in the class. Homework Mandatory to make practices in the Lab	

3. TRANSFORMERS		**4 Hours**
Specific Objective:	**The student will know the principle of operation of transformers and ranking.**	
3.1 Analysis of the single phase transformer. 3.1.1 Turns ratio of the transformer. 3.1.2 Dot Convention. 3.2 Types and construction of transformers.		
Readings and other resources		
Teaching Methodologies	Presentation of topics by the teacher. Using multimedia resources presenting operating temperature measurement instruments Presentation of application examples to the sensors seen in this topic	
Learning Activities	Investigation of applications using this type of sensor Exercises interpretation of data sheets for these instruments Practices for identification and use of instruments for temperature	

4. PRINCIPLES OF ELECTRICAL MACHINES		**3 Hours**
Specific Objective:	**The student will know the basic principles of conversion of electromagnetic energy**	
4.1 A simple loop in a uniform magnetic field 4.1.1 The voltage induced in a simple rotating loop 4.1.2 The torque induced in a current carrying loop.		
Readings and other resources	To read the topics of the bibliography is recommended To solve problems suggested by the teacher	
Teaching Methodologies	Collaborative Learning Problem-based learning	

Learning Activities	Projects To solve problems in the class. Homework Mandatory to make practices in the Lab

5. DC MOTORS		**8 Hours**
Specific Objective:	**The student will learn the principle of operation of DC motors, the types of motors, torque-speed characteristics and applications, and apply in problems of selection of motors.**	
5.1 Introduction to DC motors. 5.2 The equivalent circuit of a DC motor 5.3 The magnetization curve of a DC machine. 5.5 Separately excited and shunt DC motors. 5.5 The series DC motor. 5.6 The permanent magnet DC motor.		
Readings and other resources	To read the topics of the bibliography is recommended To solve problems suggested by the teacher..	
Teaching Methodologies	Collaborative Learning Problem-based learning	
Learning Activities	Projects To solve problems in the class. Homework Mandatory to make practices in the Lab	

6. INDUCTION MOTORS		**8 Hours**
Specific Objective:	**The student will know the different types of induction motors, application, and operation features, he will understand the practical problems of start, protection and control, and he will learn the methods for solving these problems.**	
6.1 Magnetic field rotation and the development of induced torque. 6.2 Torque-speed curve of the induction motors. 6.3 Types of design of the cage motor and his application. 6.4 Starting induction motors, speed control and protection in induction motors.		
Readings and other resources	To read the topics of the bibliography is recommended To solve problems suggested by the teacher.	
Teaching Methodologies	Collaborative Learning Problem-based learning	
Learning Activities	Projects To solve problems in the class. Homework Mandatory to make practices in the Lab	

7. STEPPER MOTORS, SERVOMOTORS, UNIVERSAL MOTOR AND SINGLE		**8 Hours**
Specific Objective:	**The student will understand the basic principles of operation of stepper motors and servomotors and of the universal motors and single phase induction, and he will apply these principles in the selection of motors for specific applications.**	

7.1 Brushless motor 7.2 Stepper motor. 7.2.1 Principles of operation. 7.2.2 Selection. 7.3 Servomotors. 7.3.1 Principles of operation. 7.3.2 Selection. 7.4 Universal motor. 7.5 Single phase motor.	
Readings and other resources	To read the topics of the bibliography is recommended To solve problems suggested by the teacher.
Teaching Methodologies	Collaborative Learning Problem-based learning
Learning Activities	Projects To solve problems in the class. Homework Mandatory to make practices in the Lab

E) TEACHING AND LEARNING METHODOLOGIES

Presentation by the teacher with the support of audiovisual material.
Analysis theoretical concepts.
Problem-based learning related to motor selection.
Laboratory practices.

F) EVALUATION CRITERIA:

Evaluation:	Schedule	Suggested Form of Evaluation and weighing	Topics
1st Term	Session 16	Exam 85%, Homework 15%,	Units 1 and 2
2nd Term	Session 32	Exam 85%, Homework 15%,	Units 3, 4 and 5
3rd Term	Session 48	Exam 85%, Homework 15%,	Units 6 and 7
Final evaluation		100% (Average of the partial evaluations)	
Other activity:			
Extraordinary Exam	According to schedule	100% Exam	100% of topics
Title Exam	According to schedule	100% Exam	100% of topics
Regularization Exam	According to schedule	100% Exam	100% of topics

G) BIBLIOGRAPHY AND ELECTRONIC RESOURCES

Main Books

a) ROBERT L. BOYLESTAD, Introducción al análisis de circuitos, 12ª Ed., Pearson Educación de México,

2010.

b) S. J, CHAPMAN, 5ª Ed., Máquinas Eléctricas, McGraw Hill, 2011.

c) W. BOLTON, Mecatrónica, 5a Ed., Alfaomega, 2013

Complementary Books

a) JOSEPH A. EDMINISTER, Circuitos Eléctricos, Mc Graw Hill – Schaum. 1970.

b) RICHARD C. DORF, JAMES A. SVOBODA, Circuitos Eléctricos, 9ª Edición, Alfaomega, 2013.

c) WILLIAM H. HAYT, Jr., JACK E. KEMMERLY, STEVEN M. DURBIN, Análisis de Circuitos en Ingeniería, 8a.
d) Edición, Mc Graw-Hill, 2011.

e) P. C. SEN, Principles of Electric Machines and Power Electronics, 3a Ed., John Wiley & Sons, 2013.

f) ENRIQUEZ HARPER, Máquinas Eléctricas, Limusa, 2005.

g) IRVING L KOSOW, Electric Machinery and Transformer, Prentice Hall, 1972

h) S. GRAY, Máquinas Eléctricas y Sistemas Accionadores, Alfaomega, 2000.

i) ANDRZEJ M. PAWLAK, Sensors and Actuators in Mechatronics, Design and Applications, CRC Press Taylor
j) & Francis Group, 2007.

k) DAVID G. ALCIATORE AND MICHAEL B. HISTAND, Introduction to Mechatronics and Measurement Systems, fourth edition, McGraw Hill, 2011.

Internet Links