A) COURSE

Course Id:	Course
5565	Electrical Protections.

Class Hours per Week	Lab hours per week	Complementary practices	Credits	Total hour course
3	2	3	8	48 theory 32 practice

A) General Course Information

	EE (IEA)	ME (IM)	MME (IMA)	EME (IME)	MTE (IMT)
Level:	IX			IX	
Course Type (Required/Elective)	Elective			Elective	
Prerequisite Course:	315 credits			360 credits	
CACEI Classification:	IA			IA	

C) Course Objective

At the end of the course, the student will be capable of:
Determine the protection characteristics of the different parts of an electrical system. You will know the operation and implementation of the various devices used to protect of an electrical systems. You will meet the applicable standards of protection systems. You can make basic studies of adjustment and protection coordination.

D) Topics (Contents and Methodology)

1. Introduction to the protection systems		**3hours**
Specific Objective:	The students apply the basic concepts and tools used in the design of protection systems of electrical power systems.	
1.1.- Introduction and function of the protection. 1.2.- Considerations of the protection problem. 1.3.- General structure of a protection. 1.4.- Properties of the protection. 1.5.- Classification of protections and relays. 1.6.- Need for backup systems. 1.7.- Economic considerations.		
Readings and other resources	Readings of specialized books in the topic [1]-[6].	
Teaching methods	Presentation of topics by the teacher and student exposition.	
Learning activities	Discussion of the topics of unity, simulation using professional programs, laboratory experiments, exercises, problems and readings.	

2. Measurement transformers		**3hours**
Specific Objective:	The student learns to select the transformers used, current and voltage measurement used in the protection schemes.	
2.1.-Introduction. 2.2.- Steady state theory. 2.3.- Current transformers. 2.4.- Voltage transformers.		
Readings and other resources	Readings of specialized books in the topic [1]-[6].	
Teaching methods	Presentation of topics by the teacher and student exposition.	
Learning activities	Discussion of the topics of unity, simulation using professional programs, laboratory experiments, exercises, problems and readings.	

3. Fuses		**3hours**
Specific Objective:	The student learns select fuses to protection.	
3.1.- Introduction. 3.2.- Fuse operating mechanism 3.3.- Arc voltage. 3.4.- Time/current characteristics. 3.5.- Discrimination. 3.6.- Tests of fuses		
Readings and other resources	Readings of specialized books in the topic [1]-[2].	
Teaching methods	Presentation of topics by the teacher and student exposition.	
Learning activities	Discussion of the topics of unity, simulation using professional programs, laboratory experiments, exercises, problems and readings.	

4. Overcurrent relays		**5hours**
Specific Objective:	The student learns to identify overcurrent relays and their application.	
4.1.- Introduction. 4.2.- General considerations. 4.3.- Protection of constant time overcurrent. 4.4.- Protection of reverse time overcurrent. 4.5.- Protection of overcurrent against short circuit to ground in solidly grounded systems.. 4.6.- Overcurrent relay. 4.7.- Application distribution feeders. 4.8.- Protection of three-phase feeders. 4.9.- Overcurrent directional relay 4.10.- Limitations of overcurrent relays.		
Readings and other resources	Readings of specialized books in the topic [1]-[6].	
Teaching methods	Presentation of topics by the teacher and student exposition, team organization and use of the method of problem-based learning.	
Learning activities	Discussion of the topics of unity, simulation using professional programs, laboratory experiments, readings, resolution of problems and exercises, and analyzing real problems.	

5. Distance protection		**6hours**
Specific Objective:	That the student learns to apply the principle of operation and the methodology of calculating the adjustment parameters of the distance protections and connections, basic principles of operation and its effect on power swings.	
5.1.- Principle of operation. 5.2.- Adjustment parameters requirements. 5.3.- Characteristics of the relays of distance in the complex plane. 5.4.- Principle of operation of the relays of monophasic distance. 5.5.- Oscillations effect of power and synchronism losses and methods of shooting block. 5.6.- Protection pilot type of transmission lines.		
Readings and other resources	Readings of specialized books in the topic [1], [2], [4].	
Teaching methods	Presentation of topics by the teacher and student exposition, team organization and use of the method of problem-based learning.	
Learning activities	Discussion of the topics of unity, simulation using professional programs, laboratory experiments, readings, resolution of problems and exercises, and analyzing real problems.	

6. Generators protection		**15hours**
Specific Objective:	That the student learns the fundamentals of the generators protection	
6.1.- Introduction. 6.2.- Protection against short circuit between phases in the stator. 6.3.- Differential percentage relay. 6.4.- Protection against short circuit between turns at the same phase in the stator. 6.5.- Protection against short circuit to ground in the stator. 6.6.- Backup protection against external short circuits. 6.7.- Protection against over balanced loads. 6.8.- Protection against over unbalanced loads. 6.9.- Protection against losses or excitement reduction. 6.10.- Protection against overvoltage. 6.11.- Protection against contacts with ground in the excitement circuit. 6.12.- Protection against motorization.		
Readings and other resources	Readings of specialized books in the topic [1], [2], [4].	
Teaching methods	Presentation of topics by the teacher and student exposition, team organization and use of the method of problem-based learning.	
Learning activities	Discussion of the topics of unity, simulation using professional programs, laboratory experiments, readings, resolution of problems and exercises, and analyzing real problems.	

7. Protection for transformers and buses		**13hours**
Specific Objective:	That the student learns the different schemes of protection and the elements used in transformers and buses.	
7.1.- Differential protection in transformers. 7.2.- Protection against over currents in transformers. 7.3.- Mechanic protection in transformers. 7.4.- Studie cases of transformer protection. 7.5.- Buses protection. 7.6.- Studie cases of buses protection.		
Readings and other resources	Readings of specialized books in the topic [1]-[6].	

Teaching methods	Presentation of topics by the teacher and student exposition, team organization and use of the method of problem-based learning.
Learning activities	Discussion of the topics of unity, simulation using professional programs, laboratory experiments, readings, resolution of problems and exercises, and analyzing real problems.

E) Teaching and learning methodologies

Topics exhibition: analysis and synthesis of the concepts presented in the course syllabus. Modeling exercises and simulation in digital programs in to support meaningful learning, use of tools like online digital platforms, discussion of homework that stimulate the collaborative work in the students, application of exams and develop of lab practices.

The practical proposals for this lab are:

	Name	Objective
1	Voltage measurement transformers	Identify the characteristics and applications of voltage transformers, in particular, the use of three-phase voltage transformers grounded to ground.
2	Current measurement transformers	Identify the characteristics and applications of current transformers.
3	Digital relay of low voltage and overvoltage	Identify the characteristics and applications of overcurrent and low current relays
4	Overcurrent relay of inverse time	Identify the characteristics and applications of the overcurrent relay of inverse time.
5	Overcurrent relay dependent of the direction	Identify the characteristics and applications of the overcurrent relay dependent of the direction, like protection devices in distribution systems.
6	Protection of overcurrent with hardware in the simulation loop	Perform the protection of overcurrent using real time simulation. The student will understand the form of calculating and deposit the parameters to relay.
7	Protection of distance with hardware in the simulation loop	Perform the protection of distance using real time simulation. The student will understand the form of calculating and deposit the parameters to relay.
8	Power directional relay	Identify the characteristics and applications of the Power directional relay.
9	Transformers and buses protection	The goal in this exercise is examine the fundamental theory principles to transformers and buses protection using the differential transformer.

F) Evaluation Criteria

Suggested Form of Evaluation and weighing		Schedule	Include	Weighing
First partial exam				
Theoretical exam: Homework: Coordination practices: Total:	50 % 20 % 30 % 100 %	In the session 14. To the end of unit IV.	Unit I, II III y IV.	29.16 %
Second partial exam		In the session 35. To the end of unit VI.	Unit V y VI.	43.75 %
Theoretical exam: Homework: Coordination practices:	50 % 20 % 30 %			

Total:	100 %			
Third partial exam		In the session 48.	Unit VII.	27.08%
Theoretical exam: Practices transient stability: Homework: Total:	50 % 30 % 20 % 100 %	To the end of unit VII.		
Total				100 .00%
Ordinary exam		The sum of the percentages in each partial.		
Extraordinary exam		Written theoretical exam of all units 100%		
Title exam		Written theoretical exam of all units 100%		
Regularization exam		Written theoretical exam of all units 100%		
Other required academic activities.		Assistance to local conferences, national or international or visits.		

G) Bibliography and Electronic Resources

Main Books

[1] Blackburn, J. L., &Domin, T. J. (2014). Protectiverelaying: principles and applications. CRC press.
[2] Horowitz, S. H., &Phadke, A. G. (2008). *Powersystemrelaying* (Vol. 22). John Wiley&Sons.
[3] Short, T. A. (2014). *Electric powerdistributionhandbook*. CRC press.
[4] Phadke, A. G., &Thorp, J. S. (2009). *Computerrelayingforpowersystems*. John Wiley&Sons.
[5] Khan, S., Khan, S., & Ahmed, G. (2007). *Industrial powersystems*. CRC Press.
[6] Zocholl, S. E. (2004). *Analyzing and ApplyingCurrentTransformers*. SchweitzerEngineeringLaboratories.

Internet Links

http://ieeexplore.ieee.org/Xplore/home.jsp
https://www.selinc.com/
http://www.abb.com/