ELE4353:SYSTEMPROTECTIONANDCOORDINATION

Division

Engineering Technology and Science

Credit Hours (Lecture-Practical-Credits):

Total Credit Hours

3

Lecture Hours

3

Lab Hours

1

Total Contact Hours

4

Prerequisites and/or Co-requisites

Prerequisites

ELE 2314 - Principles of Machines and Power

Corequisites

ELE 4343 - Power System Analysis

Course Description

Examines power system protection fundamentals, basic design requirements, and principles of operation for over-current, overvoltage, and under-voltage protection schemes for various power system components. Three-phase asymmetrical faults are analysed under various conditions and are used as a basis to select circuit breaker types and ratings. Various protective devices, such as over current and earth leakage, differential, distance, over voltage, and under voltage relays, are applied as appropriate. Unit protection, back up protection, and protection coordination are introduced.

Course Learning Outcomes (CLO)

Upon successful completion of the course, the student will demonstrate the ability to:

	Learning Outcome
CLO1	**Explain the basics of power system protection and associated equipment.**
CLO2	**Describecommonabnormal conditionsinelectricalpowersystemsandanalyzethree-phaseasymmetrical faults.**
CLO3	**Describetheprinciples of over-current and earth fault protection and protection coordination.**
CLO4	**Apply unit protection concepts to individual power system components.**

Professional Certificates and Qualifications (PCQ):

Professional Certifications

Not Applicable

Course Resources

E-text Title

No E-Text required

Author(s)

None

Publisher

None

Publisher Year

2014

Use Type

None

Resource Type

STUD

Additional Resources

Resource Type	Details
Labresources	**Festo**

Teaching and Learning Methodologies (TLM):

Description

A knowledge and practical based course covering construction material usage, properties, field and lab testing as per international standards with local and international specifications done in a team environment. In-class lab experiments and assignments deepen the understanding of the course and these will be evaluated as part of practical and theoretical assessment strategy. The following TLM were used during course delivery and assessment.

Methodologies

TLM	% of course delivery
Standard Lecture (SL)	**40**
Multimedia Content (MC)	**5**
Physical Labs (PL)	**25**
Project Based Learning (PBL)	**5**
Computer Simulations/Labs (CSL)	**10**
Seminars (SEM)	**15**

Weekly Course Topics and Schedule:

Delivery Framework (Week-by-Week)

Week	Topic and Contents	CLO	TLM1	TLM2	TLM3	PCQ
1	**1.1 Explain the objectives of system protection** **1.2 Explain the role of CTs and VTs in protection application and the effect of CT saturation on the ratio error.** **Tutorial # 1 (CT characteristic)**	1	**SL**	**SEM**		
2	**1.3 List relays types and explain their use with** **Lab # 1: Current Transformer Saturation using**	1	**SL**	**MC**		
3	**1.4 List types of CBs and explain factors affecting the breaker selection and rating** **1.5 List fuse types used in protection schemes.** **Lab # 2: Current and Voltage Transformers Operation**	1	**SL**	**PL**		
4	**2.1 Represent unbalanced three-phase systems** **2.2 Produce symmetrical components sequence** **Tutorial # 2 (Operator a)**	2	**SL**	**SEM**		
5	**2.3 Discuss the different types of asymmetrical faults in three-phase power systems.** **2.4 Develop equivalent circuits and calculate faults currents for the following asymmetrical faults: (a) line to ground fault.** **Lab#3:Current Transformer- Relay-Circuit Breaker Operation**	2	**SL**	**PL**		

6	**(b) doublelinetogroundfault,and(c) linetoline** **Lab # 4: Fault Simulation on a Transmission Line using MATLAB**	**2**	**SL**	**MC**		
7	**Tutorial # 3 (Asymmetrical Fault Calculation)** **Theory Exam 1 (10%)**	**2**	**SL**	**SEM**		
8	**3.1 Explain the principles of over-current and earth fault protection and the basis of fault.** **3.2 Explain the basis of protection coordination.** **Lab # 5: Inverse Definite Minimum Time of Overcurrent Relay using MATLAB**	**2**	**SL**	**MC**		
9	**Tutorial#4(relaysettings-characteristics)** **3.3 Explain the function of the directional over current and Reverse power relays.**	**3**	**SL**	**SEM**		
10	**Tutorial # 5 (relay coordination)** **Lab # 6: Ex. 2-3 Restricted Earth Fault Protection of a Three -Phase Power Transformer**	**3**	**SL**	**SEM**	**PL**	
11	**4.1 Apply unit protection to generators.** **4.2 Apply unit protection to transformers.** **Lab#7:Ex.1-2ReversePowerProtectionofa Synchronous Generator**	**3**	**SL**	**PL**		
12	**4.3 Apply unit protection to feeders.** **4.4 Apply unit protection to bus systems.** **Tutorial # 6 (unit protection)** **Lab # 8: Ex. 1-1 Differential Protection of a Synchronous Generator**	**3**	**SL**	**PL**	**SEM**	
13	**Practical Project Presentation** **Lab # 9: Ex. 1-7 Overcurrent Protection of a Synchronous Generator**	**4**	**SL**	**SEM**	**PL**	
14	**Theory Exam 2** **Lab # 10. Ex. 2-4 Overcurrent Protection of a Three-Phase Transformer**	**4**	**SL**	**PL**		
15	**Final Practical Exam** **Review Final Exam**	**1-4**	**SL**	**PL**		
16	**Final Exam (FWA)**	**1-4**				

Schedule of Laboratory and other Non-Lecture Sessions:

Schedule of Laboratory and other Non-Lecture Sessions:

Week	Topic	CLO	TLM1	TLM2	TLM3	PCQ
2	**Lab#1 Current Transformer Saturation using MATLAB**	**1**	**MC**			
3	**Lab # 2 Current and Voltage Transformers**	**1**	**PL**			
5	**Lab#3CurrentTransformer–Relay–Circuit Breaker Operation**	**1**	**PL**			
6	**Lab#4FaultSimulationonaTransmissionLine**	**2**	**MC**			
8	**Lab # 5 Inverse Definite Minimum Time of Overcurrent Relay using MATLAB**	**3**	**PL**			
10	**Lab # 6 Ex. 2-3: Restricted Earth Fault Protection**	**3**	**PL**			
11	**Lab#7Ex.1-2ReversePowerProtectionofa Synchronous Generator**	**3**	**PL**			
12	**Lab # 8: Ex. 1-1 Differential Protection of a**	**4**	**PL**			
13	**Lab # 9: Ex. 1-7 Overcurrent Protection of a Synchronous Generator**	**4**	**PL**			

14	**Lab # 10. Ex. 2-4 Overcurrent Protection of a Three-Phase Transformer**	**4**	**PL**

Out-of-Class Assignments and Dates:

Out-of-Class Assignments and Dates:

Week Due	Assignment	TLM1	TLM2	TLM3
4	**Assignment 1: CT andrelay solving problems, MCQ CLO#1)**	**SEM**		
8	**Assignment 2: Three phase Asymmetrical**	**SEM**		
10	**Assignment 3: Overcurrent relay characteristics (CLO#3)**	**SEM**		
11	**Assignment 4: Overcurrent relay**	**SEM**		
12	**Assignment 5: Earth fault, Directional and Reverse power relays (CLO#3)**	**SEM**		
13	**Assignment 6: Unit protection (Differential**	**SEM**		
13	**Assignment 7: Unit protection (Transformer – Bus bar) (CLO#4)**	**SEM**		

Assessment Strategy

Assessments:

Assessment Type	Assessment Method	Assessment Description	Weight	Due Date/Week	CLO
Course Work	**Written Assessment (essay, case analysis, paper, reflection paper,report, review,labreport)**	**Theory Exam 1**	**10**	**Week 7**	**1-2**
Course Work	**Written Assessment (essay, paper,report,review,labreport)**	**Theory Exam 2**	**10**	**Week 14**	**3-4**
Course Work	**Test / Quiz**	**Quizzes**	**5**	**Week 4-13**	**1-4**
Course Work	**Practical Skills Assessment**	**Laboratory Work**	**25**	**Week 3-14**	**1-4**
Course Work	**Project (simulation, multimedia product, poster, artifact)**	**Project**	**20**	**Week 13**	**1-3**
Course Work	**Practical Skills Assessment**	**Final Practical Exam**	**15**	**Week 15**	**1-4**
Final Assessment	**Written Examination (FWA)**	**FWA**	**15**	**Week 16**	**1-4**

Contribution of Course to Program Outcomes

This course contributes to the accomplishment of the following program outcomes:

	Program Outcomes (PLOs)	Emphasis in course
1	**An ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve broadly-defined engineering problems appropriate to the Electrical Engineering Technology;**	**High**
2	**An ability to design systems, components, or processes meeting specified needs for broadly-definedengineering problems appropriatetotheelectrical engineering technology;**	**High**
3	**An ability to apply written, oral, and graphical communication in broadly defined technical and non-technical environments; and an ability to identify and use appropriate technical literature;**	**High**
4	**An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes;**	**High**

5	**An ability to function effectively as a member as well as a leader on technical teams.**	**Low**
6	**An ability to develop and evaluate a business plan to transform an engineering design (systems, products ,services and solutions) into a business opportunity utilizing entrepreneurial skills and knowledge**	**Low**

Mapping of Course Learning Outcomes to Program Learning Outcomes

Mapping:

CLO	PLO
CLO 1	**1.1, 1.2, 1.3, 3.1, 3.2, 4.1**
CLO 2	**1.1, 1.2, 1.3, 3.2**
CLO3	**1.1, 1.2, 1.3, 3.1, 3.2**
CLO4	**1.1, 1.2, 1.3, 4.1**

Hybrid Delivery Plan 202020

OL: Online,

OC_Ass_Exam 1: On Campus assessment exam 1,

OC_PL1: On Campus physical lab 1

OC_Assessment_Practical FWA

No. of students: **No. of Groups:**

Week	Day	Group 1	Group 2
1	D1	OL-SI	OC-SI
	D2	OC-SI	OL-SI
2	D1	OL-PI	OL-PI
	D2	OC-PL1-ACS	OL-PL2 SI
3	D1	OL-PI	OL-PI
	D2	OL-PL2 SI	OC-PL1-ACS
4	D1	OL-PI	OL-PI
	D2	OC-PL3-ACS	OL-PL4 SI
5	D1	OL-PI	OL-PI
	D2	OL-PL4 SI	OC-PL3-ACS
6	D1	OL-PI	OL-PI
	D2	OC-PL5-ACS	OL-PL6 SI

7	D1	OL-SI	OL-SI
	D2	OC Ass- Ex1	OC Ass - Ex1
8	D1	OL-PI	OL-PI
	D2	OL-PL6 SI	OC-PL5-ACS
9	D1	OL-PI	OL-PI
	D2	OC-PL7-ACS	OL-PL8 SI

10	D1	OL-PI	OL-PI
	D2	OL- PL8 SI	OC-PL7-ACS
11	D1	OL-PI	OL-PI
	D2	OC-PL9-ACS	OL-PL10 SI
12	D1	OL-PI	OL-PI
	D2	OC-PL10 SI	OL-PL9 ACS
13	D1	OL-PI	OL-PI
	D2	OC-Proj. Pres	OC-Proj Pres.
14	D1	OL-PI	OL-PI
	D2	OC Ass-Ex2	OC Ass-Ex2
15	D1	OC – Prac Exam FWA	OC – Prac Exam FWA
	D2	OL-SI	OL-SI
16	D1	FINAL ASS.	FINAL ASS.
	D2		

Key: 4517