

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
20.	Cycloconverter: Three-phase to single-phase and three-phase to three-phase	2	C	3	3,4
21.	Introduction to matrix converter	2	C	3	1,7
22.	UPS - SMPS – HVDC systems – Tap changing of transformers	3	C	3	1,3
Total contact hours		45			

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Single-phase Semi and Full converter	3	I,O	2	1-3
2.	Cuk converter	3	I,O	2	1,6
3.	Sepic converter	3	I,O	2	1,6
4.	3-phase PWM inverter using IGBT	3	I,O	2	1,3
5.	Series inverter and Parallel Inverter	3	I,O	2	1,3
6.	Single-phase Cycloconverter	3	I,O	3	1,3
7.	Single-phase AC voltage controller using Triac	3	I,O	3	1,3
8.	Fly back converter(SMPS)	3	I,O	3	1,3
9.	FPGA based single-phase diode clamped multi-level inverter	3	D,I,O	2	1,7
10.	Simulation of Boost converter using MATLAB	3	D,I	2	1,3
Total contact hours		30			

LEARNING RESOURCES

Sl. No.	TEXT BOOKS
1.	Rashid, M.H., “Power Electronics - Circuits Devices and Applications”, Prentice Hall of India, 2014, 4 th edition.
2.	Sen.P C, “Power Electronics”, Tata Mc Graw Hill Education, 2012, 39 th reprint .
3.	Bhimbra .P. S. “Power Electronics”, Khanna publishers, 2012, Fifth edition.

REFERENCE BOOKS/OTHER READING MATERIAL

4.	Singh. M.D and Kanchandani-“Power Electronics”-Tata McGraw-Hill & Hill Publication Company Ltd, 2015, 23 rd reprint.
5.	Joseph Vithayathil, “Power Electronics Principle and applications”, Mc Graw Hill Education, edition 2010.
6.	Ned Mohan, T.M Undeland and W.P Robbin, “Power Electronics: converters, Application and design”, John Wiley and sons, 3 rd edition, 2006.
7.	Andrzej M. Trzynadlowski “Introduction to modern power electronics”, John Wiley and sons, 3 rd edition, 2015.
8.	V R Moorthi, "Power Electronics: Devices, Circuits and Industrial Applications", Oxford University Press India, 2005.

Course nature		Theory + Practical					
Assessment Method – Theory Component (Weightage 50%)							
In-semester	Assessment tool	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	Total
	Weightage	10%	15%	15%	5%	5%	50%
End semester examination Weightage :							50%
Assessment Method – Practical Component (Weightage 50%)							
In-semester	Assessment tool	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	Total	
	Weightage	40%	5%	5%	10%	60%	
End semester examination Weightage :							40%

15EE302	Power System Protection			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32 nd Academic Council Meeting , 2016						

PURPOSE	To gain the knowledge on the basic concepts of protection schemes of power system equipment, Switch gear and get familiarized with the modern trends in protection.						
INSTRUCTIONAL OBJECTIVES				STUDENT OUTCOMES			
At the end of the course, student will be able to							
1.	Realize the basic protective schemes applied in power system protection.	a					
2.	Emphasize the significance and application of protection for electrical equipment	a	e				
3.	Educate the new developments in power system protection	a	h				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO PROTECTIVE SCHEMES	9			
1.	Realise the basic protective schemes applied in power system protection.	1	C	1	1,2,3
2.	Evolution of protective relays - Zones of protection - Primary and Back -up Protection	1	C	1	1,2,3
3.	Essential qualities of Protection - Classification of Protective schemes	1	C	1	1,2,3
4.	Concept of reset, pick up, inverse time and definite time characteristics, over current, over voltage, directional, relay	2	C	1	1,2,3
5.	Differential relay	1	C	1	1,2,3
6.	Distance relays on R-X diagram	1	C	1	1,2,3
7.	Static Relays: Introduction, advantages and limitations of static relays, static over current, directional relays.	1	C	1	1,2,3
8.	Negative sequence relays	1	C	1	1,2,3
	UNIT II : PROTECTION OF EQUIPMENT	9			
9.	Types and detection of faults and their effects	1	C	2	1,2,3
10.	Alternator protection schemes (stator, rotor, reverse power protection etc.)internal faults protection), generator-transformer unit protection scheme	2	C	2	1,2,3
11.	Transformer protection (External and internal faults protection), Buccholz relay, generator-transformer unit protection schemes	2	C	2	1,2,3
12.	Bus bar protection	1	C	2	1,2,3
13.	Transmission line protection (current/time grading, distance)	1	C	2	1,2,3
14.	Pilot relaying schemes.	1	C	2	1,2,3
15.	Power line carrier protection	1	C	2	1,2,3
	UNIT III : SWITCHGEAR	9			
16.	Theory of current interruption- energy balance and recovery rate theory, arc quenching, recovery and restriking voltagesTypes of circuit breakers. bulk oil CB	1	C	2	1,3
17.	Types of circuit breakers. bulk oil CB	1	C	2	1,3
18.	Minimum oil CB	1	C	2	1,3
19.	Air break and air blast CBs	1	C	2	1,3
20.	Sulphur hexafluoride (SF6) and vacuum circuit breakers	2	C	2	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
21.	Rating selection and testing of circuit breakers	1	C	2	1,3
22.	Operating mechanisms - LT switchgear, Gas insulated switchgear	1	C	2	1,3
23.	HRC fuses, types, construction and applications.	1	C	2	1,3
	UNIT IV : SURGE PROTECTION AND INSULATION CO-ORDINATION	9			
24.	Introduction-Power frequency, switching and lightning overvoltages	1	C	2	1,3,4
25.	Klydonograph and magnetic link	1	C	2	1,4
26.	Protection of transmission lines against direct line strokes	1	C	2	1,4
27.	Protection of stations and sub-stations from direct strokes	2	C	2	1,4
28.	Protection against travelling waves	1	C	2	1,4
29.	Peterson coil, Insulation co-ordination, Basic impulse insulation level	3	C	2	1,4
	UNIT V : MODERN TRENDS IN POWER SYSTEM PROTECTION	9			
30.	Numerical Protection-Data acquisition systems (DAS), Numerical over current protection	2	C	3	1,2,3,5
31.	Numerical differential protection,	1	C	3	1,2,3,5
32.	Numerical distance protection	1	C	3	1,3,5
33.	Fibre optic based relaying, microwave relaying	2	C	3	1
34.	FPGA based relays, adaptive protection, Wide area protection	1	C	3	1,6
35.	Applications of AI techniques to power system protection, protection substation Automation	2	C,I	3	1,3
	Total contact hours			45	

LEARNING RESOURCES

Sl. No.	TEXT BOOKS
1.	Badriram & Vishwakarma, "Power System Protection", Tata McGraw-Hill Education, 10 th reprint, 2015.
2.	Paithankar Y. G., S. R. Bhide., "Fundamentals of power system protection" PHI Learning Pvt. Ltd., 10 th reprint, 2010.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Ravindra Nath.B, and Chandar.M "Power systems protection and switchgear", New age international (P) Ltd. 3 rd reprint, 2014.
4.	Rao Sunil.S, "Switchgear and protection" Khanna Publishers, 2 nd Edition, 2011.
5.	T.S.M Rao, "Digital/Numerical Relays", Tata McGraw-Hill Education, 2005.
6.	Bhavesh Bhalja, R P Maheswari, Nilesh G Chothani, "Protection and Switchgear" Oxford University press, first edition, 5 th reprint 2014.

Course nature		Theory					
Assessment Method (Weightage 100%)							
In-semester	Assessment tool	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	Total
	Weightage	10%	15%	15%	5%	5%	50%
End semester examination Weightage :							50%