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SCHOOL OF ENGINEERING AND TECHNOLOGY	ELECTRICAL AND ELECTRONICS ENGINEERING DEPARTMENT	OPERATIONAL FROM (2013-2014)	FOR STUDENTS ADMITTED STARTING (2012-2013)
1	Course number	EEE410	
2	Course Title	**SWITCHGEAR AND PROTECTION (DC)**	
3	Credits	4	
4	Contact Hours (L-T-P)	(3-0-2)	
5	Course Objective	The objective of the course is to expose students to the techniques of protecting the various subsystems of a power system during their normal operation and also under fault condition. The students will also be acquainted with the techniques to coordinate these protecting devices and systems.	
6	Course Outcomes	On successful completion of this course students will be able to 1. know the need for protection and power system earthing and different faults 2. list the essential qualities of protection 3. describe the principles of protection schemes 4. describe the function and characteristics of various protection relays 5. different between analogue and digital protection schemes 6. compare the protection systems used for electric machines, transformers, bus bars, overhead and underground feeders 7. apply the various principles of protection techniques for power system components 8. describe modern relays 9. discuss the theory of circuit interruption and physical phenomena of arc 10. explain the function and operation of various circuit breakers 11. interpret of testing of circuit breakers 12. apply the different standards of circuit breakers	
7	Outline syllabus:		
7.01	**EEE410.A**	**Unit A**	**Introduction to Power System Protection**
7.02	EEE410.A1	Unit A Topic 1	Nature and causes of faults on power system elements, need of protection.
7.03	EEE410.A2	Unit A Topic 2	Zones of protection, essential qualities of protection, primary and backup protection, CTs and VTs and their applications in protection.
7.04	EEE410.A3	Unit A Topic 3	Earthing of generator, transformer and transmission lines.
7.05	**EEE410.B**	**Unit B**	**Operating Principles and Construction of Relays**
7.06	EEE410.B1	Unit B Topic 1	Principle of Electromagnetic relays, various relay constructions.

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7.0 7	EEE410.B2	Unit B Topic 2	Electromagnetic relays: over-current, directional, differential and distance relays and their operating characteristics.
7.0 8	EEE410.B3	Unit B Topic 3	Modern relays: introduction to static and digital/numerical (microprocessor based) relays and Intelligent Electronic Device (IED) relays.
7.0 9	**EEE410.C**	**Unit C**	**Protection of Power Apparatus**
7.1 0	EEE410.C1	Unit C Topic 1	Faults on transformers and its protection: protection against external faults, protection against internal faults, protection against magnetic inrush.
7.1 1	EEE410.C2	Unit C Topic 2	Faults on Generator and its protection: Stator protection, protection against inter-turn faults, stator-overheating, Rotor protection, field ground-fault protection, loss of excitation protection, overvoltage protection, overspeed protection.
7.1 2	EEE410.C3	Unit C Topic 3	Faults on transmission lines and its protection: wire pilot protection, carrier current protection, protection of busbar: differential current protection, high impedance relay protection.
7.1 3	**EEE410.D**	**Unit D**	**Theory of Circuit Interruption**
7.1 4	EEE410.D1	Unit D Topic 1	Physics of arc phenomena and arc interruption.
7.1 5	EEE410.D2	Unit D Topic 2	Restriking voltage & recovery voltage, rate of rise of recovery voltage.
7.1 6	EEE410.D3	Unit D Topic3	Resistance switching, current chopping, interruption of capacitive current.
7.1 7	**EEE410.E**	**Unit E**	**Circuit Breakers**
7.1 8	EEE410.E1	Unit E Topic 1	Types of circuit breakers, principle of operation and construction of air-break, air blast, oil, SF6 and vacuum circuit breakers, their merits and demerits.
7.1 9	EEE410.E2	Unit E Topic 2	Testing of circuit breakers, familiarization with Indian and International standards on LV and HV circuit breakers.
7.2 0	EEE410.E3	Unit E Topic 3	Concept of HVDC circuit breaker.
7.2 1	EEE410.L01	Lab expt 1	To form the bus admittance matrix (Y_{BUS}) using MATLAB.
7.2 2	EEE410.L02	Lab expt 2	To find the load flow solution by Gauss-Seidel method using MATLAB.
7.2 3	EEE410.L03	Lab expt 3	To form the bus impedance matrix (Z_{BUS}) using MATLAB.
7.2 4	EEE410.L04	Lab expt 4	To analyse the single-phase fault on a power system network using MATLAB.
7.2 5	EEE410.L05	Lab expt 5	To analyse the Line-Line fault on a power system network using MATLAB.
7.2	EEE410.L06	Lab expt 6	To analyse the three-phase fault on a power system network

6			using MATLAB.
7.2 7	EEE410.L07	Lab expt 7	To determine the power angle curve for a one-machine system using MATLAB.
7.2 8	EEE410.L08	Lab expt 8	To solve the swing equation of a one-machine system using MATLAB.
7.2 9	EEE410.L09	Lab expt 9	To determine the operating characteristics of over-current relay.
7.3 0	EEE410.L10	Lab expt 10	To determine the operating characteristics of over-voltage relay.
7.3 1	EEE410.L11	Lab expt 11	To determine the operating characteristics of inverse definite mean time relay.
7.3 2	EEE410.L12	Lab expt 12	To determine the operating characteristics of bimetallic Thermal relay.
8	Course Evaluation		
8.1	Course work: 30 marks		
8.1 1	Attendance	None	
8.1 2	Homework	None	
8.1 3	Quizzes	Two 30 minutes surprise quizzes in lecture hours: 10 marks	
8.1 4	labs	Evaluation of work done on each lab turn in the lab notebook and feedback from oral quiz about the work done that day. Zero, if the student is absent. 0.75N best marks out of N such evaluations: 20 marks	
8.1 5	Presentations	None	
8.1 6	Any other	None	
8.2	MTE	One, 20 marks	
8.3	End-term examination:	50 marks	
9	References		
9.1	Text books	Badri ram, D.N.Vishwakarma, 'Power System Protection & Switchgear', Tata McGraw –hill publishing company ltd, New Delhi. C.L Wadhwa, 'Electrical Power Systems', New Age International (p) limited.	
9.2	Other references	B. Ravindranath, and N. Chander, 'Power System Protection & Switchgear', Wiley Eastern Ltd. Sunil S. Rao, 'Switchgear and Protection', Khanna publishers, New Delhi. M.L. Soni, P.V. Gupta, V.S. Bhatnagar, A. Chakrabarti, 'A Text Book on Power System Engineering', Dhanpat Rai & Co. Y.G. Paithankar and S.R. Bhide, 'Fundamentals of Power System Protection', Prentice Hall of India Pvt. Ltd., New Delhi. C.R. Mason," The Art and science of protective Relaying", Wiley Eastern. T.S.M. Rao , "Power System Protection - Static Relays with Microprocessor Applications", 2nd Edition, Tata McGraw Hill.	
9.3	Software	MATLAB/Simulink.	

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Mapping of Outcomes vs. Topics

Outcome no. → Syllabus topic↓	1	2	3	4	5	6	7	8	9	10	11	12
EEE410.A1	X	X										
EEE410.A2	X	X										
EEE410.A3		X	X									
EEE410.B1				X								
EEE410.B2				X								
EEE410.B3					X			X				
EEE410.C1						X	X					
EEE410.C2						X	X					
EEE410.C3						X	X					
EEE410.D1									X			
EEE410.D2									X			
EEE410.D3									X			
EEE410.E1										X		
EEE410.E2											X	
EEE410.E3												X