



SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE
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Department of Electrical and Electronics

Number of programmes where syllabus revision was carried out

SL. NO.	COURSE CODE	COURSE OFFERED
1	SEE1401	Power System Protection and Switch Gear
2	SEE5102	Analysis of Inverters

SEE1401	POWER SYSTEM PROTECTION AND SWITCHGEAR	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

To discuss the cause and effect of abnormal operating conditions in a Power system and the protective schemes along with the problems associated with circuit interruptions.

UNIT 1 INTRODUCTION DRIVES

8 Hrs.

Essential requirements of protection - nature and causes of faults - types of faults - effects of faults - zones of protection - protection schemes - CTs and PTs and their applications - Basic relay terminology.

UNIT 2 PROTECTIVE RELAYS

10 Hrs.

Electromagnetic relays - operating principle - torque equation - relay characteristics - over current relay, directional relay, distance relay, differential relay, negative sequence relay, amplitude and phase comparator of over current static relays, duality between comparators. Microprocessor based over current relay.

UNIT 3 APPARATUS PROTECTION

9 Hrs.

Protection of Generator- stator & rotor protection - Large Motor protection. Transformer protection - Bus bar Protection - Transmission line protection.

UNIT 4 THEORY OF ARC QUENCHING

9 Hrs.

Arcing phenomena - theory and methods of arc quenching - recovery voltage - restriking voltage - RRRV - Resistance switching - current chopping - capacitive current breaking - Characteristics of fuses - HRC fuse.

UNIT 5 CIRCUIT BREAKERS

9 Hrs.

Classification of circuit breakers - air circuit breakers - oil circuit breakers - vacuum circuit breaker - SF6 circuit Breakers - selection of circuit breakers - rating of circuit breakers - testing of circuit breakers.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Categorize various faults, their effects on power system and need of protection.
- CO2 - Analyze the various electromagnetic and static relay used in power system.
- CO3 - Design appropriate relay for various power system apparatus
- CO4 - Investigate various Arc quenching technique for power system protection
- CO5 - Evaluate the effectiveness of various circuit breakers with respect to Arc quenching
- CO6 - Examine the characteristics, rating and testing of circuit breakers

TEXT / REFERENCE BOOKS

1. Sunil S.Rao "Switchgear and protection", Khanna publishers, New Delhi, 2008.
2. Badri Ram and D.N.Vishwakarma "Power System Protection and Switchgear", Tata McGraw Hill publishing, New Delhi, 2005.
3. S.L.Uppal, "Electrical Power", Khanna publishers, New Delhi, 1995.
4. Soni, Gupta and Bhatnagar "A Course in Electrical power", Dhanpat Rai&sons, New Delhi, 2010.
5. TSM Rao, "Digital Numerical Relays", Tata McGraw Hill publishing, New Delhi, 2005.
6. B.Ravindranath and N.Chander, " Power System Protection and Switchgear", New age International (P) Ltd, 2005.
7. Dr.N.Veerappan and Dr.S.R.KrishnaMurthy, "Power System Switchgear and Protection", S.Chand,2009.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks: 80

Exam Duration: 3 Hrs.

PART A: 10 questions of 2 marks each - No choice

20 Marks

PART B: 2 questions from each unit of internal choice, each carrying 12 marks

60 Marks

SEE5102	ANALYSIS OF INVERTERS	L	T	P	Credits	Total Marks
		4	0	0	4	100

COURSE OBJECTIVES

- Ability to analyse and comprehend the various operating modes of different configurations of power converters
- Ability to design different single phase and three phase inverters.

UNIT 1 SINGLE PHASE INVERTER 12 Hrs.

Introduction – Principle of operation – Performance parameters – Single phase half bridge Inverters – Single phase full bridge Inverter – Single phase Series Inverter – Single phase parallel Inverter - Modified McMurray Inverter – McMurray Bedford half bridge and full Inverter Voltage control of single phase Inverters

UNIT 2 VOLTAGE SOURCE AND CURRENT SOURCE INVERTER 12 Hrs.

Three phase bridge Inverter with 180° and 120° mode of operation – Voltage control of three phase Inverters - Analysis of single phase and three phase auto sequential current source Inverter - Current source bridge Inverter– Harmonic Elimination Techniques.

UNIT 3 Z-SOURCE INVERTER 12 Hrs.

Comparison with VSI and CSI-Equivalent circuit and operation –Circuit analysis and calculation. Introduction to Quasi Z- source inverter-basic topology-Extended boost quasi Z- source inverter topologies

UNIT 4 RESONANT PULSE INVERTERS 12 Hrs.

Introduction – Series resonant Inverters with unidirectional and Bidirectional switches – Parallel resonant Inverters– Class E resonant Inverter - Zero current switching resonant converter – Zero voltage switching resonant converter– Two quadrant ZVS resonant converter – Resonant DC link Inverter.

UNIT 5 MULTILEVEL INVERTER 12 Hrs.

Multilevel concept – Diode clamped – Flying capacitor – Cascade type multilevel Inverters - Comparison of multi-level Inverters - Application of multilevel Inverters

Max. 60 Hours**COURSE OUTCOMES**

On the completion of the course, student will be able to

- CO1 - Understand the Operation of inverter for single phase and three phase circuits
- CO2 - Understand how to do the analysis for the inverter for harmonics.
- CO3 - Control the inverter output voltage by using the modulation techniques.
- CO4 - Design an inverter for a particular application and power level.
- CO5 - Understand the need for multi-level inverter and its operation.

TEXT / REFERENCE BOOKS

1. Rashid M.H, 'Power Electronics – Circuits, Devices & Applications', Pearson Education, 2013.
2. P.S.Bimbra, "Power Electronics", Khanna Publishers, 5th Edition, 2014.
3. Fang Lin luo, Hong Ye, "Advanced DC/AC Inverters:Applications in Renewable Enegy" CRC press, Taylor and Francis Group, 2013.
4. Mohan .N, Undeland & Robbins, "Power Electronics – Converters, Application & Design", John Wiley & Sons, Inc, 2nd Edition, Newyork, 2001.
5. P.C Sen, "Modern Power Electronics", S.Chand Ltd., 2005.
6. Rashid M.H., "Hand book on Power Electronics", Nihar Kularatna, Newnes, 1998.
7. M.D. Singh & K.B. Khanchandani, "Power Electronics", Tata Mc Graw Hill Publishing Company Limited, 2nd edition, 3rd reprint 2008.

END SEMESTER EXAM QUESTION PAPER PATTERN**Max. Marks : 70****Exam Duration : 3 Hrs..****PART A** : 5 questions of 4 marks each – No choice**20 Marks****PART B** : 2 questions from each unit of internal choice, each carrying 10 marks**50 Marks**