INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

COURSE DESCRIPTION FORMS

Course Title	**:**	**SWITCH GEAR AND PROTECTION**			
Course Code	**:**	**A70231**			
Regulation	**:**	**R15**			
Course Structure	**:**	Lectures	Tutorials	Practical's	Credits
		4	1	-	4
Course Coordinator	**:**	**Mr. P Shiva Kumar Assistant Professor, EEE**			
Team of Instructors	**:**	**Mr. P Shiva Kumar Assistant Professor, EEE**			

I. COURSE OVERVIEW:

"Switch Gear &Protection" subject gives general awareness of different Protective Equipments for Power Systems such as Relays, Circuit Breakers, and Isolators. It also explains about protective system- how it works and where it works? A different application of the relays for different elements of power system is also discussed in the subject.

II. PREREQUISITES:

Level	Credits	Periods	Prerequisite
UG	4	4	Knowledge of power systems, Different types of machinery and protecting equipments is required

III. COURSE ASSESSMENT METHODS:

a) Marks distribution:

Session Marks	University End Exam Marks	Total Marks
There shall be two mid tem examinations. Each id term exam consists of subjective type and objective type test. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each semester shall contain four questions; the student has to answer two out of them. Each carrying 5 marks The objective test paper Is prepared by JNTUH, which consists of 20 questions each carrying 0.5 marks and total of 10 marks. The student is assessed by giving two assignments, one, after completion of 1to 4 units and the second, after the completion of 4 to 8 units each carrying 5 marks. On the total the internal marks are 25. The average of two internal tests is the final internal marks. The external question paper is set by JNTUH consisting of 8 questions each carrying 15 marks out of which 5 questions are to be answered their by external examination is of total 75 mark	75	100

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1	I Mid Examination	90 minutes	20
2	I Assignment	--	05
3	II Mid Examination	90 minutes	20
4	II Assignment	--	05
5	External Examination	3 hours	75

V. COURSE OBJECTIVE:

At the end of the course, the students will be able to:

i. Understand students to power system protection and switchgear
ii. Understand students theory and applications of the main components used in power system protection for electric machines, transformers, bus bars, overhead and underground feeders
iii. Understand students the theory, construction, applications of main types Circuit breakers, Relays for protection of generators
iv. Understand students transformers and protection of feeders from over- voltages and other hazards. it emphasis on neutral grounding for overall protection
v. develop an ability and skill to design the feasible protection systems needed for each main part of a power system in students

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. Understand various types of faults in Power system
2. Student gain knowledge on different Protective Equipments or Power Systems
3. Understand about various protective systems- how it works and where it works?
4. Understand the construction and working of Fuse and circuit breakers
5. Understand protective relays
6. Understand and justify a suitable protection system for a specified application.
7. Compare the different type of circuit breakers performance based on which selection of circuit breaker can be made for a given application
8. Understand recovery and Restriking
9. Understand the faults and protection for the Alternators and Transformers
10. Remember the faults and protection for the Feeders and Bus-Bars
11. Understand DMT,IDMT type relays
12. Understand Rotor, Stator Faults, inter turn faults and their protection
13. Understand protect power system against over voltages
14. Understand layout of Substations
15. Understand layout of Substations, neutral earthling, testing of CB, CT and PT

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	S	Exercise
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	H	Projects
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	N	-------
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	S	Discussion, Seminars
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	S	Exercise
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	H	Discussion, Seminars
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	S	Discussions
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	S	Discussions
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	S	Discussion, Seminars
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	S	Discussions, Seminars
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	S	Prototype, discussions

N= None **S=Supportive** **H=highly related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	S	Lectures, Assignments
PSO2	**Problem-Solving Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	N	------
PSO3	**Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.	S	Guest Lectures

N – None **S – Supportive** **H - Highly Related**

IX. SYLLABUS:

UNIT I:

Circuit Breakers

Circuit Breakers: Elementary principles of arc interruption, Recovery, Restriking Voltage and Recovery voltages.- Restriking Phenomenon, Average and Max. RRRV, Numerical Problems – Current Chopping and Resistance Switching – CB ratings and Specifications: Types and Numerical Problems. – Auto reclosures Description and Operation of following types of circuit breakers: Minimum Oil Circuit breakers, Air Blast Circuit Breakers, Vacuum and SF6 circuit breakers.

UNIT II:

Electromagnetic and Static Relays

Principle of Operation and Construction of Attracted armature, Balanced Beam, induction Disc and Induction Cup relays. Relays Classification: Instantaneous, DMT and IDMT types. Application of relays: Over current/ Under voltage relays, Direction relays, Differential Relays and Percentage Differential Relays. Universal torque equation, Distance relays: Impedance, Reactance and Mho and Off-Set Mho relays, Characteristics of Distance Relays and Comparison. Static Relays: Static Relays verses Electromagnetic Relays.

UNIT III:

Generator and Transformer Protection

Protection of generators against Stator faults, Rotor faults, and Abnormal Conditions. Restricted Earth fault and Inter-turn fault Protection. Numerical Problems on % Winding Unprotected. Protection of transformers: Percentage Differential Protection, Numerical Problem on Design of CT s Ratio, Buchholtz relay Protection.

UNIT IV:

Feeder and Bus-Bar Protection and Grounding: Protection of line:

Protection of Lines: Over Current, Carrier Current and Three-zone distance relay protection using Impedance relays. Translay Relay. Protection of Bus bars – Differential protection. Grounded and Ungrounded Neutral Systems.- Effects of Ungrounded Neutral on system performance. Methods of Neutral Grounding: Solid, Resistance, Reactance – Arcing Grounds and Grounding Practices.

UNIT V:

Protection against over voltages

Generation of Over Voltages in Power Systems.-Protection against Lightning Over Voltages – Valve type and Zinc-Oxide Lighting Arresters – Insulation Coordination -BIL, Impulse Ratio, Standard Impulse Test Wave, Volt-Time Characteristics

X. TEXT BOOKS:

1. Switchgear and Protection – by Sunil S Rao, Khanna Publlishers.
2. Power System Protection and Switchgear by Badari Ram , D.N Viswakarma, TMH Publications.
3. Principles of power systems-by vk Mehta.

XI. REFERENCE BOOKS:

1. Fundamentals of Power System Protection by Paithankar and S.R.Bhide.,PHI, 2003.
2. Art & Science of Protective Relaying – by C R Mason, Wiley Eastern Ltd.
3. Electrical Power Systems – by C.L.Wadhwa, New Age international (P) Limited, Publishers, 3nd editon
4. A Text book on Power System Engineering by B.L.Soni, Gupta, Bhatnagar, Chakrabarthy, Dhanpat Rai & Co.

XII. COURSE PLAN

The course plan is meant as a guideline. There may be probably be changes.

Lecture No.	Learning Objectives	Topics To Be Covered	Reference
1	To know about circuit breaker	Introduction of circuit breakers,	T3,R3
2,3	To understand recovery, restriking voltage and recovery voltages	Recovery, restriking voltage and recovery voltages.	T3,R3
4	To analyze restriking	Restriking phenomenon	T3,R3
5	To understand average and Max. RRRV	Average and Max. RRRV	T3,R3
6	To evaluate problems	Numerical problems	T3,R3
7	To Understand current chopping and resistance switching	Current chopping and resistance switching	T3,R3
8,9	To Remember CB ratings and Specifications: Types and Numerical Problems.	CB ratings and Specifications: Types and Numerical Problems.	T3,R3
10, 11	To Understand Elementary	Elementary principles of arc interruption	T3,R3
12	To Analyze Auto reclosures	Auto reclosures.	T3,R3
13,14	To understand description and operation of	Description and Operation of Minimum Oil circuit breaker	T3,R3
15,16	To Analyze, Air Blast Circuit breakers	Description and Operation of, Air Blast Circuit breakers	T3,R3
17,18	To Analyze SF6 Circuit breakers	Description and Operation of Vacuum and	T3,R3
19	To Analyze	Principle of Operation and Construction of	T3,R3
20	To Analyze Balanced Beam Relay	Principle of Operation and Construction of Balanced Beam Relay	T3,R3
21	To Analyze induction Disc Relay	Principle of Operation and Construction of induction Disc Relay	T3,R3
22	To Analyze Induction Cup relays	Principle of Operation and Construction of	T3,R3
23,24	To Understand DMT IDMT types.	Relays Classification: Instantaneous, DMT IDMT types.	T3,R3
25	To Understand IDMT types	IDMT types.	T3,R3
26,27	To Remember Application of relays	Application of relays: Over current/ Under voltage relays	T3,R3
28	To Understand Direction relays,	Direction relays, Differential Relays	T3,R3
29	To Understand Percentage	Percentage Differential Relays	T3,R3
30	To Remember Universal torque	Universal torque equation, Distance relays	T3,R3
31	To Understand Impedance,	Impedance, Reactance relays	T3,R3
32	To Understand Mho and Off-Set Mho relays	Mho and Off-Set Mho relays	T3,R3
33	To Analyze Characteristics of	Characteristics of Distance Relays and	T3,R3

34	To Understand relays	Static Relays: Static Relays verses Electromagnetic Relays	T3,R3
35	To Analyze Protection of generators	Protection of generators against Stator faults, Rotor faults, and Abnormal condition	T3,R3
36,37	To Analyze fault Protection	Restricted Earth	T3,R3
38	To Evaluate Problems on % Winding Unprotected	Numerical Problems on % Winding Unprotected	T3,R3
39	To Understand Protection of transformer	Introduction of Protection of transformers	T3,R3
40	To Understand Percentage Differential Protection	Percentage Differential Protection	T3,R3
41,42	To Evaluate Problem on Design of CT s Ratio	Numerical Problem on Design ofCT s Ratio	T3,R3
43	To Analyze Buchholtz relay	Buchholtz relay Protection	T3,R3
44	To Understand Protection of Lines	Protection of Lines:	T3,R3
45,	To Understand over current protection	Over Current, Carrier Current	T3,R3
46,	To Understand Three-zone distance relay protection	Three-zone distance relay protection using Impedance relays	T3,R3
47	To Understand Translay Relay	Translay Relay	T3,R3
48	To Understand Protection of Bus bars	Protection of Bus bars	T3,R3
49	To Understand Differential	Differential protection	T3,R3
50	To Understand Grounded and	Grounded and Ungrounded Neutral Systems	T3,R3
51	To Understand Effects of Ungrounding	Effects of Ungrounded Neutral on system performance. Methods of Neutral Grounding	T3,R3
52	To Understand Resistance grounding	Solid, Resistance, Reactance	T3,R3
53	To Understand Grounding Practices	Arcing Grounds and Grounding Practices	T3,R3
54	To Understand Over Voltages in Power Systems	Generation of Over Voltages in Power Systems	T3,R3
55	To Understand Lightning Over Voltages	Protection against Lightning Over Voltages	T3,R3
56,57	To Understand Lighting Arresters	Valve type and Zinc-Oxide Lighting Arresters	T3,R3
58	To Understand Insulation Coordination	Insulation Coordination	T3,R3
59	To Understand Impulse Ratio	BIL, Impulse Ratio, Standard Impulse Test	T3,R3
60	To Analyze Volt-Time Characteristics	Volt-Time Characteristics	T3,R3

XIII. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES:

Course objectives	Program outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
i		S				H	H	H		S	H	S
ii	H	H				S	S	S		S	S	S
iii		S				H	H	H		S	H	S
iv	H	S				S		S		S	H	S
v	H	H				S	S	S		S	S	S

S=Supportive H= Highly related

XIV. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES

Course Outcomes	Program outcomes												Program Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	S		H	H	S	S						S	S		
2	S		H	H		S			S						S
3	S		S	S	S							S	S		
4	H		S	S	S	H						S			
5	S		S		S							S			
6	S		S		S				S			S			
7	S		S	H					S			S	S		S
8	S			S		S			S			S			
9	S			S		H			S			S			
10	S		S	S	S							S	S		
11	S		H	H	S	S						S			
12	S		S	H					S			S			S
13	S			S		S			S			S	S		
14	H		S	S	S	H						S			
15	S			S		H			S			S	S		S

Prepared by: Mr. P Shiva Kumar, Assistant Professor, EEE

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