



# Indra Ganesan

## COLLEGE OF ENGINEERING

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai  
Accredited by NAAC with 'B+' Grade, 2(f) & 12B Status Institution by UGC

IG Valley, Madurai Main Road, Manikandam, Tiruchirappalli - 620012

# NAAC DOCUMENTS

## QUALITY INDICATOR FRAME WORK

### CRITERION – 1

## CURRICULAR ASPECTS

SUBMITTED BY

**IQAC**

INTERNAL QUALITY ASSURANCE CELL

**INDRA GANESAN COLLEGE OF ENGINEERING**





# Indra Ganesan

## COLLEGE OF ENGINEERING

Madurai Main Road (NH-45B), Manikandam, Tiruchirappalli - 620 012  
Approved by AICTE, NewDelhi & Affiliated to Anna University, Chennai  
NAAC Accredited, 2(F) Status Institution by UGC



<b>Criteria 1</b>	<b>Curricular Aspects</b>	<b>100</b>
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## 1.1 Curricular Planning and Implementation (20)

**1.1.1 The Institution ensures effective curriculum planning and delivery through a well-planned and documented process including Academic calendar and conduct of continuous internal Assessment**

### Table of Content

S. No	Description
1.	Preface of the Course File
2.	Faculty Time Table
3.	Course Plan
4.	Content Beyond Syllabus
5.	Academic Audit Form
6.	Question Paper
7.	Answer Key
8.	Sample Answer Sheet
9.	Co Based Mark Entry
10.	Root Cause Analysis

# INDRA GANESAN COLLEGE OF ENGINEERING

IG Valley, Manikandam, Tiruchirappalli, Tamil Nadu – 620 012, India  
(Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai-25)

## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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### PREFACE OF THE COURSE FILE

Batch : 2019-2023

Academic Year : 2021-2022 / ODD


Program : ELECTRICAL AND ELECTRONICS ENGINEERING

Year & Semester : 2<sup>nd</sup> Year / 3<sup>th</sup> Semester


Course Code : EE8602                      NBA Course Code: C311

Name of the Course : Protection and Switchgear

Faculty in-charge : Dr.G.Malathi, Prof / EEE

  
Signature of the Faculty in-charge

  
HoD / EEE

  
Dr. G. Balakrishnan, M.E., Ph.D.,  
Principal  
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— air blast, air break, oil, SF6, MCBs, MCCBs and vacuum circuit breakers — comparison of different circuit breakers — Rating and selection of Circuit breakers.

**TOTAL : 45 PERIODS**

**OUTCOMES:**


- Ability to understand and analyze Electromagnetic and Static Relays.
- Ability to suggest suitability circuit breaker.
- Ability to find the causes of abnormal operating conditions of the apparatus and system.
- Ability to analyze the characteristics and functions of relays and protection schemes.
- Ability to study about the apparatus protection, static and numerical relays.
- Ability to acquire knowledge on functioning of circuit breaker.

**TEXT BOOKS:**

1. Sunil S.Rao, 'Switchgear and Protection', Khanna Publishers, New Delhi, 2008.
2. B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., First Edition 2011.
3. Arun Ingole, 'Switch Gear and Protection' Pearson Education, 2017.

**REFERENCES**

1. BadriRam ,B.H. Vishwakarma, 'Power System Protection and Switchgear', New AgeInternationalPvt Ltd Publishers, Second Edition 2011.
2. Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', SecondEdition,Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
3. C.L.Wadhwa, 'Electrical Power Systems', 6th Edition, New Age International (P) Ltd., 2010
4. RavindraP.Singh, 'Switchgear and Power System Protection', PHI Learning Private Ltd.,NewDelhi, 2009.
5. VK Metha, " Principles of Power Systems" S. Chand, 2005.
6. Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani,'Protection and Switchgear' OxfordUniversity Press, 2011.

  
**Signature of the HoD/EEE**

  
**Dr. G. Balakrishnan, M.E., Ph.D.**  
Principal

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## DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

### Lecture Schedule

Degree/Program: B.E / EEE Course code & Name: EE8602 PROTECTION AND SWITCHGEAR

Duration: 2021-2022

Semester: VI

Faculty: Dr.G.Malathi, Prof / EEE

#### AIM:

To impart knowledge about the configuration of the Protection And Switchgear

#### OBJECTIVES:

To impart knowledge on the following Topics

To impart knowledge on the following Topics

- Causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
- Characteristics and functions of relays and protection schemes.
- Apparatus protection, static and numerical relays
- Functioning of circuit breaker

**PREREQUISITES:** Circuit theory, Electron Devices and Circuits.

#### **COURSE OUTCOMES:**

After the course, the student should be able to:

CO	Course Outcomes	POs	PSOs
C302.1	Ability to understand and analyze Electromagnetic and Static Relays.	1,2,3,4	1,2
C302.2	Ability to suggest suitability circuit breaker.	1,2,3,4	1,2
C302.3	Ability to find the causes of abnormal operating conditions of the apparatus and system.	1,2,3,4	1,2
C302.4	Ability to analyze the characteristics and functions of relays and protection schemes.	1,2,3,4	1,2
C302.5	Ability to study about the apparatus protection, static and numerical relays.	1,2,3,4	1,2
C302.6	Ability to acquire knowledge on functioning of circuit breaker.	1,2,3,4	1,2

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S.No	Date	Period	Topics to be Covered	Book & Page No.
<b>UNIT -I - PROTECTION SCHEMES</b>			<b>Target periods :9</b>	
1	01.03.2022	3	Principles and need for protective schemes	T1,R1
2	02.03.2022	2	Nature and causes of faults	T1,R1
3	03.03.2022	4	Types of faults	T1,R1
4	07.03.2022	3	Methods of grounding	
5	07.03.2022	7	Zones of protection	T1,R1
6	08.03.2022	3	Essential qualities of protection	T1,R1
7	09.03.2022	2	Protection scheme	T1,R1
8	10.03.2022	4	Revision	
9	14.03.2022	3	Revision	
<b>UNIT II - ELECTROMAGNETIC RELAYS</b>			<b>Target periods :9</b>	
10	14.03.2022	7	Operating principles of relays	T1,R1
11	15.03.2022	3	The universal relay	T1,R1
12	16.03.2022	2	Torque equation	T1,R1
13	17.03.2022	4	R-x diagram	T1,R1
14	19.03.2022	3	Electromagnetic relays	T1,R1
15	21.03.2022	3	Over current relays	T1,R1
16	21.03.2022	7	Directional relays,Distance relays	T1,R1
17	22.03.2022	3	Differential relays	T1,R1
18	23.03.2022	2	Negative sequence relays	T1,R1
19	24.03.2022	4	Under frequency relays	T1,R1
20	26.03.2022	2	Revision	
21	28.03.2022	3,7	Revision	
<b>UNIT III - APPARATUS PROTECTION</b>			<b>Target Periods :9</b>	
22	29.03.2022	3	Current transformers	T1,R1
23	30.03.2022	2	Potential transformers	T1,R1
24	31.03.2022	4	Applications in protection schemes	
25	04.04.2022	3	Protection of transformer	T1,R1
26	04.04.2022	7	Protection of generator	T1,R1
27	05.04.2022	3	Protection of motor,	T1,R1
28	06.04.2022	2	Protection of bus bars	T1,R1
29	07.04.2022	4	Protection of transmission line	T1,R1
30	11.04.2022	3	Revision	T1,R1
31	11.04.2022	7	Revision	
32	12.04.2022	3	Revision	
<b>UNIT IV - STATIC RELAYS AND NUMERICAL PROTECTION</b>			<b>Target Periods :9</b>	
33	13.04.2022	2	Static relays	T1,R1
34	21.04.2022	4	Phase comparators	
35	25.04.2022	3	Amplitude comparators	T1,R1
36	25.04.2022	7	Synthesis of various relays using static comparators	T1,R1

  
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36	26.04.2022	3	Block diagram of numerical relays	T1,R1
37	27.04.2022	2	Over current protection	T1,R1
38	28.04.2022	4	Transformer differential protection	T1,R1
39	02.05.2022	3	Distant protection of transmission lines	T1,R1
40	02.05.2022	7	Revision	T1,R1
41	04.05.2022	2	Revision	T1,R1
<b>UNIT V -CIRCUIT BREAKERS Target Periods:9</b>				
42	05.05.2022	4	Physics of arcing phenomenon	T1,R1
43	09.05.2022	3	Arc interruption	T1,R1
44	09.05.2022	7	Dc circuit breaking and	T1,R1
45	10.05.2022	3	Ac circuit breaking	T1,R1
46	11.05.2022	2	Re-striking voltage and recovery voltage	T1,R1
47	12.05.2022	4	Rate of rise of recovery voltage	T1,R1
48	19.05.2022	4	Resistance switching,current chopping	T1,R1
49	23.05.2022	3,7	Interruption of capacitive current	T1,R1
50	24.05.2022	3	Types of circuit breakers-air blast, air break, oil	T1,R1
51	25.05.2022	2	Sf6, mcbs, mccls	T1,R1
52	26.05.2022	4	Vacuum circuit breakers , comparison of different circuit breakers	T1,R1
53	30.05.2022	3,7	Rating and selection of circuit breakers.	T1,R1
<b>Content Beyond the Syllabus</b>				
54	31.05.2022	3	Hybrid Switchgears	Material

#### Book Reference - Text Books

Sl.No	Title of the Book	Author	Publisher	Year
1	Switchgear and Protection	Sunil S.Rao	Khanna Publishers	2008
2	Power System Protection and Switchgear	B.Rabindranath and N.Chander	New Age International (P) Ltd.	2011
3	Switch Gear and Protection	Arun Ingole	Pearson Education	2017

#### Book Reference - Reference

Sl.No	Title of the Book	Author	Publisher	Year
1	Power System Protection and Switchgear	BadriRam ,B.H. Vishwakarma	New Age International Pvt Ltd Publishers	2011
2	Fundamentals of power system protectio	Y.G.Paithankar and S.R.Bhide	Prentice Hall of India Pvt	2010
3	Electrical Power Systems	C.L.Wadhwa	New Age International (P) Ltd.,	2010

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## DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

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### DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

#### Identification of Curricular Gap & Content beyond Syllabus (CBS)

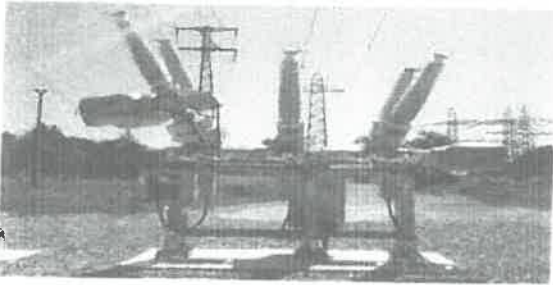
#### MATERIAL

Name of the Faculty : Dr.G. Malathi, Prof / EEE

Course Code & Name: EE8602 PROTECTION AND SWITCHGEAR

Degree & Program: B.E. /EEE Semester & Section: III / A Academic Year: 2018 -2019/ODD

TOPIC: Hybrid Switchgears



Hybrid switchgears combine the components of traditional air-insulated switchgears (AIS) and SF6 gas-insulated switchgear (GIS) technologies. Hybrid switchgears are characterized by a compact and modular design which encompasses several different functions in one module. These are condensed switchgears which are mainly used in the renovation and extension of substations with AIS-based switchgears where such 5 | Five Trends Shaping the Future of the Switchgear Market, October 2021 ©Lucintel modifications must be carried out while keeping the substation in service. Expensive land prices, unavailability of adjacent land, and increasingly intricate approval procedures have made space and time the main cost factors in the development of substations. Hybrid switchgears provide the opportunity to adapt a substation to the modern world's demands in the fastest time possible, and, most importantly, without requiring additional space, and they have circuit breakers, switches, disconnections and transformers all housed in one pressure resistant and gas-tight enclosed space.

It typically involves a combination of air-insulated (AIS) or gas-insulated (GIS) or Solidly insulated compartments or modules within a single switchgear arrangement. Generally, Breaker poles may be gas insulated, while the busbar is outside gas compartment in Air with solid insulation in Hybrid GIS.

  
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HT panels are installed both outdoor and indoor as well, while mostly used in substations for controlling the electricity flow. LT Panels are used with low tension cables to obtain power from the generator or transformer and distribute electricity to various electrical devices and distribution boards

Mixed Technologies Switchgear is defined by the following: Compact switchgear assemblies consist of at least one switching device directly connected to, or sharing components with, one or more other devices such that there is an interaction between the functions of the individual devices.

**Application:**

Switchgears perform various functions in the power grid. They are primarily responsible for energy distribution – they ensure constant energy supplies to all network recipients. These are ZK – cable connectors, SK – cable cabinets. They also have measuring and balancing function.



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**DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING**


**Assignment Question Paper**

Assignment – 03		Date of Issue:	13.08.2018	Marks	10
Course code	EE8602	Course Title	Protection & Switch Gear		
Year	II	Semester/Section	III	Date of Submission:	23.08.2018

Q.No	Questions	CO
1	Describe the Principle of percentage biased differential relay with necessary diagram. also discuss it application	C204.4
2	Explain in details Merce -Price Differential relay	C204.4

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## DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

### Assignment Answer Sheet

Name of the Student: Hariharan E AU Register

Number: 811221105012

Assignment – 03		Date of Issue:	13.08.2018	Marks	10
Course code	EE8602	Course Title	Protection & Switch Gear		
Year	II	Semester/Section	III	Date of Submission:	23.08.2018

Q.No	Questions	CO
1	Describe the Principle of percentage biased differential relay with necessary diagram. also discuss it application	C204.4
2	Explain in details Merce -Price Differential relay	C204.4

### Mark Allocation

Rubrics	Marks Allocated	Marks obtained
Content Quality	6	5
Presentation Quality	2	1
Timely submission	2	1
<b>Total marks</b>	<b>10</b>	<b>07</b>

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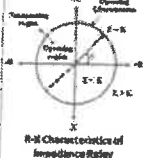
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Internal Assessment Exam - III			Date/Session	08/03/23 AN	Marks	50
Course code	EE8602	Course Title	Protection & Switch Gear			
Regulation	2017	Duration	90 minutes	Academic Year	2018-19	
Year	2 <sup>ND</sup>	Semester	III	Department	EEE	
<b>COURSE OUTCOMES</b>						
CO1:	Ability to understand and analyze Electromagnetic and Static Relays.					
CO2:	Ability to suggest suitability circuit breaker.					
CO3:	Ability to find the causes of abnormal operating conditions of the apparatus and system.					
CO4:	Ability to analyze the characteristics and functions of relays and protection schemes.					
CO5:	Ability to study about the apparatus protection, static and numerical relays.					
CO6:	Ability to acquire knowledge on functioning of circuit breaker.					


Q.No.	Question	CO
<b>PART A</b> (Answer all the Questions 10 x 2 = 20 Marks)		
1	List the basic requirement of protective relay	CO4
2	Show the different type of electromagnetic relay	CO4
3	Discuss R-X Diagram	CO4
4	In What way a distance relay is superior to over current protection of transmission line	CO4
5	Define differential relay	CO4
6	Show the merits of mho relay	CO5
7	Define under frequency relay	CO5
8	When is under frequency relay require in power system	CO5
9	Which type of relay is best suited for long distance very high voltage transmission line	CO5
10	What is RRRV?	CO5
<b>PART B</b> (Answer all the Questions 2 x 10 = 20 Marks)		
11a	Explain the Principle of working of distance relays. Describe with neat sketch the following type of relays and indicate difference on RX diagrams and show each type	CO4
OR		
11b	Explain the construction details & principle of operation of directional induction cup relay	CO4
12a	Describe the Principle of percentage biased differential relay with necessary diagram. also discuss its application	CO5
OR		
12b	Describe the principle of i) Negative sequence relay (ii) under frequency relay	CO5
<b>PART C</b> (Answer all the Questions 1 x 10 = 10 Marks)		
13a	Explain in details Merce -Price Differential relay	CO4

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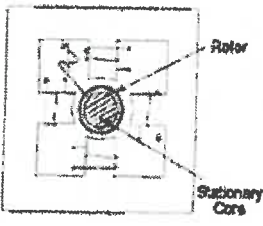
**PART A**  
(Answer all the Questions 10 x 2 = 20 Marks)

1	List the basic requirement of protective relay. Selectivity, Speed, Sensitivity, Reliability, Simplicity, Economy.	CO4
2	Show the different type of electromagnetic relay. Attracted armature type relays, induction disc type relays, induction cup type relays, balanced beam type relays, and more.	CO4
3	Discuss R-X Diagram. 	CO4
4	In What way a distance relay is superior to over current protection of transmission line. They are not nearly so much affected by changes in short-circuit-current magnitude.	CO4
5	Define differential relay. One that operates when the phasor difference of two or more similar electrical quantities exceeds a pre-determined value.	
6	Show the merits of mho relay. Mho relay is suitable for EHV/UHV heavily loaded transmission lines as its threshold characteristic in Z-plane is a circle passing through the origin, and its diameter is ZR.	CO5
7	Define under frequency relay. Under Frequency Relay means an electrical measuring relay intended to operate when its characteristic quantity reaches the relay settings by decrease in frequency.	CO5
8	When is under frequency relay require in power system . These relays are designed to detect a decrease in frequency, which may be caused by an overload, a sudden loss of generation, or a fault in the power system.	CO5
9	Which type of relay is best suited for long distance very high voltage transmission line . Mho Relay: The relay which is selected for long transmission lines should be less affected due to power swings. Hence Mho relay is preferred.	CO5
10	What is RRRV? The Rate of Rise of Recovery Voltage (RRRV) is defined as peak transient recovery voltage divided by the total time from zero voltage to peak voltage	CO5

**PART B**  
(Answer all the Questions 2 x 10 = 20 Marks)


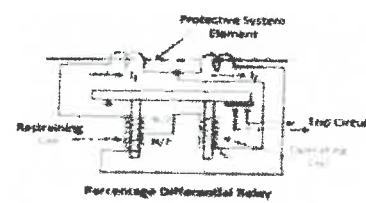
11a	Explain the Principle of working of distance relays. Describe with neat sketch the following type of relays and indicate difference on RX diagrams and show each type 	CO4
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OR

11b	Explain the construction details & principle of operation of directional induction cup relay Induction cup relay work in same principle of induction disc relay. The basis construction of this relay is just like four poles or eight pole induction motor. The number of poles in the protective relay depends upon the number of winding to be accommodated. The figure shows a four pole induction cup relay 	CO4
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12a	Describe the Principle of percentage biased differential relay with necessary diagram. also discuss it application The concept of percentage biased differential comes into play wherein relay operation is based on differential current as a function of through current. In this way, pick-up setting is raised as through current increases.	CO5
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	OR		
12b	<p>Describe the principle of i) Negative sequence relay (ii) under frequency relay</p> <p>Negative sequence relays protect electrical machines against overheating due to unbalance currents in the stator. These unbalance winds cause heating of the rotor and damage it. Unbalance three-phase currents have negative sequence components.</p>		CO5
<b>PART C</b> <b>(Answer all the Questions 1 x 10 = 10 Marks)</b>			
13a	<p>Explain in details Merce -Price Differential relay</p> <p>The difference of the currents under fault conditions is arranged to pass through the operating coil of the relay. The relay then closes its contacts to isolate protected section from the system. This form of protection is also known as Merz-Price circulating current scheme</p>		CO4

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IG Valley, Manikandam, Tiruchtrappathi, Tamil Nadu - 622 012, India  
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## Internal Assessment Test Answer Book

Name	A. Praveen Kumar	Year/Semester/Section	1/1/2
Batch No	EE0207186012	Date/Session	
Course code	EE3802	Department	EE
Course Title	Power System & Reliability		
Internal Assessment Test	IAT 1 <input checked="" type="checkbox"/>	IAT 2 <input type="checkbox"/>	IAT 3 <input type="checkbox"/> Model <input type="checkbox"/>

Name and Signature of the Investigator with date

*G. Srinivasan*  
G. Srinivasan

Instructions to the Student: Put tick mark to the questions attended in the column. Ignore questions

Part A		Part B / Part C		Total Marks
Q. No	Marks	Q. NO.	Marks	
1		11	05	05
2		12	07	07
3		13	08	08
4		14		
5		15		
6		16		
-				
				<b>Total</b>
				23
10				
<b>Total</b>		<b>Grand Total</b>		

*G. Srinivasan*  
Name and Signature of the Examiner with date

To be filled by the examiner

Date	1	4	1	1
Time	10	10	10	10
Remarks	10	10	10	10

M. Audit - Remarks

*G. Srinivasan*

*G. Srinivasan*  
Name and Signature of the Examiner with date

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