MUZAFFARPUR INSTITUTE OF TECHNOLOGY,
Muzaffarpur
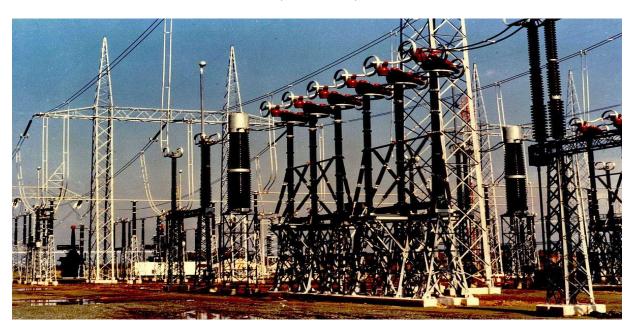
COURSE FILE

OF

Switch gear and protection

(031833)

Faculty Name:

MR. HARI CHARAN VERMA

ASSISTANT PROFESSOR, DEPARTMENT OF ELECTRICAL ENGINEERING

Content

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VISION STATEMENT OF ELECTRICAL ENGINEERING DEPARTMENT

To produce cutting edge Electrical Engineers, innovators, researchers, and entrepreneurs with high human values to serve society, industry, nation and the world.

MISSION STATEMENT OF ELECTRICAL ENGINEERING DEPARTMENT

M1. To create state-of-the-art facilities for under-graduate, post- graduate and R&D work.

M2. To cater the needs of society with recent technologies, innovative ideas and inculcate ethical responsibilities.

M3. To develop strong collaborative links with premier industries, institutions and the government agencies.

Program Educational Objectives (PEOs) of Electrical Engineering Department:

PEO 1. Students will be able to engage in life-long learning and research including supportive and responsible roles on multi-disciplinary tasks.

PEO 2. Students will acquire, use and develop skills as required for effective professional and societal practices and leadership quality.

PEO 3. Students will be able to create a new dimension of innovation and entrepreneurship.

Program Outcomes (POs) based on Program Educational Objectives (PEOs) of Electrical Engineering Department:

PO 1. Students will be able to apply knowledge of applied mathematics & science in electrical engineering problems.

PO 2. Students will be able to identify, formulate and solve society and industries related problems.

PO 3. Students will be able to apply knowledge to design a system, component or process to meet desired needs within realistic constraints.

PO 4. Students will be able to conduct laboratory experiments and to critically analyze and interpret experimental data.

PO 5. Students will be able to use the recent techniques, skills, and modern tools necessary for engineering practices.

PO 6. Students will be able to understand the impact of engineering problems, solutions in a global and societal context.

PO 7. Students will be able to demonstrate professional and ethical responsibilities.

PO 8. Students will be able to apply leadership quality to work with team in the area of electrical engineering towards the solution of multi-disciplinary tasks.

PO 9. Students will be able to communicate effectively through verbally, technical writing, reports and presentation.

PO 10. Students will be able to develop confidence for self-education and ability to engage in life-long learning.

COURSE OBJECTIVE AND COURSE OUTCOMES:

Institute/college Name	Muzaffarpur Institute of Technology, Muzaffarpur
Program Name	B.E. Electrical (VIII semester)
Course Code/course credits	031833 (4)
Course Name	Switch Gear and Protection
Lecture/ Sessional (per week)	3/1
SEE duration	4 hours
Course Coordinator Name	Mr. Hari Charan Verma

Course objective:

To understand the need of protection of electric equipment and their protection schemes. To understand the operations & characteristics of protective system like circuit breaker, transducers and protective relays. To understand the unit protection and over voltage protection of different apparatus in power system.

Course outcomes (CO):

CO1: Identify various types of faults in Power system. Select suitable switchgears for different applications

CO2: Explain the working of different types of switchgear equipment's like circuit breakers and relays. Design the ratings for fuses according to the requirement.

CO3: Explain various protection schemes of various power system components like alternators, motors, feeders, transformers and bus-bars.

CO4: Explain various methods to protect power system against over voltages

MAPPING OF COs AND POs

Sr. No.	Course Outcome	PO
1.	CO1: Identify various types of faults in Power system. Select suitable switchgears for different applications	PO1, PO2, PO3, PO5, PO6, PO9, PO10
2.	CO2: Explain the working of different types of switchgear equipment's like circuit breakers and relays. Design the ratings for fuses according to the requirement.	PO3, PO6, PO9, PO10
3.	CO3: Explain various protection schemes of various power system components like alternators, motors, feeders, transformers and bus-bars.	PO1, PO3, PO6, PO7, PO8, PO10
4.	CO4: Explain various methods to protect power system against over voltages	PO1, PO2, PO4, PO10

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	√	√	√	-	√	√	-	-	√	√
CO2	-	-	√	-	-	√	-	-	√	√
CO3	√	-	√	-	-	√	√	√	-	√
CO4	√	√	-	√	1	-	-	-	-	√

Course Syllabus:

UNIT-I

Circuit breakers: arc voltage mechanism of arc interruption restriking voltage and recovery voltage, classification of CBs oil CBs Air CBs Vacuum, Sf6 CBs HVDC CBs, Rating and Resting of CBs.

UNIT-II

Protective Relaying: Introduction to protective relaying, thermal relay, over current relay, Directional relay, Differential really.

Transmission Line and Feeder Protection: Over Current and directional relay applications distance Protection using impedance relay, reactance relay, MHO relay.

UNIT-III

Generator Protection: Protection against stator and rotor faults and abnormal operating conditions such as unbalanced loading, loss excitation, over speeding.

Transformer Protection: Types of faults, over current protection, differential protection, Differential relay with harmonic restraint, Protection against high resistance ground faults, interturn faults, Bucholz relay.

UNIT-IV

Introduction Motor Protection: Production against phase fault, ground fault and abnormal operating conditions such as single phasing, Phase reversal and overloading.

Introduction to carrier-aided protection and numerical protection

Books:

- **Power System Protection & Switch Gear by Badriram and Vishwakarma, TMH Publication.**
- **Switch Gear and Protection by Sunil S. Rao, Khanna Publications**
- **Power System Protection & Switch Gear by Ravindranath & Chander, New Age Publications**
- **The Art and Science of Protective Relaying by C. Russel Mason, Wiley Western Ltd.**

GATE Syllabus of Switch Gear and Protection:

Section: Power Systems

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss-Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis**, Principles of over-current, differential and distance protection; Circuit breakers,** System stability concepts, Equal area criterion.

MUZAFFARPUR INSTITUTE OF TECHNOLOGY
B.Tech. 8th (Eight) Semester (2014 Batch)

DAY	I (10-10.50AM)	II (10.50-11.40AM)	III (11.40-12.30PM)	IV (12.30-01.20PM)		V (01.50-1.40PM)	VI (2.40-3.30PM)	VII (3.30-4.20PM)
MON			M CTRL(NK)53	P.M.&I.R.(H)48	B	---------------- PROJECT (MAJOR) (YNS)----------------		
TUE		---------------- PROJECT (MAJOR) (YNS) 48 ----------------			R	---------------- SEMINAR (RSS) IT4 ----------------		
WED	SGP(HCV)50	P.M.&I.R.(H)48	Pwr S Des(YNS)48		E	------------- POWER SYSTEM DESIGN (YNS)-----------		
THU	SGP(HCV)50	SGP(HCV)50	M CTRL(NK) 53	M CTRL(NK) 53	A	---------------- PROJECT (YNS) 15A ----------------		
FRI	M CTRL(NK)53	P.M.&I.R.(H)53	SGP(HCV)50	Pwr S Des(YNS)53	K	-------------- PROJECT (YNS) ----------------		
SAT		---------------- PROJECT MAJOR (YNS)IT3 --------------						

HCV-Hari Charan Verma, NK-Nayan Kumar, RSS- Ram Sagar Singh, YNS- Yagyanand Sharma

Asst.Prof.-in-charge (TT)   Prof.-in-charge (TT)   Principal

STUDENT LIST:

S.NO.	Roll No	Name
1	14EE01	AYUSH KUMAR
2	14EE02	ANSHU PRIYA
3	14EE03	ANJALI SINHA
4	14EE04	NIHARIKA
5	14EE05	ABHISHEK
6	14EE06	UDIT KUMAR
7	14EE07	NEHA KUMARI
8	14EE08	DEEPAK KUMAR
9	14EE09	NAVENDU JHA
10	14EE10	VIKASH KUMAR
11	14EE11	PANKAJ KUMAR RAMAN
12	14EE12	KUMAR AYUSH
13	14EE13	ADITYA KUMAR
14	14EE14	SUDHAKAR PRASAD
15	14EE15	SHWETA KUMARI
16	14EE16	LAVANYA
17	14EE17	PAMIT KUMAR
18	14EE18	DEEP SHIKHA
19	14EE19	MD SHAH JAHAN
20	14EE20	CHANDAN PRAKASH
21	14EE21	ASHUTOSH KUMAR
22	14EE22	ANURANJAN KUMAR

23	14EE23	SHALU KUMARI
24	14EE24	KANHAIYA LAL MANDAL
25	14EE25	DEEPAK KUMAR
26	14EE27	RAHUL KUMAR
27	14EE28	SURYA KANT PATEL
28	14EE30	GULSHAN KUMAR
29	14EE31	ARVIND KUMAR
30	14EE32	SATISH KUMAR SINGH
31	14EE33	AVINASH KUMAR
32	14EE34	RANJIT KUMAR
33	14EE35	RAVI RANJAN
34	14EE36	ABHISHEK KUMAR
35	14EE37	AMIT KUMAR
36	14EE38	ALAKH NIRANJAN KUMAR
37	14EE39	KAMLESH KUMAR
38	14EE40	DHARAMVEER KUMAR
39	14EE41	ABHISHEK RAJ
40	14EE42	RAVINDAR KUMAR
41	14EE43	SHOAA AKBARI
42	14EE44	NITESH
43	14EE45	KAMLESH KUMAR
44	14EE46	CHANDAN KUMAR
45	14EE47	BHAWNA SINHA
46	14EE48	AHMAD RAJA
47	14EE51	NIDHI

48	14EE52	ROHIT
49	14EE53	KUMARI PALLAVI
50	14EE54	RAVI KANT SINGH
51	14EE55	PRASHANT KUMAR
52	14EE56	RAJAN KUMAR
53	14EE57	MAHBOOB AKHTAR
54	14EE58	MD NAHID ALAM
55	14EE59	PRINCE KUMAR
56	14EE60	MANI RAJ
57	14EE61	PANKAJ KUMAR SAW
58	14EE62	ALEKH RAJ
59	14EE63	SURAJ KUMAR
60	15(LE)EE01	VICKEY KUMAR
62	15(LE)EE03	ANAND KUMAR
63	15(LE)EE04	SONAM SINHA
64	15(LE)EE05	SARITA KUMARI
65	15(LE)EE06	PRATIBHA KUMARI
66	15(LE)EE07	ABHISHEK KUMAR
67	15(LE)EE08	ASHUTOSH KUMAR
68	13EE17	NEERAJ KUMAR

Course Plan:

Text Books:

TB1: Sunil S Rao, "Switchgear and Protection" 12th ed., Khanna Publlishers, 2007.

TB2: Badari Ram, "Power System Protection and Switchgear" 1st ed., D.N Viswakarma, TMH Publications, 2005.

TB3: J. B. Gupta, "Switchgear and Protection" S. K. Kataria & Sons, 2009

Reference Books:
RB1: T S Madhav Rao, "Power System Protection: Static Relays", 2nd ed. Tata MC Graw-Hill, 2007.
RB2: CL Wadhwa, "Electrical Power Systems", 4th ed., New Age international (P) Limited, 2008.
RB3. Paithankar and S. R. Bhide, "Fundamentals of Power System Protection" 1st ed., Prentice Hall of India, 2007.
RB4. Power System Protection & Switch Gear by Ravindranath & Chander, New Age Publications.

Other readings and relevant websites

S.No.	Link of Journals, Magazines, websites and Research Papers
1.	http://nptel.ac.in/downloads/108101039/
2.	http://nptel.ac.in/courses/108101039/39
3.	http://nptel.ac.in/courses/Webcourse-contents/IIT%20Bombay/Power%20System%20Protection/TOC_M1.html
4.	https://www.eiseverywhere.com/.../aaf42a76a5588f69c7a1348d6f77fe0f_Introduction
5.	http://www.faadooengineers.com/threads/25566-Power-system-protection-complete-notes-ebook-free-download-pdf
6.	http://doctord.dyndns.org/Courses/BEI/ECE477/LectureNotes.pdf

COURSE PLAN

Lecture Number	Topics	Web Links for video lectures	Text Book / Reference Book	Page numbers of Text Book(s)
1-7	**Circuit breakers**		TB2, RB4	533-575
	Arc voltage mechanism of arc interruption restriking voltage and recovery voltage, classification of CBs oil CBs Air CBs Vacuum, Sf6 CBs HVDC CBs, Rating and Resting of CBs.	https://www.youtube.com/watch?v=6zhOFTBf1wU		
7-12	**Protective Relaying**		TB2, TB3	1-64
	Introduction to protective relaying, thermal relay, over current relay, Directional relay, Differential realy.	https://www.youtube.com/watch?v=4J51nID431E&list=PL8B4h5UPC4CXKTE7-CQ8e2nbFYwQgRRAx		
12-18	**Transmission Line and Feeder Protection**		TB1, TB2, RB4	221-304
	Over Current and directional relay applications distance Protection using impedance relay, reactance relay, MHO relay.	https://www.youtube.com/watch?v=4sc2Dq-is_M&list=PL8B4h5UPC4CXKTE7-CQ8e2nbFYwQgRRAx&index=10		
18-23	**Generator Protection**		TB3, RB1	349-361
	Protection against stator and rotor faults and abnormal operating conditions such as unbalanced loading, loss excitation, over speeding.	https://www.youtube.com/watch?v=pYbznK0nqW0&index=3&list=PL8B4h5UPC4CXKTE7-CQ8e2nbFYwQgRRAx		
23-28	**Transformer Protection**		TB2, TB3, RB3	364-377
	Types of faults, over current protection, differential protection, Differential relay with harmonic restraint, Protection against high resistance ground faults, interturn faults, Bucholz relay.	https://www.youtube.com/watch?v=pYbznK0nqW0&index=3&list=PL8B4h5UPC4CXKTE7-CQ8e2nbFYwQgRRAx		
28-33	**Introduction Motor Protection**		TB2, RB2	349-361

Production against phase fault, ground fault and abnormal operating conditions such as single phasing, Phase reversal and overloading.	https://www.youtube.com/watch?v=kX0gQ9MOSKI		
33-35	**Introduction**		TB2, RB4	379-450
	Introduction to carrier-aided protection and numerical protection	https://www.youtube.com/watch?v=j3o5n80gyjU		

LECTURE PLAN

Topics	Lecture Number	Date on which the Lecture was taken
Circuit breakers		
Arc voltage mechanism of arc interruption restriking voltage and recovery voltage	1	15/02/2018
classification of CBs oil CBs Air CBs Vacuum	2	15/02/2018
Sf6 CBs HVDC CBs,	3	20/02/2018
Rating and Resting of CBs	4	21/02/2018
Protective Relaying		
Introduction to protective relaying	5	22/02/2018
thermal relay	6	22/02/2018
over current relay	7	14/03/2018
Directional relay	8	15/03/2018
Differential relay	9	15/03/2018
Transmission Line and Feeder Protection		
Over Current and directional relay applications	10	20/03/2018
distance Protection using impedance relay	11	21/03/2018
Reactance relay	12	27/03/2018
MHO relay	13	28/03/2018
Generator Protection		
Protection against stator and rotor faults	14	02/04/2018

Protection against abnormal operating conditions such as unbalanced loading	**15**	**04/04/2018**
Protection against loss excitation, over speeding	**16**	**05/04/2018**
Transformer Protection		
Types of faults, over current protection	**17**	**09/04/2018**
differential protection,	**18**	**11/04/2018**
Differential relay with harmonic restraint	**19**	**12/04/2018**
Protection against high resistance ground faults, interturn faults, Bucholz relay.	**20**	**16/04/2018**
Introduction Motor Protection		
Protection against phase fault, ground fault	**21**	**18/04/2018**
Protection against abnormal operating conditions such as single phasing, Phase reversal and overloading	**22**	**19/04/2018**
Introduction to carrier-aided protection and numerical protection	**23**	**23/04/2018**

DETAILS OF ASSIGNMENTS:

S.No.	Assignment	Topic No.
1	Assignment 1	1
2	Assignment 2	2
3	Assignment 3	3
4	Assignment 4	3
5	Assignment 5	4

DETAILS OF TUTORIAL:

S.No.	Tutorial	Topic No.
1	Tutorial 1	1
2	Tutorial 2	2

Switch gear and Protection (EE-031833)

Assignment 1 (Protective Relaying)

1. What is an impedance relay? Explain its operating principle. Discuss how it is realized using the

   (i)Electromagnetic principle

   (ii)Amplitude comparator

   (iii)phase comparator

2. Explain impedance, reactance and mho relay characteristic on the R-X diagram. Discuss the range setting of three impedance relays placed at a particular location. Discuss why the I zone unit is not set for the protection of 100% of the line.

3. Draw and explain the circuit connection of three impedance relays together with the directional relay, circuit breaker trip coil, CB auxiliary switch, flags, seal-in relay.

4. Explain stepped time-distance characteristics of three distance relaying units used for I, II, III zone of protection.

Switch gear and Protection(EE-031833)
Assignment 2(Distance Protection)

1. What are different types of distance relays. Compare their merits and demerits. Discuss their field of applications.

2. What is an angle impedance relay. Discuss how its characteristics is realized using the phase comparison technique.

3. Discuss the protection employed against loss of excitation of an alternator.

4. What type of a protective scheme is employed for the protection of the field winding of the alternator against ground faults.

5. What type of protective device is used for the protection of an alternator against overheating of its (a) stator (b) rotor
   Discuss them in brief.

6. Describe with a neat sketch, the percentage differential protection of a modern alternator.

Switch gear and Protection(EE-031833)
Assignment 3(Circuit Breaker)

1. What are the different types of circuit breaker when the arc quenching medium is the criterion ? Mention the voltage range for which a particular types of circuit breaker is recommended.

2. Discuss the recovery rate theory and energy balance theory of arc interruption in a circuit breaker.

3. What are the advantages of an air blast circuit breaker over the oil circuit breaker?

4. Explain the phenomenon of current chopping in a circuit breaker. What measures are taken to reduce it?

5. Briefly describe the various types of SF_6 circuit breakers and discuss the arc extinction phenomenon in SF_6 circuit breakers.

6. Describe the construction, operating principle and application of vaccum circuit breaker. What are its advantages over conventional type circuit breakers? For what voltage ranges it is recommended?

Switch gear and Protection(EE-031833)
Assignment 4 (Relay)

1. What is an impedance relay? Explain its operating principle. Discuss how it is realized using the
   (i)Electromagnetic principle
   (ii)Amplitude comparator
   (iii)phase comparator

2. Explain impedance, reactance and mho relay characteristic on the R-X diagram. Discuss the range setting of three impedance relays placed at a particular location. Discuss why the I zone unit is not set for the protection of 100% of the line.

3. Draw and explain the circuit connection of three impedance relays together with the directional relay, circuit breaker trip coil, CB auxiliary switch, flags, seal-in relay.

4. Explain stepped time-distance characteristics of three distance relaying units used for I, II, III zone of protection.

5. What are different types of distance relays. Compare their merits and demerits. Discuss their field of applications.

Assignment 5(Generator Protection)

1. What is an angle impedance relay. Discuss how its characteristics is realized using the phase comparison techanique.

2. Discuss the protection employed against loss of excitation of an alternator.

3. What type of a protective scheme is employed for the protection of the field windind of the alternator against ground faults.

4. What type of protective device is used for the protection of an alternator against overheating of its (a) stator (b) rotor
Discuss them in brief.

5. Describe with a neat sketch, the percentage differential protection of a modern alternator.

Switch gear and Protection (EE-031833)

TUTORIAL SHEET 1

1. In a 132 kV system, the reactance per phase up to the location of the circuit -breaker is 5 Ω and capacitance to earth is 0.03 μF. Calculate (a) The maximum value of restriking voltage. (b) The value of RRRV, and (c) the frequency of transient oscillations.

2. Apply The short-circuit current of a 132 kV system is 8000 A. The current chopping occurs at 2.5% of peak value of the current. Calculate the prospective value of the voltage which will appear across the contacts of the circuit breakers. The value of stray capacitance to the earth is 100 μF.

3. In a 132 kV system, the inductance and capacitance per phase up to the location of the circuit breaker is 10 H and 0.02 μF, respectively. If the circuit breaker interrupts a magnetizing current of 20 A (instantaneous), current chopping occurs. Determine the voltage which will appear across the contacts of the circuit breaker. Also calculate the value of the resistance which should be connected across the contacts to eliminate the transient restriking voltage.

4. In a 132 kV system, reactance and capacitance up to the location of the circuit breaker is 5 Ω and 0.02 μF, respectively. A resistance 500Ω is connected across the breaker of the circuit breaker. Determine the (a) natural frequency of oscillation, (b) damped frequency of oscillation, and (c) critical value of resistance.

5. In a 132 kV system, the inductance and capacitance up to the location of the circuit breaker are 0.4H and 0.015μF respectively. Determine (a) the maximum value of the restriking voltage across the contacts of the circuit breaker, (b) frequency of transient oscillation and the maximum value of RRRV.

6. Dual In a 220 kV system, the reactance and capacitance up to the location of circuit breaker is 8 Ω and 0.025 μF, respectively. A resistance of 600 Ω is connected across the contacts of the circuit breaker. Determine the following:

(a) Natural frequency of oscillation.

(b) Damped frequency of oscillation.

(c) Critical value of resistance which will give no transient oscillation.

(d) The value of resistance which will give damped frequency of oscillations, one-forth of the natural frequency of oscillation.

Switch gear and Protection(EE-031833)
TUTORIAL SHEET 2

1. What are the different methods of testing of circuit breakers? Discuss their merits and demerits. Which method is more suitable for testing the circuit breakers of large capacity?

2. In a multi-break circuit breaker, what measures are taken to equalize the voltage distribution across the breaks?

3. In a 132 kV system, reactance and capacitance up to the location of the circuit breaker is 5 Ω and 0.02 μF, respectively. A resistance 500Ω is connected across the breaker of the circuit breaker. Determine the (a) natural frequency of oscillation, (b) damped frequency of oscillation, and (c) critical value of resistance.

4. In a 132 kV system, the inductance and capacitance up to the location of the circuit breaker are 0.4H and 0.015μF respectively. Determine (a) the maximum value of the restriking voltage across the contacts of the circuit breaker, (b) frequency of transient oscillation and the maximum value of RRRV.

5. What is the difficulty in the development of HVDC circuit breaker? Describe its construction and operating principle.

6. What are the main parts of equipment which are used for the testing of a laboratory type testing station.

MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR
B.Tech 8ᵗʰ Semester Mid-Term Examination, 2018
Switch Gear and Protection (031833)

Time: 2 hours   **Full Marks: 20**

Instructions: **(i) Attempt any four questions.**
                     (ii) The marks are indicated in the right-hand margin.
                     (iii) All questions carry equal marks.

1. What are the advantages of an air blast circuit breaker over the oil circuit breaker.   **5**

2. Explain the phenomenon of current chopping in a circuit breaker.   **5**

3. Explain the different types of circuit breaker.   **5**

4. Explain the phenomenon of restriking voltage.   **5**

5. Briefly describe SF_6 circuit breaker. And for what voltage ranges it is recommended   **5**

6. Operating principle and application of vaccum circuit breaker,   **5**

Question Bank:

(b) Explain the working of a harmonic restraint relay for a transformer protection. 7+7

6. (a) Discuss the benefits of computer relaying. 7+7

(b) Explain carrier pilot protection. What are the advantages of carrier channel protection over pilot wire protection?

7. (a) Define a circuit breaker.

(b) Define breaking current, symmetrical and asymmetrical breaking current.

(c) What are the classifications of circuit breaker using different criteria? 2+6+6

8. (a) Discuss all the property of SF_6 gas.

(b) For a 132 kV system, the reactance and capacitance up to the location of the circuit breaker is 3 ohms and 0.015 μF, respectively. Calculate

(i) the frequency of transient oscillation,

(ii) the maximum value of restriking voltage across the contacts of the circuit breaker and

(iii) the maximum value of RRRV. 9+5

9. Write short notes on any two of the following: 7×2

(a) Induction relay

(b) Physics of arc phenomenon in a circuit breaker.

(c) High voltage DC(HVDC) circuit breaker.

***

Code : 031833   4

Code : 031833

B. Tech. 8th Semester Exam., 2017

Switchgear and Protection

Time : 3 hours   Full Marks : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are *NINE* questions in this paper.

(iii) Attempt *FIVE* questions in all.

(iv) Questions No. 1 is compulsory.

1. Choose the correct options (Any seven):   2×7=14

(a) The probability of occurrence is very high for

    (i) L-G fault   (ii) L-L fault

    (iii) L-L-G fault   (iv) L-L-L fault

(b) Which type or relay is applicable for AC?

    (i) Attracted armature type relay

    (ii) Induction type relay

    (iii) Both

    (iv) None of the above

(c) The protection against unbalanced loading of alternator is provided by

    (i) Overcurrent relay

    (ii) Negative phase sequence relay

P.T.O.

(iii) Unbiased differential protection

(iv) None of the above

(d) Mho relay is normally used for the protection of

(i) Long transmission line

(ii) Medium transmission line

(iii) Short length line

(iv) No length criterion

(e) If the fault current is 2000 ampere, the relay is set to operate at 200 ampere with relay setting 50% and the CT ratio is 400/5, then the plug setting multiplier for relay setting of 100% will be

(i) 10   (ii) 5

(iii) 20   (iv) None of the above

(f) A fault is more severe from the view point of RRRV if it is a

(i) Short line fault (ii) Medium length line fault

(iii) Long line fault (iv) None of the above

(g) The capacitor switching is easily done with

(i) Air blast circuit breaker (ii) Oil circuit breaker

(iii) Vacuum circuit breaker (iv) All of the above

(h) The current chopping tendency is minimized by using SF$_6$ gas at relatively

(i) High pressure and low velocity

(ii) High pressure and high velocity

(iii) Low pressure and low velocity

(iv) Low pressure and high velocity

(i) The stability of arc in vacuum depends upon

(i) The contact material only

(ii) The contact material and its vapour pressure

(iii) The circuit parameter only

(iv) The combination of (ii) and (iii)

(j) The number of pilot wires required for protecting 3-phase transmission lines using translay system of protection is

(i) 6   (ii) 4

(iii) 3   (iv) 2

2. (a) Define a relay and draw its block diagram.

(b) List different components of a protection scheme and explain their role in a protection system.

(c) Describe the principle of overcurrent protection and its application.

(d) Define plug setting multiplier and time multiplier setting of an IDMT relay.   3+3+4+4

3. (a) Describe all methods of discriminating a fault. 6+4+4

(b) Explain Merz-Price principle of differential protection.

(c) Describe the functioning of an impedance relay.

4. (a) "Unlike other apparatus opening a breaker to isolate a faulty generator is not sufficient to prevent." Explain.

(b) Explain abnormal running conditions of a generator.

(c) Discuss the protection against overload employed in a generator.   3+6+5

5. (a) Explain all the problems encountered in differential protection of a transformer.

Result of the students

Roll No	Name	Marks of attendance	Class test	End semester exam	Total
14EE01	AYUSH KUMAR	5	5	20	30
14EE02	ANSHU PRIYA	5	5	16	26
14EE05	ABHISHEK	5	5	13	23
14EE06	UDIT KUMAR	5	5	13	23
14EE07	NEHA KUMARI	5	5	18	28
14EE08	DEEPAK KUMAR	5	5	15	25
14EE09	NAVENDU JHA	5	5	13	23
14EE10	VIKASH KUMAR	5	5	18	28
14EE11	PANKAJ KUMAR RAMAN	5	5	12	22
14EE12	KUMAR AYUSH	5	5	9	19
14EE13	ADITYA KUMAR	5	5	9	19
14EE14	SUDHAKAR PRASAD	5	5	11	21
14EE15	SHWETA KUMARI	5	5	14	24
14EE16	LAVANYA	5	5	16	26
14EE17	PAMIT KUMAR	5	5	14	24
14EE18	DEEP SHIKHA	5	5	17	27
14EE19	MD SHAH JAHAN	5	5	13	23
14EE20	CHANDAN PRAKASH	5	5	13	23
14EE21	ASHUTOSH KUMAR	5	5	10	20
14EE22	ANURANJAN KUMAR	5	5	10	20
14EE23	SHALU KUMARI	5	5	20	30

14EE25	DEEPAK KUMAR	5	5	12	22
14EE28	SURYA KANT PATEL	5	5	15	25
14EE30	GULSHAN KUMAR	5	5	20	30
14EE31	ARVIND KUMAR	5	5	0	10
14EE32	SATISH KUMAR SINGH	5	5	14	24
14EE33	AVINASH KUMAR	5	5	14	24
14EE34	RANJIT KUMAR	5	5	15	25
14EE35	RAVI RANJAN	5	5	14	24
14EE36	ABHISHEK KUMAR	5	5	11	21
14EE38	ALAKH NIRANJAN KUMAR	5	5	20	30
14EE39	KAMLESH KUMAR	5	5	10	20
14EE40	DHARAMVEER KUMAR	5	5	16	26
14EE41	ABHISHEK RAJ	5	5	20	30
14EE42	RAVINDAR KUMAR	5	5	11	21
14EE43	SHOAA AKBARI	5	5	10	20
14EE44	NITESH	5	5	14	24
14EE45	KAMLESH KUMAR	5	5	13	23
14EE46	CHANDAN KUMAR	5	5	18	28
14EE47	BHAWNA SINHA	5	5	20	30
14EE48	AHMAD RAJA	5	5	12	22
14EE51	NIDHI	5	5	16	26
14EE52	ROHIT	5	5	16	26
14EE53	KUMARI PALLAVI	5	5	15	25
14EE54	RAVI KANT SINGH	5	5	18	28

14EE55	PRASHANT KUMAR	5	5	13	23
14EE58	MD NAHID ALAM	5	5	16	26
14EE59	PRINCE KUMAR	5	5	13	23
14EE60	MANI RAJ	5	5	12	22
14EE61	PANKAJ KUMAR SAW	5	5	18	28
14EE62	ALEKH RAJ	5	5	10	20
14EE63	SURAJ KUMAR	5	5	11	21
15(LE)EE01	VICKEY KUMAR	5	5	10	20
15(LE)EE03	ANAND KUMAR	5	5	15	25
15(LE)EE04	SONAM SINHA	5	5	10	20
15(LE)EE05	SARITA KUMARI	5	5	15	25
15(LE)EE06	PRATIBHA KUMARI	5	5	20	30
15(LE)EE07	ABHISHEK KUMAR	5	5	11	21
15(LE)EE08	ASHUTOSH KUMAR	5	5	13	23
13EE17	NEERAJ KUMAR	5	5	13	23

RESULT ANALYSIS

Theory (bar chart)

- <60%: 1
- 60-70%: 9
- 70-80%: 18
- 80-90%: 18
- 90-100%: 13

Theory (pie chart)

- <60%: 2%
- 60-70%: 15%
- 70-80%: 30%
- 80-90%: 31%
- 90-100%: 22%