SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

M.E (Power System Engineering)

QUESTION BANK

II SEMESTER

1916203-ADVANCED POWER SYSTEM PROTECTION

Regulation – 2019

Academic Year 2019– 20 (Even)

Prepared by

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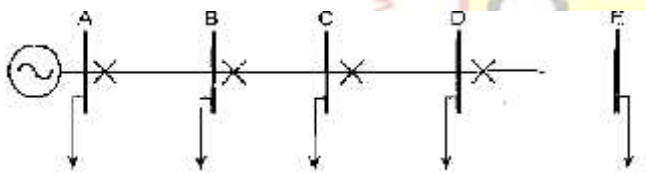
DEPARTMENT OF EEE

QUESTION BANK

SUBJECT : 1916203-ADVANCED POWER SYSTEM PROTECTION

SEM / YEAR: II / 2019-20 (Even)

UNIT I- OVER CURRENT AND EARTH FAULT PROTECTION				
Zones of protection – Primary and Backup protection – operating principles and Relay Construction - Time – Current characteristics-Current setting – Time setting-Over current protective schemes – Concept of Coordination - Protection of parallel / ring feeders - Reverse power or directional relay– Polarisation Techniques – Cross Polarisation – Quadrature Connection -Earth fault and phase fault protection - Combined Earth fault and phase fault protection scheme - Phase fault protective - scheme directional earth fault relay - Static over current relays – Numerical over – current protection; numerical coordination example for a radial feeder.				
PART - A				
Q.No	**Questions**	**BT Level**	**Competence**	**Course outcomes**
1.	Outline the necessity of protection for power system	BT-1	Remember	CO1
2.	Discuss about the zone of protection	BT-2	Understand	CO1
3.	Distinguish between internal and external fault	BT-2	Understand	CO1
4.	Briefly explain various concepts of cross polarisation	BT-2	Understand	CO1
5.	Distinguish between primary and backup protection	BT-2	Understand	CO1
6.	What do you understand from quadrature connection	BT-1	Remember	CO1
7.	Explain time setting and plug setting in over current relays	BT-3	Apply	CO1
8.	Define static over current relay	BT-1	Remember	CO1
9.	State the draw backs of over current protection	BT-1	Remember	CO1
10.	State the trip law of Reactance relay	BT-3	Apply	CO1
11.	Discuss about reclosure	BT-2	Understand	CO1
12.	Explain about instantaneous OC relay	BT-1	Remember	CO2
13.	Define Thermal relay	BT-1	Remember	CO2
14.	How will you adjust the MTA of a directional relay	BT-2	Understand	CO2
15.	Examine the scheme that shall be used to protect the parallel feeders and ring feeders	BT-4	Analyze	CO2
16.	Examine the reason for fault current variation between a minimum and a maximum at any location	BT-4	Analyze	CO2
17.	Differentiate phase fault and ground fault	BT-4	Analyze	CO2
18.	Can protective relay prevent faults?	BT-3	Apply	CO2
19.	Comment on “Speed of protection so important”	BT-6	Create	CO2
20.	Estimate the circuit breaker operating time and relay operating time	BT-5	Evaluate	CO2
PART - B				
1.	Explain the implementation of over current relay using induction disc	BT-1	Remember	CO3
2.	Describe the protection of Ring feeders	BT-2	Understand	CO2

3.	Explain the following 1. HRC Fuse and its current versus time characteristics 2. Thermal relay 3. Plug setting and time sitting in over current relay 4. Instantaneous OC relay	BT-1	Remember	CO2
4.	Discuss various zones of Protection	BT-1	Remember	CO3
5.	Describe the protection of Parallel and Ring feeders	BT-2	Understand	CO3
6.	Briefly explain about Polarisation techniques	BT-2	Understand	CO3
7.	Illustrate about the earth fault and phase fault protection with near sketches	BT-3	Apply	CO3
8.	Explain construction of Different types of over current protection Relays and its characteristics	BT-2	Understand	CO2
9.	Examine the procedure for time setting of relays on a ring main feeder system	BT-4	Analyze	CO2
10.	Elaborately discuss about quadrature connection.	BT-5	Evaluate	CO2
11.	Describe the concept of coordination	BT-4	Analyze	CO2
12.	Briefly explain Phase fault protective scheme	BT-2	Understand	CO2
13.	Describe the concept of Numerical Over current protection	BT-3	Apply	CO2
14.	Briefly explain static Over current relays	BT-2	Understand	CO2
1.	**PART C** For the system shown below, design the complete OC protection using the IDMT relays. Thus, decide the CT ratios, the plug settings and the TMS at all locations  Load current: 115A, 80A, 100A, 77A, 70A Minimum fault current: 1500A, 1000A, 780A, 585A, 390A Maximum fault current: 6000A, 5000A, 3000A, 2000A, 1000A	BT-6	Create	CO1
2.	Power systems are moving towards increasing complexity and demand equally Complex protection. Discuss	BT-6	Create	CO2
3.	Compare an isolated power system and an interconnected power system. How do their protection requirements differ?	BT-6	Create	CO2
4.	Explain the terms sensitivity and selectivity with respect to their use in the Protective relaying field	BT-6	Create	CO3

UNIT II - TRANSFORMER AND BUSBAR PROTECTION

Types of transformers –Types of faults in transformers- Types of Differential Protection – High Impedance – External fault with one CT saturation – Actual behaviours of a protective CT – Circuit model of a saturated CT - Need for high impedance – Disadvantages - Percentage Differential Bias Characteristics – Vector group & its impact on differential protection - Inrush phenomenon – Zero Sequence filtering – High resistance Ground Faults in Transformers – Restricted Earth fault Protection - Inter-turn faults in transformers – Incipient faults in transformers –DGA for transformer monitoring, Phenomenon of over fluxing in transformers – Transformer protection application chart. Differential protection of busbar external and internal fault - Supervisory relay-protection of three – Phase busbars – Numerical examples on design of high impedance busbar differential scheme –Biased Differential Characteristics – Comparison between Transformer differential & Busbar differential

PART - A

Q.No	Questions	BT Level	Competence	Course outcomes
1.	Mention the factors that cause spill current on external fault in case of transformer differential protection	BT-1	Remember	CO2
2.	Discuss the phenomenon of inrush in transformer?	BT-2	Understand	CO1
3.	List out the harmonic that is most dominant in the inrush waveform? Write all harmonic currents and its typical magnitudes	BT-1	Remember	CO2
4.	Examine the reasons for the failure of percentage differential relay to detect high resistance winding to core faults?	BT-4	Analyze	CO2
5.	Discuss about over-fluxing or over-excitation? Give the significance of the (V/f) ratio	BT-2	Understand	CO3
6.	Comment on “Fault current vary between a minimum and a maximum at any location	BT-6	Create	CO2
7.	Which harmonic is the most dominant in the inrush waveform	BT-1	Remember	CO2
8.	Why is over-fluxing harmful for the transformer	BT-1	Remember	CO3
9.	“During faulty operation of busbar protection causes large disturbances to the system” Comment	BT-1		CO3
10.	“Busbar differential scheme have a tendency to operate for external faults”- Comment	BT-2	Understand	CO2
11.	Define Stabilizing resistance? How to decide its value	BT-5	Evaluate	CO2
12.	Necessity of high impedance busbar differential protection scheme-Infer	BT-2	Understand	CO2
13.	Define stability ratio with respect to busbar differential protection	BT-3	Apply	CO2
14.	List out the needs for high impedance busbar protection	BT-4	Analyze	CO2
15.	Define stability ratio of high impedance busbar differential scheme	BT-3	Apply	CO2
16.	Explain supervisory relay	BT-2	Understand	CO2
17.	Explain the selection of CT ratio in case of busbar protection	BT-5		CO3
18.	Discuss the behaviour of a CT in deep saturation. What	BT-1	Remember	CO3
19.	How is the value of stabilizing resistance and its wattage	BT-1	Remember	CO3
20.	What is the typical range of values of stability ratio for a high impedance busbar differential scheme?	BT-5	Evaluate	CO3

PART - B				
1.	Explain how the transformer is protected against incipient faults and analysis of trapped gases.	BT-1	Remember	CO3
2.	Sketch the high impedance busbar differential protection for a three phase busbar having four incoming and 5 outgoing feeders	BT-1	Remember	CO3
3.	While normal load is being supplied, an open circuit takes place in one of the pilot wires. What will be the consequences as far as the busbar differential relay is concerned? Suggest an add-on to the differential relay, to avert a possible maloperation in the above scenario	BT-1	Remember	CO2
4.	Discuss the phenomenon of inrush? What are the factors on which the magnitude of inrush current depends	BT-2	Understand	CO3
5.	Illustrate the protection of transformer against incipient faults	BT-3	Apply	CO3
6.	Sketch the high impedance busbar differential protection for a three phase busbar having one incoming and 2 outgoing feeders	BT-4	Analyze	CO3
7.	A 132 kV busbar consists of two incoming lines and four outgoing lines. The system is solidly earthed and the switchgear capacity is 3000 MVA at 132 kV The parameters are: Maximum full-load current in one line = 500 A Rs = CT secondary resistance = 0.7 ohm, $R_{lead\ wire}$ = 2.0 ohm, Relay load (1 A relay is used) = 1.0 ohm, CT magnetizing current up to 120 V = 0.28 mA/V (assumed linear), CT saturation voltage V_{knee}> 120 V. **(i)** If the over-current relay in the spill path is set at 1.0A and the voltage setting $V_{set}$is 100 V, find (a) The maximum 'through fault' current up to which the scheme will remain stable. (b) Whether the answer in part (a) is commensurate with the switchgear capacity. (c) The minimum internal fault current which will be detected by the scheme. (d) The setting for detecting minimum internal fault current of 500 A? (e) The value of the stabilizing resistance. **(ii)** It is required that a break in the pilot wire from a CT carrying a current of 25A and more should be detected by the supervisory relay. Calculate the setting of the supervisory relay?	BT-3	Apply	CO3
8.	Explain the high impedance busbar differential protection scheme and derive the expression for maximum external fault current up to which the differential protection scheme remains stable and minimum fault current that can be detected by the scheme	BT-4	Analyze	CO3
9.	Explain the need for supervisory relay with suitable diagram	BT-5	Evaluate	CO3

10.	Explain the behaviour of busbar differential protection scheme on internal and external faults	BT-6	Create	CO3
11.	Briefly explain the concept of interturn faults in transformer	BT-4	Analyze	CO3
12.	Briefly explain about DGA monitoring of Power transformers	BT-5	Evaluate	CO3
13.	Briefly explain on design of high impedance bus bar differential scheme	BT-6	Create	CO3
14.	Briefly explain on Differential protection of bus bars	BT-4	Analyze	CO3
1.	**PART C** Discuss the behaviour of a CT in deep saturation. What are its implications for the busbar differential protection	BT-6	Create	CO3
2.	Design the differential protection for a three-phase, 50 Hz transformer with the following nameplate ratings: MVA 250, 15.75 kV/400 kV 50 Hz, delta-star	BT-6	Create	CO3
3.	Busbar differential scheme have a tendency to operate for external faults-Discuss	BT-6	Create	CO3
4.	Consider a single-phase 11 kV/11 kV, 1.1 MVA transformer protected by percentage Differential protection. CTs with 5 **A** secondaries are used. It is known that the magnetizing currents of the two CTs, for maximum external fault current, differ by 0.5 **A.** Assuming no other source of error and a minimum pick-up of 0.01 **A.** Find the minimum percentage bias setting so that the scheme remains table on maximum external fault current.	BT-6	Create	CO2

UNIT III- DISTANCE AND CARRIER PROTECTION OF TRANSMISSION LINES				
Drawback of over – Current protection – Introduction to distance relay – Simple impedance relay Reactance relay – mho relays comparison of distance relay – Distance protection of a three – Phase line-reasons for inaccuracy of distance relay reach - Three stepped distance protection - Trip contact configuration for the three - Stepped distance protection - Three stepped protection of three-phase line against all ten shunt faults - Impedance seen from relay side - Three-stepped protection of double end fed lines-need for carrier – Aided protection – Various options for a carrier –Coupling and trapping the carrier into the desired line section - Unit type carrier aided directional comparison relaying – Carrier aided distance schemes for acceleration of zone II; numerical example for a typical distance protection scheme for a transmission line. Protection schemes for FACTS devices.				
PART - A				
Q.No	**Questions**	**BT Level**	**Competence**	**Course outcomes**
1.	State the draw backs of over current protection	BT-1	Remember	CO4
2.	State the trip law of Reactance relay	BT-1	Remember	CO4
3.	Define three- stepped Distance Protection	BT-1	Remember	CO3
4.	Define permissive inter trip	BT-1	Remember	CO3
5.	Outline the concept of reclosure	BT-1	Remember	CO3
6.	Describe the situations where DTOC relays are preferred over IDMT relays	BT-2	Understand	CO3
7.	Summarize the reasons for requirement of distance protection for transmission line	BT-2	Understand	CO3
8.	List out the effects of arc resistances on the reach of simple impedance relay	BT-2	Understand	CO3
9.	Explain the trip law of Mho relay	BT-2	Understand	CO2
10.	What is meant by reach of relay	BT-3	Apply	CO3
11.	Sketch R-X diagram for Mho relay	BT-3	Apply	CO4
12.	Sketch R-X diagram for reactance relay	BT-3	Apply	CO4
13.	Distinguish reactance relay and mho relay	BT-4	Analyze	CO4
14.	List out the needs for carrier aided protection of transmission line	BT-4	Analyze	CO4
15.	Analyze the concept of Inter trip?	BT-4	Analyze	CO4
16.	Analyze the concept of comparison relaying?	BT-4	Analyze	CO4
17.	Discuss unit type carrier aided directional comparison relaying	BT-5	Evaluate	CO4
18.	Discuss longitudinal differential scheme	BT-5	Evaluate	CO4
19.	Discuss under impedance relay	BT-5	Evaluate	CO4
20.	Examine the reasons or factors contributing to inaccuracy of Distance relay reach	BT-6	Create	CO4
PART - B				
1.	List the possible causes for loss of excitation and explain protection against loss of excitation using offset Mho relay	BT-1	Remember	CO4
2.	Explain in detail about Carrier Aided Distance schemes for acceleration of Zone	BT-1	Remember	CO4

3.	Explain about the trip contact configuration for the three stepped distance protection	BT-1	Remember	CO4
4.	Discuss in detail about the distance protection of a three phase line	BT-2	Understand	CO4
5.	What is reactance relay? Describe in detail the operating Principle, implementation and also the various performance of reactance relay	BT-2	Understand	CO3
6.	Demonstrate with a neat diagram of Unit type carrier aided directional comparison Relaying	BT-3	Apply	CO3
7.	Demonstrate with a neat diagram of Mho relay	BT-3	Apply	CO3
8.	Examine about the three stepped distance protection?	BT-4	Analyze	CO3
9.	Explain how coupling and trapping of the carrier into the desired line section takes place	BT-5	Evaluate	CO3
10.	Discuss about various protection schemes of FACTS devices	BT-6	Create	CO3
11.	Briefly explain Unit type carrier aided directional	BT-3	Apply	CO3
12.	Briefly explain Stepped distance protection	BT-4	Analyze	CO4
13.	Discuss about Three stepped distance protection	BT-5	Evaluate	CO4
14.	Briefly explain Carrier aided distance schemes for	BT-6	Create	CO4
1.	**PART C** How many distance measuring units will be required for the complete three stepped Protection of a transmission line section in case of (i) a singly-fed systems and (ii) a double-end-fed system	BT-6	Create	CO3
2.	The impedance seen from the relay side in a distance relay is 10 ohms. Given that the CT ratio is 1000 : 1 and the PT ratio is 100,000 : 110, determine the actual Impedance. Given that the line has a resistance of 1 milliohm per km and a reactance of 20 milliohm per km, find the distance to fault. Assume single-phase line.	BT-6	Create	CO3
3.	Carrier helps in overcoming the limitation of the three-stepped Distance protection. Discuss	BT-6	Create	CO4
4.	Sending the carrier over a faulty line need to be avoided-Discuss	BT-6	Create	CO4

UNIT IV- GENERATOR PROTECTION

Electrical circuit of the generator –Various faults and abnormal operating conditions – Stator Winding Faults – Protection against Stator (earth) faults – third harmonic voltage protection – Rotor fault – Abnormal operating conditions - Protection against Rotor faults – Potentiometer Method – injection method – Pole slipping – Loss of excitation – Protection against Mechanical faults; Numerical examples for typical generator protection schemes

PART - A

Q.No	Questions	BT Level	Competence	Course outcomes
1.	List out various faults of generator	BT-1	Remember	CO4
2.	Define ground fault and phase fault	BT-6	Create	CO4
3.	Summarize various faults to which a turbo-alternator is likely to be subjected?	BT-6	Analyze	CO4
4.	Conventional differential protection cannot detect inter-turn faults on the same phase? Justify	BT-1	Remember	CO5
5.	Distinguish between longitudinal and transverse differential protection	BT-4	Analyze	CO5
6.	Generator need to be tripped in case of loss of excitation- Interpret	BT-1	Remember	CO5
7.	Can a generator be allowed to run with its prime mover	BT-1	Remember	CO4
8.	Sketch the Electrical circuit of Generator	BT-1	Remember	CO5
9.	Examine the interconnection of generator	BT-2	Understand	CO4
10.	State the relationship between P_e and Q_e of a generator before and after loss of prime mover	BT-2	Understand	CO4
11.	Define Sympathetic inrush current	BT-2	Understand	CO4
12.	What do you understand from Potentiometer method	BT-3	Apply	CO4
13.	What do you understand from injection method	BT-3	Apply	CO5
14.	Give the concept behind pole slipping	BT-3	Apply	CO5
15.	Explain about the loss of excitation	BT-3	Apply	CO4
16.	Describe about various electrical faults that occurs in Generator	BT-3	Apply	CO4
17.	Enumerate various mechanical faults in generator	BT-4	Analyze	CO5
18.	List out various losses in generator and methods to reduce the loss	BT-4	Analyze	CO5
19.	What do you understand from third harmonic voltage protection	BT-5	Evaluate	CO4
20.	List out various schemes to overcome rotor faults	BT-6	Create	CO5

	PART - B			
1.	Explain the different Abnormal operating conditions of turbo alternator and its protection against abnormal operating conditions	BT-3	Apply	CO4
2.	Explain the longitudinal differential protection of generator	BT-6	Create	CO4
3.	Compare Longitudinal and Transverse differential protection of turbo alternator	BT-5	Evaluate	CO4
4.	Explain the methods to prevent rotor faults	BT-1	Remember	CO4
5.	Examine how generator behaves during unbalanced loading and over speeding	BT-1	Remember	CO4
6.	Briefly explain about Potentiometer method	BT-1	Remember	CO5
7.	Briefly explain about Injection method of generator protection	BT-2	Understand	CO5
8.	Briefly discuss about pole slipping	BT-2	Understand	CO5
9.	Briefly discuss about Loss of excitation	BT-4	Analyze	CO5
10.	Briefly discuss about protection against mechanical faults	BT-4	Analyze	CO4
11.	Briefly discuss Protection against Rotor faults	BT-1	Remember	CO5
12.	Explain about Potentiometer Method	BT-2	Understand	CO5
13.	Briefly discuss various faults and abnormal operating conditions	BT-2	Understand	CO4
14.	Briefly discuss Stator Winding Faults	BT-4	Analyze	CO4
1.	**PART C** Explore the method for Protection of turbo alternator against rotor faults	BT-4	Analyze	CO5
2.	Explain about Loss Of Excitation (LOE) (in the context of generator protection)	BT-6	Create	CO4
3.	Briefly explain about various faults in Generator	BT-6	Create	CO5
4.	Discuss about various protective schemes for generator	BT-6	Create	CO4

UNIT V - NUMERICAL PROTECTION

Introduction–Block diagram of numerical relay - Sampling theorem- Correlation with a reference wave–Least error squared (LES) technique-Digital filtering-numerical over - Current protection– Numerical transformer differential protection-Numerical distance protection of transmission line

PART - A

Q.No	Questions	BT Level	Competence	Course outcomes
1.	List out the advantages of numerical relays over conventional relays	BT-6	Create	CO5
2.	Draw the block diagram of the numerical relay	BT-3	Apply	CO5
3.	Outline the concept of aliasing	BT-2	Understand	CO5
4.	Sampling frequency is less than the Nyquist limit-Discuss	BT-6	Create	CO5
5.	Distinguish between FIR and IIR filters	BT-5		CO5
6.	Write the trigonometric Fourier series representation	BT-4	Analyze	CO5
7.	Compare analog and digital domain representation of signals	BT-1	Remember	CO5
8.	Outline the concept of wavelet analysis and how it will be used for numerical protection	BT-3	Apply	CO5
9.	Define least error squared technique	BT-2	Understand	CO5
10.	Explore the needs of digital filtering in power system relaying	BT-1	Remember	CO5
11.	Examine IIR filter	BT-4	Analyze	CO4
12.	Examine numerical over current protection	BT-5	Evaluate	CO5
13.	Differentiate FIR and IIR filters	BT-2	Understand	CO5
14.	Discuss the concept of Fourier analysis? Explain	BT-4	Analyze	CO4
15.	For numerical relaying purpose the differential equation gets converted into a linear algebraic equation. Explain	BT-1	Remember	CO4
16.	Is sample and hold circuit must an absolute?	BT-1	Remember	CO4
17.	List the methods to analyse the reference wave	BT-2	Understand	CO4
18.	Draw the block diagram of numerical protection of transformer	BT-1	Remember	CO4
19.	Define weights	BT-1	Remember	CO4
20.	List out the need for carrier aided protection	BT-4	Analyze	CO4

PART - B

1.	Explain the numerical over current protection of transmission line. Derive the necessary equations	BT-1	Remember	CO5
2.	Explain numerical transformer differential protection scheme	BT-1	Remember	CO5
3.	Explain the process of development of new numerical relay using flowchart	BT-1	Remember	CO5
4.	Describe the numerical over current protection algorithm with flowchart	BT-1	Remember	CO5
5.	Describe Fourier analysis and least error squared technique	BT-2	Understand	CO5
6.	Discuss the sample and derivative methods of estimating the rms value and phase angle of a signal. Clearly state the underlying assumptions	BT-2	Understand	CO4
7.	Explain the statement that all numerical relays have the same hardware but what distinguishes the relay is the underlying software	BT-2	Understand	CO5
8.	Discuss in detail about Digital filters	BT-3	Apply	CO4
9.	How do sampling theorem help in conversion of analog signals into digital signals	BT-4	Analyze	CO4

10.	Discuss about Mann and Morris method	BT-4	Analyze	CO5
11.	Briefly explain about Digital filtering	BT-3	Apply	CO5
12.	Discuss about Numerical transformer differential protection	BT-4	Analyze	CO5
13.	Discuss about Least error squared	BT-4	Analyze	CO5
14.	Briefly explain about Numerical distance protection of transmission line	BT-2	Understand	CO5
1.	**PART C** Develop the differential equation algorithm for distance protection of a Transmission line	BT-6	Create	CO5
2.	For numerical relaying purpose the differential equation gets converted into a Linear algebraic equation. Explore	BT-6	Create	CO5
3.	Discuss the methods to find numerical differentiation and numerical integration	BT-6	Create	CO4
4.	Discuss about Shannon's sampling theorem	BT-6	Create	CO5

Course Outcome

1. Upon completion of the course, the learners will be able to understand the various schemes available in vercurrent protection
2. The Learners will have knowledge on Transformer & Busbar protection
3. Learners will attain knowledge about Distance and Carrier protection of transmission lines
4. Learners will understand the concepts of Generator protection
5. Learners will attain knowledge on numerical protection Schemes