DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

SUBJECT: EE6702-PROTECTION AND SWITCHGEAR

SEM / YEAR: VII/IV

UNIT I - PROTECTION SCHEMES			
SYLLABUS Principles and need for protective schemes – nature and causes of faults – types of faults – fault current calculation using symmetrical components – Methods of Neutral grounding – Zones of protection and essential qualities of protection – Protection schemes			
PART - A			
Q.N	**Questions**	**BT**	**Competence**
1.	Show the need for protective schemes in power system?	BTL 3	Apply
2.	Name the types of fuses?	BTL 1	Remember
3.	Summarize the role of protective relay in a modern power	BTL 5	Evaluate
4.	Define the term pick up value in a protective relay.	BTL 1	Remember
5.	Define auto re-closing?	BTL 1	Remember
6.	Summarize the functions of isolating switch?	BTL 5	Evaluate
7.	Explain surge absorber? Differentiate it from surge diverter?	BTL 4	Analyze
8.	Identify the sources of fault power?	BTL 1	Remember
9.	Identify the different types of faults occurring in power system?	BTL 1	Remember
10.	Write down the importance of symmetrical components for fault current calculation.	BTL 4	Analyze
11.	Explain the importance of ground wire?	BTL 2	Understand
12.	List the merits of resistance grounded system.	BTL 4	Analyze
13.	Analyze how arcing ground avoided can be avoided?	BTL 2	Understand
14.	What happen if earth wire is not provided in overhead	BTL 6	Create
15.	Classify the different types of earthing	BTL 2	Understand
16.	What is the necessity for earthing.	BTL 3	Apply
17.	What is primary protection?	BTL 6	Create

18.	Define protection zone.	BTL 6	Create
19.	Classify the different types of zones of protection.	BTL 1	Remember
20.	Show the examples for unit and non unit system of protection.	BTL 2	Understand
	PART – B		
1.	(i) Summarize the importance of protective schemes employed in power system. (7) (ii) Show the essential quantities of protection. (6)	BTL 6,3	Apply Create
2.	Discuss the symmetrical components method to analyze an unbalanced system. (13)	BTL 4	Analyze
3.	Discuss about three-phase symmetrical fault? Also discuss the different types of unsymmetrical faults that can occur on a three-phase system. (13)	BTL 2	Understand
4.	Explain and draw the sequence network for the following type of faults: a. Single-line-to-ground fault (5) b. Double- line-to- ground fault (4) c. Line-to-line fault. (4)	BTL 4	Analyze
5.	Explain in detail about the need and different methods for neutral grounding with suitable diagram. (13)	BTL 3	Apply
6.	(i) Explain different types of earthing the neutral point of the power system (7) (ii) Formulate an expression for the reactance of the peterson coil in terms of capacitance of the protected line. (6)	BTL 4,6	Analyze Create
7.	Describe in detail about the Peterson coil? List the protective functions performed by this device. (13)	BTL 1	Remember
8.	Discuss and compare the various methods of netural Earthing . (13)	BTL 2	Understand
9.	(i) Explain the overlapping of protective zones with neat sketch. (7) (ii) Describe the different faults in power system. Which of these are more frequents? (6)	BTL 5,1	Remember Evaluate
10.	(i) Describe the fundamental requirements of protective Relaying. (7) (ii) Differentiate between surge diverter and surge absorber.Also explain the characteristics of an ideal surge diverter. (6)	BTL 1,2	Remember Understand

11.	.(i)List the causes of over voltage? (4) (ii)Describe the protection scheme employed to protect from lighting and switching effects. (9)	BTL 1,1	Remember
12.	(i) List the causes of short circuits due to failure of insulation on overhead conductors? (4) (ii) Briefly explain about resistance earthing and reactance earthing. (9)	BTL 1,4	Remember Analyze
13.	(i) Define the terms pick-up value ,Plug setting multiplier and auto reclosure. (6) (ii) Discuss briefly the operation of (a) surge absorbers (b) surge diverters. (7)	BTL 1,2	Remember Understand
14.	(i) Draw and explain protective zone diagram for a sample power system netwoks. (7) (ii) A 3 phase 11 kV,25000 kVA alternator with X_{go} = 0.05 p.u., X_1= 0.15 p.u., X_2= 0.14 p.u., is grounded through a reactance of 0.3 ohm. Calculate the line current for a single line to ground fault. (6)	BTL 5,3	Evaluate Apply
	PART-C		
1.	What are the essential qualities for protective relay? Explain in detail. (15)	BTL 4	Analyze
2.	A 30 MVA,11 KV generator has Z_1= Z_2=j0.21p.u and Z_0=j0.05p.u . if a line to line fault occurs on the terminals of the generator , find the line current and line to neutral voltage under fault condition. (15)	BTL 5	Evaluate
3.	The positive, negative and zero sequence reactance of a 20 MVA, 13.2 KV synchronous generator are 0.3 p.u , 0.2 p.u and 0.1 p.u respectively. The generator is solidly grounded and is not loaded. A line to ground fault occurs on phase A, neglecting all the resistance, determine the fault current. (15)	BTL 4	Analyze
4.	Determine the inductance of peterson coil to be connected between the neutral and ground to neutralize the charging current of overhead line having the line to ground capacitance of 0.15µF. If the supply frequency is 50 HZ and the operating voltage is 132KV. Find the KVA rating of the coil. (15)	BTL 5	Evaluate

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UNIT II - ELECTROMAGNETIC RELAYS			
SYLLABUS Operating principles of relays – the Universal relay – Torque equation – R-X diagram – Electromagnetic Relays – Overcurrent, Directional, Distance, Differential, Negative sequence and Under frequency relays.			
PART - A			
Q.N	**Questions**	**BT**	**Competence**
1.	List the basic requirements of protective relay	BTL 1	Remember
2.	Summarize the functions of protective relays.	BTL 5	Evaluate
3.	Show the different types of electromagnetic relays?	BTL 3	Apply
4.	Identify the applications of attracted armature type	BTL 1	Remember
5.	Define time setting multiplier in protective relays.	BTL 1	Remember
6.	Determine plug setting multiplier of a 5 ampere,3 second over current relay having a current setting of 125% and a time setting multiplier of 0.6 connected to supply circuit through a 400/5 current transformer when the circuit carries a fault current of 400A.	BTL 5	Evaluate
7.	Discuss the effects of arc resistance?	BTL 2	Understand
8.	Discuss R-X diagram?	BTL 2	Understand
9.	Mention the principle of operation of distance relay.	BTL 2	Understand
10.	Write the torque equation of the universal relay.	BTL 6	Create
11.	In what way a distance relay is superior to over current protection for protection of transmission line.Justify	BTL 6	Create
12.	List the different types of distance relay.	BTL 1	Remember
13.	Show the merits of mho relay? And also draw its R-X Diagram.	BTL 3	Apply
14.	Explain the principle of differential relay.	BTL 4	Analyze
15.	Define differential relay?	BTL 1	Remember
16.	Give the principle of negative sequence relay.	BTL 2	Understand
17.	Explain under frequency relay?	BTL 4	Analyze

18.	Give the function of under frequency relay.	BTL 2	Understand
19.	When is under frequency relay required in a power	BTL 1	Remember
20.	Show which type of relay is best suited for long distance very high voltage transmission lines.	BTL 3	Apply
	PART – B		
1.	Develop the different inverse time characteristics of over current relays and mention how the characteristics can be achieved in practice for an EM relay? (13)	BTL 6	Create
2.	Explain the general working of a relay and derive the fundamental torque equation. (13)	BTL 4	Analyze
3.	Discuss the construction details and principle of operation of induction type directional over current relay. (13)	BTL 2	Understand
4.	Discuss the construction and principle of operation of non-directional induction-disc relay. (13)	BTL 2	Understand
5.	Discuss the construction and operating principle of over current relay with directional scheme. (13)	BTL 2	Understand
6.	Describe the operating principle, constructional features and area of applications of directional relay. How do you implement directional feature in the over current relay. (13)	BTL 1	Remember
7.	(i)Explain the construction details and principle of operation of directional induction cup relay. (7) (ii) Explain with the help of neat diagram the construction and working of induction type directional power relay. (6)	BTL 4,4	Analyze
8.	Show the MHO relay characteristic on the R-X diagram. Discuss the range setting of various distance relays placed on a particular location .(13)	BTL 3	Apply
9.	Show in what way distance protection is superior to over current protection for the protection of transmission line. (13)	BTL 3	Apply
10.	Explain the principle of working of distance relays. Describe with neat sketches the following types of relay(i)Impedance relay (ii)Reactance relay (iii) Mho relay Indicate the difference on RX diagrams and show where each type is suitable. (13)	BTL 5	Evaluate

11.	Describe the operating principles and characteristic of impedance , admittance and mho relays. (13)	BTL 1	Remember
12.	Describe the principle of percentage biased differentia relay with necessary diagrams. Also discuss its applications. (13)	BTL 1	Remember
13.	Describe the principle of percentage biased differential relay with necessary diagrams. Also discuss its applications. (13)	BTL 3	Apply
14.	(i) With neat skectch explain negative sequence relay (7) (ii)Explain clearly about current balance differential relays. (6)	BTL 4,4	Analyze
	PART-C		
1.	With neat diagram explain the various types of electromagnetic relays. (15)	BTL 4	Analyze
2.	Describe the construction and principle of operation of non directional induction type over current relay. (15)	BTL 5	Evaluate
3.	Explain impedance relay with suitable R-X diagrams (15)	BTL 5	Evaluate
4.	Derive the torque equation of mho relay from universal torque equation. (15)	BTL 4	Analyze

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UNIT III- APPARATUS PROTECTION			
SYLLABUS Current transformers and Potential transformers and their applications in protection schemes – Protection of transformer, generator, motor, busbars and transmission line.			
PART - A			
Q.N	**Questions**	**BT**	**Competence**
1.	Justify, Why secondary of transformer should not be opened ?	BTL 6	Create
2.	List the application of current transformer.	BTL 1	Remember
3.	Mention the difference between CTs used for protection	BTL 4	Analyze
4.	Define the term burden on CT.	BTL 1	Remember
5.	List the application of potential transformer.	BTL 1	Remember
6.	Discuss the short comings of differential protection scheme as applied to power transformer .	BTL 2	Understand
7.	Define the term pilot with reference to power line	BTL 1	Remember
8.	Show the applications of Buchholz's relay.	BTL 3	
9.	Identify the problems arising in differential protection in power transformer and how are they overcome?	BTL 1	Remember
10.	Explain current grading of relays?	BTL 5	Evaluate
11.	Explain over fluxing protection of a transformer?	BTL 4	Analyze
12.	List the common faults that occur in a generator	BTL 1	Remember
13.	Discuss the causes of over speed and how alternators are protected from it ?	BTL 2	Understand
14.	Discuss the type of relay is best suited for generation	BTL 2	Understand
15.	What are the protection methods used for transmission line?	BTL 3	Apply
16.	Explain the secondary of CT should not be open.	BTL 4	Analyze
17.	Discuss the type of relays are used to protect transmission	BTL 2	Understand
18.	Compose the common methods used for line protection?	BTL 6	Create
19.	Classify the types of bus bar protection.	BTL 3	Apply
20.	Explain time-graded system protection?	BTL 5	Evaluate

	PART – B		
1.	(i) Compare CT & PT. What are the applications of CT & PT. (7) (ii) An 11 kV, 200MVA alternator is provided with differential protection. The % of winding to be protected against phase to ground fault is 85 %.The relay is set to operate when there is 20% out of balance current. Determine the value of the resistance to be placed in the neutral toground connection. (6)	BTL 5	Evaluate
2.	Briefly discuss the protective devices used for the protection of large transformer. (13)	BTL 2	Understand
3.	Classify different protection schemes normally used for protection of a power transformer from internal faults? Discuss one of them in brief. (13)	BTL 4	Analyze
4.	(i) Explain the Merz-price circulation current scheme of protection used for power transformer. (7) (ii) A three phase transformer of 220/11000 line volts is connected in star/delta. The protective transformers on 220V side have a current ratio of 600/5 . Calculate the current transformer ratio on 11000V side. (6)	BTL 4,3	Analyze Apply
5.	A 3 phase transformer having line voltage ratio of 440 V / 11 kV is connected in star – delta. The protection transformer on the LV side has a ratio of 500 / 5. Estimate the ratio of the protection transformer connected on HV side? (13)	BTL 2	Understand
6.	(i) Describe the differential protective scheme of transformer. (7) (ii) Show the protective scheme employed for the bus bar. (6)	BTL 1,3	Remember Apply
7.	(i) Describe clearly about Buchholz relay for the protection of incipient faults in transformers (7) (ii) A star connected , 3 phase,10 MVA,6.6KV alternator has a per phase reactance of 10%. It is protected by Merz-price circulating current principle which is set to operate for fault currents not less than 175 A. Calculate the value of earthing resistance to be provided in order to ensure that only 10% of the alternator winding remains unprotected. (6)	BTL 1,4	Remember Analyze
8.	Discuss the principle of percentage biased differential protection with necessary diagrams. Also discuss its applications (13)	BTL 2	Understand
9.	Describe the differential pilot wire method of protection of feeder (13)	BTL 3	Apply

10.	A star connected 3-phase,20MVA,11KV Alternator has a per phase reactance of 0.75 ohms/phase .It is protected by Merz price circulating current principle which is to operate for fault currents not less than 175A. Formulate the value of earthing resistance to be provided in order to ensure only 10% of the alternator winding remains unprotected (13)	BTL 6	Create
11.	Describe the types of protective schemes employed for the protection of field winding and loss excitation of alternator. (13)	BTL 1	Remember
12.	Describe the types of protective schemes employed for the protection of Busbar. (13)	BTL 1	Remember
13.	Explain the types of protective schemes employed for the protection of Transmission line (13)	BTL 4	Analyze
14.	Show the different types of feeder and the protective schemes employed for the protection of feeder (13)	BTL 3	Apply
	PART-C		
1.	Give a brief account on the protection of generator using differential and biased differential protection scheme. (15)	BTL 4	Analyze
2.	Give a brief account on the faults and protection of transformer. (15)	BTL 4	Analyze
3.	A star connected 3 phase, 12 MVA,11 KV alternator has a phase reactance of 10%. It is protected by Merz- price circulating current scheme which is set to operate for fault current not less than 200A. Calculate the value of earthing resistance to be provided in order to ensure that only 15% of the alternator winding remains unprotected. (15)	BTL 5	Evaluate
4.	A 500 KVA,6.6 KV star connected alternator has a synchronous reactance of 1.0Ω per phase and negligible resistance.The different relay operates if the out of balance current through it exceeds 30% of the normal full load current of the alternator. The star point of the alternator is earthed through a resistance of 5Ω. What percent of the stator winding is left unprotected? Show that the effect of the alternator reactance can be neglected. (15)	BTL 5	Evaluate

UNIT IV - STATIC RELAYS AND NUMERICAL PROTECTION

SYLLABUS

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators– Block diagram of Numerical relays – Overcurrent protection, transformer differential protection,distant protection of transmission lines

PART – A

Q.No	Questions	BT	Competence
1.	What are the basic circuits used in static relays?	BTL-6	Create
2.	Give the advantages of static relays	BTL-2	Understand
3.	Compose the problems arising in differential protection in power transformer and how are they overcome?	BTL-6	Apply
4.	Show the Duality between Amplitude and Phase Comparators	BTL-1	Remember
5.	Explain Comparator and its type.	BTL-1	Remember
6.	Explain the function of Synthesis of Mho Relay Using Static Phase Comparator	BTL-1	Remember
7.	Define static relay.	BTL-4	Analyze
8.	Explain the function of Synthesis of Simple Impedence Relay using Amplitude Comparator	BTL-5	Evaluate
9.	Define Amplitude Comparator and Phase Comparator	BTL-2	Understand
10.	Distinguish the Synthesis of Various Distance Relays Comparators	BTL-3	Apply
11.	List out the general characteristics of numerical protection.	BTL-1	Remember
12.	Define the Over Current Protection	BTL-4	Analyze
13.	Give the Different over current protection relays	BTL-4	Analyze
14.	Define the definite time over-current relay	BTL-3	Apply
15.	Define the Inverse Time Over-current Relay	BTL-1	Remember
16.	Define the Instantaneous OC Relay	BTL-2	Understand
17.	Compose the advantages of over current relays over electromagnetic types	BTL-2	Understand
18.	Explain the Phase Comparators and write its type	BTL-5	Evaluate

19.	Illustrate with neat Block diagram of Numerical Transformer Differential Protection	BTL-3	Apply
20.	List the different methods of Numerical distant protection of transmission lines	BTL-1	Remember
	PART B		
1.	Describe the construction, working principle and operation of static over current relay. (13)	BTL-1	Remember
2.	i) Define the Duality Between Amplitude and Phase Comparators. (7) ii) Define the type of Amplitude and Phase Comparators. (6)	BTL-4	Analyze
3.	Discuss the Synthesis of Various Distance Relays Using Static Comparators (13)	BTL-6	Create
4.	Explain with neat block diagram of the function of Synthesis of Mho Relay Using Static Phase Comparator (13)	BTL-1	Remember
5.	Explain with neat block diagram of the function of Synthesis of Reactance Relay Using Cosine-type Phase Comparator (13)	BTL-3	Apply
6.	Distinguish briefly about the Phase Comparators and write its Types (13)	BTL-4	Analyze
7.	i) Compare static relay with electromagnetic relays. (7) ii) Explain the advantages of Numerical relays. (6)	BTL-4	Analyze
8.	Compose the problems arising in differential protection in power transformer and how are they overcome? (13)	BTL-2	Understand
9.	Explain with neat block diagram of the function of Synthesis of Simple Impedance Relay Using Amplitude Comparator (13)	BTL-1	Remember
10.	Discuss the various semiconductor devices used in the static relay. (13)	BTL-2	Understand
11.	Illustrate with neat Block diagram of Numerical Transformer Differential Protection (13)	BTL-2	Understand
12.	Discuss with Neat Block diagram of different methods of Numerical Distance Protection of Transmission Line. (13)	BTL-1	Remember
13	Define the Over Current Protection and Explain its types Briefly (13)	BTL-3	Apply

14	Define i) definite time over-current relay (7) ii) Inverse Time Over-current Relay (6)	BTL-5	Evaluate
	PART-C		
1.	Explain with neat block diagram the operation of static relay and list the advantages and disadvantages (15)	BTL-4	Analyze
2.	Assess the factors cause spill current on external fault in case of transformer Differential protection? (15)	BTL-5	Evaluate
3.	Discuss the coincidence principle used in phase comparators. (15)	BTL-4	Analyze
4.	Derive the characteristics equation for the phase comparator and amplitude comparator. (15)	BTL-5	Evaluate
	UNIT V - CIRCUIT BREAKERS		
	SYLLABUS Physics of arcing phenomenon and arc interruption - DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of recovery voltage - resistance switching - current chopping - interruption of capacitive current - Types of circuit breakers – air blast, air break, oil, SF6 and vacuum circuit breakers – comparison of different circuit breakers – Rating and selection of Circuit breakers		
	PART – A		
Q.No	**Questions**	**BT**	**Competence**
1.	List the methods of arc interruption.	BTL-1	Remember
2.	Differentiate a.c. and d.c. circuit breaking	BTL-2	Understand
3.	Discuss the arc phenomenon in a circuit breaker.	BTL-6	Apply
4.	State the slepian theory for arc interruption.	BTL-1	Remember
5.	Define the term “rate of rise of recovery voltage”.	BTL-1	Remember
6.	Explain recovery voltage?	BTL-1	Remember
7.	Explain resistance switching	BTL-4	Analyze
8.	Explain current chopping	BTL-5	Evaluate
9.	What are the factors responsible for the increase of arc resistance?	BTL-2	Understand
10.	Discuss the different methods of arc extinction	BTL-3	Apply
11.	Define restriking voltage	BTL-4	Analyze
12.	Assess the problems encountered in the interruption of capacitive currents	BTL-3	Apply

13.	Explain the ratings of a circuit breaker	BTL-4	Analyze
14.	Define symmetrical breaking capacity.	BTL-3	Apply
15.	Show the making capacity of a circuit breaker	BTL-1	Remember
16.	Classify the circuit breakers	BTL-2	Understand
17.	A circuit breaker is rated as 1500 A, 1000 MVA,3 second, 3 phase oil circuit breaker. Find rated making current.	BTL-6	Create
18.	Give the advantage of SF6 circuit breaker over Air blast circuit breaker	BTL-5	Evaluate
19.	Compose Peterson coil? What protective functions are performed by this device?	BTL-2	Understand
20.	Illustrate the disadvantages of an Air blast circuit breaker	BTL-1	Remember
	PART-B		
1.	Define the principle of arc extinction. What are the methods of arc extinction? Describe them in detail. (13)	BTL-1	Remember
2.	i)Explain the arc interruption methods used in circuit breakers (7) ii)Explain Resistance switching for arc extinction in circuit breakers (6)	BTL-4	Analyze
3.	Give the reason of using SF_6 circuit breaker. (13)	BTL-6	Create
4.	i) Explain how arc initiated and sustained when the circuit breaker contacts break (7) ii) Explain in detail the various methods of arc extinction in circuit breaker (6)	BTL-3	Apply
5.	i) Show an expression for Restriking voltage and rate of rise of restriking voltage (RRRV) in a C.B. (7) ii) Illustrate the current chopping? Explain how can the effect of current chopping be minimized? (6)	BTL-3	Apply
6.	Describe the consruction and principle of operation of AIR Blast circuit breaker. (13)	BTL-4	Analyze

7.	i)With neat sketch explain resistance switching. (7) ii) Explain current chopping with suitable diagrams. (6)	BTL-4	Analyze
8.	Discuss with neat sketch, the construction and working of minimum oil circuit breaker. Also gives its merits and demerits. (13)	BTL-2	Understand
9.	Describe the constructional details of SF6 circuit breaker and its operation. Give its advantages and disadvantages (13)	BTL-1	Remember
10.	Discuss the different arc control mechanisms with suitable diagrams in bulk oil CB. (13)	BTL-1	Remember
11.	Describe the principle constructional features of all types of air blast CB.Give its advantages and disadvantages. (13)	BTL-2	Understand
12.	Explain the construction, working principle, operation and application of Vaccum circuit breakers. (13)	BTL-1	Remember
13	Explain rupturing capacity, making capacity and short time rating and rated current of the circuit breaker. (13)	BTL-2	Understand
14	Compare the performance and characteristicsof different types of CB. List out their merits and demerits (13)	BTL-5	Evaluate
	PART-C		
1.	i) Solve the RRRV of 132 kV circuit breaker with neutral earthed circuit breaker data as: broken current is symmetrical, restriking voltage has frequency of 20 kHz, and power factor is 0.15. Assume fault is also earthed. (7) ii) Illustrate the selection of circuit breakers for different ranges of system voltages (8)	BTL-5	Evaluate
2.	A generator connected through 5 cycle CB to a transformer is rated 8000KVA with the reactance of X''_d=10 % , X''_d=16% and X_d=100%. It is operating at no load and rated voltage when 3 phase short circuit occurs between breaker and transformer.Find i) Sustained short circuit in circuit breaker ii) The initial symmetrical r.m.s current in breaker iii) Maximum possible d.c component of short circuit in breaker iv) The momentary current rating of breaker v) Current to be interrupted by breaker vi) The interrupting KVA (15)	BTL-5	Evaluate

3.	Compose and Draw the schematic of a HVDC Circuit Breaker and explain its function Compose the problem of direct current interruption. (15)	BTL 4	Analyze
4.	What are the different methods of testing of circuit breaker? Describe the method which is more suitable for testing the large capacity circuit breakers. Also discuss the merits and demerits of the method. (15)	BTL 4	Analyze