QuestionPaperCode : 80386

B.E./B.Tech. Degree Examinations, Nov/Dec 2016

Seventh Semester

Electrical and Electronics Engineering

EE 6702 / Protection and Switchgear

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer All Questions

PART A - ($10 \times 2 = 20$ marks)

1. What is the difference between primary and backup protection?

   Ans: If any fault occurs in the protected area, the primary protection act first and called as instantaneous protection.

   If primary protection fails to act, the backup protection comes into action and removes the faculty part from the healthy system.

2. What do you mean by dead spot in zones of protection?

   Ans: To ensure complete safety of each and every element of the system the protection zones are overlapped. The zone which is unprotected is called dead spot.

   If there are no overlaps, then dead spot may exist, means the associated circuit breaker lying within the zone may not trip even though the fault occurs. This may cause damage to the healthy system.

3. What is the significance of PSM and TSM?

   Ans:

   Significance of PSM: The tappings are connected to a plug setting bridge by which the number of turns in use can be adjusted, by giving the described current settings.

   Significance of TSM: It decides arc length through which disc travels, by reducing length of travel, operating time is reduced.

4. A relay is connected 400/5 ratio current transformer with circuit setting of 150% calculate the plug setting multiplier when circuit carries a fault of current of 4000A.

   Ans:

$$CT \text{ ratio} = 400/5$$

$$\text{Current setting} = 150\%$$

$$\text{Fault current in primary} = 4000A$$

$$PSM = \frac{\text{Fault current in relay coil}}{\text{Pick up current}}$$

$$\text{Pick up current} = \text{Rated CT secondary current} \times \text{Current setting}$$

$$= 5 \times 150\%; \quad = 5 \times 1.5 = 7.5A$$

$$\text{Fault current in CT secondary} = 4000 \times \frac{5}{400} = 50A$$

$$PSM = \frac{50}{7.5} = 6.667$$

5. What is over fluxing? How it affect transformer?

   Ans: During operation, a transformer is subjected to carry rather swallow more than peak value of flux density as per its design eliminations, the transformer is said to have faced over fluxing problem.

   It affect metallic support and surfaces structure for core and coils, windings, Lead conductors, Core lamination and tank.

6. What two protection schemes used for protection of bus-bar.

   Ans:

   (i) Differential bus-bar protection

   (a) Current differential protection
   (b) Differential protection of sectionalized bus.
   (c) Voltage differential protection of bus-bar.

   (ii) Capacitor bank protection.

7. Write two application of static relay.

   Ans:

   (a) Telecommunications
   (b) Data communications
   (c) Remote monitoring
   (d) Ground isolation
   (e) Security systems

8. State the difference between conventional relay and numerical relay.

   Ans:

	Conventional relay	**Numerical relay**
*	Bulky in size	Compact in size and use LCD for relay actuation
*	More components are used and has more component failures	Few components are used and component failures are reduced
*	Comparatively lesser sensitivity	Greater sensitively and high pick up ratio
*	Use of mechanical components.	not used here.

9. What is the difference between restriking voltage and recovery voltage?

   Ans: The transient voltage which appears across the breaker contacts at the instant of arc being extinguished is known as Restriking Voltage.

   The power frequency rms voltage, which appears across the breaker contacts after the arc is finally extinguished and transient oscillations die out is called recovery voltage.

10. State the difference between D.C. and A.C. circuit breaking.

Ans:

	D.C. circuit breaking	**A.C. circuit breaking**
*	Natural zero current does not occur for breaking.	Natured zero current occurs for breaking
*	Energy dissipated during the short interval of breaking is very high.	Less energy dissipated

PART B - ($5 \times 16 = 80$ marks)

11. (a) (i) Explain in detail about the need and different types of earthing scheme. (10)

Ans: Refer Page no: 1.9

(ii) A 132kV, a phase, 50 cycles, overhead line, 50km long has a capacitance to earth line of $0.0157\mu F/km$. Determine the inductance and KVA rating of the arc suppression coil. (6)

Ans:

Supply frequency, $f = 50Hz$

Capacitance of each line to earth, $C = 50 \times 0.0157 \times 10^{-6} F$

$C = 0.785 \times 10^{-6} F$

Inductance of arc suppression coil is

$$L = \frac{1}{3\omega^2 C}$$

$$= \frac{1}{3 \times (2\pi \times 50)^2 \times (0.785 \times 10^{-6})}$$

$$= 2.70H$$

Or

(b) (i) Explain the essential qualities of protection and explain them in detail. (6)

Ans: Refer Page no: 1.27

(ii) Explain the method of calculating fault current using symmetrical components. (10)

Ans: Refer Page no: 1.15

12. (a) With a neat diagram explain the working principle of a directional over current relay. Derive the torque equation and also explain about directional relay connection. (6+4+6)

Ans: Refer Page no: 2.16

Or

(b) From the universal torque equation determine the condition of operation for impedance relay, reactance relay and admittance relay. (16)

Ans: Refer Page no: 2.18, 2.53

13. (a) Draw the explain protection scheme of A.C. induction motor. (16)

Ans: Refer Page no: 3.34

Or

(b) (i) A generator is protected earth fault protection. The generator ratings are 13.2kV, 10MVA. The percentage of winding protected against phase to ground fault is 85%. The relay setting is such that it trips for 20% out of balance. Calculate the resistance to be added in the neutral to ground connection. (8)

Ans: Since 85% winding is being protected, 15% would be unprotected. Let r ohms be the earthing resistance required to leave 15% of the winding unprotected.

$$\text{Full load current} = \frac{10 \times 10^6}{\sqrt{3} \times 13.2 \times 10^3} = 438A$$

The relay setting is such that it trips for 20% out of balance (given)

$$= \frac{20}{100} \times 438 = 87.6A$$

Voltage induced in 15% winding

$$= \frac{15}{100} \times \frac{13.2 \times 10^3}{\sqrt{3}} = 1143.1 \text{ volts}$$

Earth fault current which 15% winding will cause

$$= \frac{1143.1}{r}$$

This current must be equal to 87.6A

$$\therefore \quad 87.6 = \frac{1143.1}{r}$$

$$r = \frac{1143.1}{87.6} = 13.04\Omega$$

Result: Resistance to be added in the neutral to ground connection is 13.04Ω

(ii) Explain protection scheme for protection of transformer against incipient fault. (8)

Ans: Refer Page no: 3.12

14. (a) How will you synthesize a mho relay using static phase comparator? (16)

Ans: Refer Page no: 4.7

Or

(b) Explain the numerical over current protection and numerical transformer differential protection. (8 + 8)

Ans: Refer Page no: 4.17, 4.19

15. (a) (i) Derive the expression for restriking voltage and maximum RRRV. (8)

Ans: Refer Page no: 5.11

(ii) In short circuits test on a 3 pole, 132kV, circuit breaker, the following observations are made. Power factor for fault = 0.4, recovery voltage 0.9 times full line value, the breaking current symmetrical, frequency of oscillation of restriking voltage 16kHz. Assume neutral is grounded and fault is not grounded. Determine average RRRV. (8)

Ans:

$$e = K_1 K_2 K_3 E_m \left[1 - \cos\left(\frac{1}{\sqrt{LC}}\right)\right]$$

Where $K_1 = \sin\phi,\ K_2 = 0.9,\ K_3 = 1.5$

$$\begin{pmatrix} \textbf{For } K_3 \\ \text{If both neutral and fault grounded, } K_3 = 1 \\ \text{If any one of the two not grounded } K_3 = 1.5 \end{pmatrix}$$

Here

$$\cos\phi = 0.4$$

$$\therefore \quad \sin\phi = 0.9165$$

Line to ground voltage

$$E_m = \frac{132}{\sqrt{3}} \times \sqrt{2} = 107.77kV \qquad \text{(Peak value)}$$

$$f_n = \frac{1}{2\pi\sqrt{LC}} = 16kHz \text{ (given)}$$

$$\frac{1}{\sqrt{LC}} = 2\pi f_n$$

$$= 2 \times \pi \times 16 \times 10^3 = 1 \times 10^5$$

Time to reach maximum restriking voltage

$$t_{\max} = \pi\sqrt{LC} = \frac{\pi}{1 \times 10^5}$$

Restriking voltage maximum

$$= 2 \times K_1 \times K_2 \times K_3 \times E_m$$

$$= 2 \times 0.9165 \times 0.9 \times 1.5 \times 107.77 \times 10^3$$

$$= 2.667 \times 1065V$$

$$\text{Average RRRV} = \frac{\text{Restriking voltage maximum}}{\text{Time to reach maximum restriking voltage}}$$

$$= \frac{2.667 \times 10^5}{\frac{\pi}{1 \times 10^5}}$$

$$= 8.48 \times 10^9 V/\text{sec}$$

$$= 8.48 \times 10^6 kV/\text{sec}$$

$$= 8.48kV/\mu\text{sec}$$

Or

(b) (i) With a neat sketch explain the principle of vacuum circuit breaker. (8)

Ans: Refer Page no: 5.44

(ii) Explain the phenomenon of interruption of capacitive current in circuit breaker. (8)

Ans: Refer Page no: 5.21

UQ.6 *Protection and Switchgear*

QuestionPaperCode : 71785

B.E./B.Tech. Degree Examinations, April/May 2017

Seventh Semester

Electrical and Electronics Engineering

EE 6702 / Protection and Switchgear

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer All Questions

PART A - ($10 \times 2 = 20$ marks)

1. State the types of faults.

   Ans: Q.No.18 - Page.no.1.42

2. Give the difference between circuit breaker and switch.

   Ans:

   (i) Switches are not automatic as they need to be manually turned on or off while circuit breakers just trips off on certain conditions.
   (ii) Switches allow users to cut off power supply to a certain area or equipment while circuit breakers are more preventive in nature.
   (iii) Circuit breakers are essentially automatic off switches designed for a very specific purpose, which is to prevent unnecessary electrical circuit damage.

3. Why a shading ring is provide in a induction disc relay?

   Ans: Q.No.23 - Page.No.2.55

4. What are the difficulties of differential protection?

   Ans: Q.No.20 - Page.No.3.62

5. What is the need for instrument transformer?

   Ans:

   (i) Instrument Transformers are used in AC system for measurement of electrical quantities like voltage, current, power, energy, power factor and frequency.
   (ii) Instrument transformers are also used with protective relays for power system protection.
   (iii) Basic function is to step down the AC System voltage and current.
   (iv) The voltage and current level of power system is very high.
   (v) It is very difficult and costly to design the measuring instruments for measurement of such high level voltage and current.

6. What are the limitations of buchholz relay?

   Ans: Q.No.18 - Page.No.3.62

7. Define sampling theorem.

   Ans: Q.No.17 - Page.No.4.31

8. Write about numerical transformer differential protection.

   Ans: Q.No.20 - Page.No.4.32

9. Define restriking voltage.

   Ans: Section 5.6 - Page.No.5.10

10. What is rupturing capacity?

    Ans: Q.No.35 - Page.No.5.71

PART B - ($5 \times 16 = 80$ marks)

11. (a) (i) Discuss in detail about different protection schemes.
    Ans: Page.No.1.29
    (ii) Explain are suppression coil earthing with neat diagram.
    Ans: Page.No.1.14

    Or

    (b) Explain how fault current is calculated using symmetrical components.
    Ans: Page.No.1.15

12. (a) Explain the construction and operating principle of impedance type distance relay with R-X diagram.
    Ans: Page.No.2.18

    Or

    (b) With the necessary sketches discuss in detail about electromagnetic attraction type relays relay.
    Ans: Page.No.2.6

13. (a) Give a detailed explanation for protection of transformer using differential protection which includes associated faults.
    Ans: Page.No.3.1

    Or

    (b) Give a detailed explanation about CT's and PT's and its application to power system.
    Ans: Page.No.3.55

14. (a) Explain the block diagram of numerical relay with necessary diagram.
    Ans: Page.No.4.16

    Or

    (b) With a neat sketch discuss in detail about the synthesis of reactance relay using phase comparator.
    Ans: Page.No.4.11

15. (a) Write short notes on:
    (i) Current chopping
    Ans: Topic 5.9 - Page.No.5.19
    (ii) Interruption of capacitive current.
    Ans: Topic 5.10 - Page.No.5.21

    Or

    (b) With a neat diagram explain the construction and working principle of Air Blast circuit breaker and Vacuum circuit breaker.
    Ans: Refer Page.No.5.37 (Air blast), Page.No.5.44 (VCB)

QuestionPaperCode : 50494

B.E./B.Tech. DEGREE EXAMINATION, Nov/Dec 2017

Seventh Semester

Electrical and Electronic Engineering

EE 6702 - Protection and Switchgear

(Regulation 2013)

Time: Three hours **Maximum: 100 Marks**

Answer ALL questions

Part-A ($10 \times 2 = 20$ Marks)

1. What is primary protection?

   Ans: Primary protection also called as Main protection is the essential protection provided for protecting an equivalent / machine or a part of the power system. This type of protection is of instantaneous type. This type of protection operates without time delay once the fault occurs.

2. Give the types of faults.

   Ans:

   (a) Symmetrical faults - 3-ϕ fault
   (b) Unsymmetrical faults

   i. L-G fault
   ii. 2L-G fault
   iii. L-L fault
   iv. Open circular phases
   v. Winding faults

3. Write the torque equation of the numerical relay.

   Ans: Q.No. 61, Page.No. 2.61

4. Give the principle of negative sequence relay.

   Ans: The principle is that due to over heating in electrical machines leads to unbalance rotor current. These unbalance currents cause heating of rotor and damage it. Unbalance three - phase currents have negative sequence components. These components rotate at synchronous speed in a direction opposite to the direction of rotation of rotor, enduring double frequency currents in the rotor.

5. Why secondary of transformer should not be opened?

   Ans: The secondary side of a CT should never be kept open because, when kept open, there is a very high voltage found across the secondary. This causes a high magnetizing current to build up on the secondary side which return causes high flux and marks the core to saturate.

6. List the type of bus - bar protection.

   Ans: (a) Differential protection of bus section (b) Frame leakage protection

7. Define static relay.

   Ans: Q.No. 1, P.no. 4.28.

8. What is phase comparator?

   Ans: Q.No. 12, P.no. 4.30.

9. State the slepian theory for arc interruption?

   Ans: Page.no. 5.9.

10. Define symmetrical breaking capacity.

    Ans: It is the rms value of the a.c component of the fault current that the circuit breaker is capable of breaking under specified conditions of recovery voltage.

Part-B ($5 \times 16 = 80$ Marks)

11. (a) Explain the various methods of neutral grounding. (16)

    Ans: Page.no. 1.9.

    (OR)

    (b) What are the essential qualities of protective relay? Explain in detail.(16)

    Ans: Page.no. 1.27

12. (a) With neat diagram explain the various types of electromagnetic relays. (16)

    Ans: Page.no. 2.6

    (OR)

    (b) Describe the construction and principle of operation of non-directional Induction type over current Relay. (16)

    Ans: Page.no. 2.13

13. (a) Give a brief account on the protection of generator using differential and biased differential protection scheme. (16)

    Ans: Page.no. 3.19.

    (OR)

    (b) Give a brief account on the faults and protection of transformers. (16)

    Ans: Page.no. 3.1

14. (a) Explain with neat block diagram the operation of static relay and list the advantages and disadvantages. (16)

    Ans: Page.no. 4.1

    (OR)

    (b) Describe the operation of static over current relay with neat diagram.(16)

    Ans: Page.no. 2.42 (Repeated)

15. (a) Write short notes on:

(i) Current chopping (8)

Ans: Page.no. 5.19

(ii) Resistance switching (8)

Ans: Page.no. 5.15

(OR)

(b) Describe the construction and principle of operation of Air blast circuit breaker. (16)

Ans: Page.no. 5.37

QuestionPaperCode : 41012

B.E./B.Tech. DEGREE EXAMINATION, April/May 2018

Seventh Semester

Electrical and Electronic Engineering

EE 6702 - Protection and Switchgear

(Regulation 2013)

Time: Three hours **Maximum: 100 Marks**

Answer ALL questions

Part-A ($10 \times 2 = 20$ Marks)

1. Why protection scheme is needed for power system?

   Ans:

   (a) If the fault is not cleared; it may cause unnecessary interruption of service to the customers.

   (b) Raped disconnection of faulted apparatus limits the amount of damage to it and prevents the effects of faults from spreading into the system.

2. Write down the importance of symmetrical components for fault current calculation.

   Ans: Symmetrical components namely positive, negative and zero sequence components are used to determine the voltages and currents on the occurrence of an unsymmetrical faults.

3. Mention the principle of operation of distance relay.

   Ans: The distance relay operates when the impedance measured during fault condition is less than the impedance during normal condition.

4. 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 4000 A.

   Ans:

$$\text{P.S.M} = \frac{\text{Fault current in the relay coil}}{\text{Pick up current}}$$

$$= \frac{50}{6.25} = 8$$

5. What is the cause of over speed and how alternators are protected from it?

   Ans:

   (i) Cause of over speed is the sudden loss of all or major part of load on the alternator.

(ii) Alternators are provided with mechanical centrifugal devices mounted on their driving shaft to trip the main valve of the prime moves when dangerous over speed occurs.

6. What are the protection methods used for transmission line?

Ans:

(i) Time - graded over current protection. (ii) Differential protection.

(iii) Distance protection.

7. List out the general characteristics of numerical protection.

Ans:

(i) Reliability
(ii) Self diagnosis
(iii) Event and distance records
(iv) Adaptive protection

8. What are the basic circuits used in static relays?

Ans:

(i) Timers
(ii) Phase comparators
(iii) Amplitude comparators
(iv) Level detectors
(v) Integrators
(vi) Polarity detectors

9. What are the factors responsible for the increase of are resistance?

Ans:

(i) Degree of ionisation
(ii) Length of the arc
(iii) Cross section of the arc
(iv) P.d between contacts

10. A circuit breaker is rated as 1500 A, 1000 MVA, 3 second, 3 phase oil circuit breaker. Find rated making current.

Ans:

$$\text{Rated making current} = 2.55 \times \text{Symmetrical breaking capacity}$$

$$\text{Symmetrical breaking capacity} = \frac{MVA}{\sqrt{3} \times \hbar V}$$

$$= \frac{1000 \times 10^6}{\sqrt{3} \times 33000}$$

(Assume for oil breakers $\hbar V$ = 33)

$$= 17496$$

Part-B ($5 \times 16 = 80$ Marks)

11. (a) (i) Explain clearly about the zones of protection in power system. (8)
Ans: Page. No. 1.25

(ii) Briefly discuss about nature and causes of faults. (8)

Ans: Page. No. 1.4

(OR)

(b) Explain in detail about the need and different methods for neutral grounding with suitable diagram. (16)

Ans: Page. No. 1.9

12. (a) (i) With neat sketch explain negative sequence relay. (8)

Ans: Page. No. 2.35

(ii) Explain clearly about current balance differential relays. (8)

Ans: Page. No. 2.28

(OR)

(b) Explain impedance relay with suitable R-X diagrams. (16)

Ans: Page. No. 2.18

13. (a) (i) Explain clearly about Buchholz relay for the protection of incipient faults in transformers. (10)

Ans: Page. No. ?

(ii) A star connected, 3 phase, 10 MVA, 6.6 KV 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)

Ans: Solution

$$\text{Phase voltage,} \quad V_{ph} = \frac{6.6 \times 10^3}{\sqrt{3}}$$

$$\boxed{V_{ph} = 3810 \text{ Volts}}$$

$$\text{Current,} \quad I = \frac{10 \times 10^6}{\sqrt{3} \times 6.6 \times 10^3} \qquad \text{i.e., } \left(I = \frac{VA}{\sqrt{3} \times V_L}\right)$$

$$\boxed{I = 875 \text{ Amps}}$$

Let x be the reactance per phase in ohms

$$= \sqrt{3} \times x \times 875 \times \frac{100}{6600}$$

$$= 0.436\ \Omega$$

$$\text{Reactance of 10\% winding} = 0.436 \times \frac{10}{100}$$

$$= 0.0436\ \Omega$$

$$\text{E.M.F induced in 10\% winding} = V_{ph} \times 0.1$$

$$= 381 \text{ Volts}$$

Impedance offered to fault by 10% winding is $Z_f = \sqrt{(0.0436)^2 + r^2}$

E/f current due to 10% winding $= \dfrac{381}{Z_f}$

When the fault current become 175 A, the relay will trip,

$$r = \frac{381}{175} = 2.177\Omega$$

(OR)

(b) (i) With neat sketch explain the protection schemes for motors. (8)
Ans: Page. No. 3.34

(ii) With suitable diagrams explains bus bar protection. (8)
Ans: Page. No. 3.39

14. (a) Describe the construction, working principle and operation of static over current relay. (16)
Ans: Page. No. 2.42

(OR)

(b) (i) Compare static relays with electromagnetic relays. (8)
Ans: Page. No. 2.60, 2.38, 2.5, 4.28 (Q.no.4)

(ii) Explain the advantages of Numerical relays. (8)
Ans: Page. No. 4.25 (Q.no.6), 4.17

15. (a) (i) Which neat sketch explain resistance switching. (8)
Ans: Page. No. 5.15

(ii) Explain current chopping with suitable diagrams. (8)
Ans: Page. No. 5.19

(OR)

(b) Explain the construction, working principle, operation and application of Vacuum circuit breakers. (16)
Ans: Page. No. 5.44