Switch Gear and Protection
VTU CBCS Question Paper Set
2018
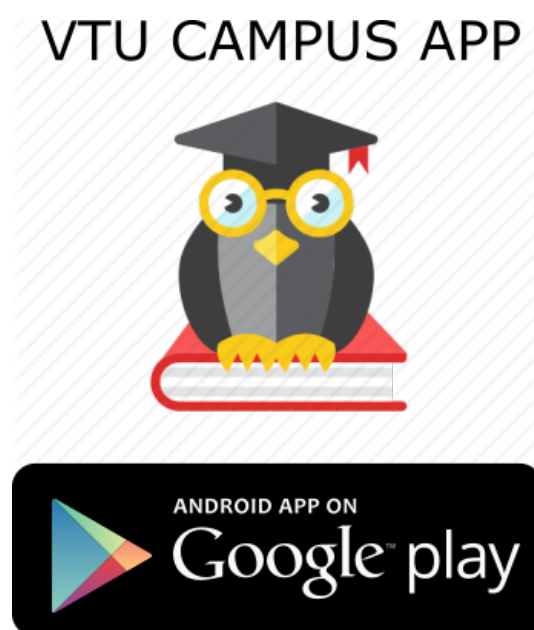
USN | | | | | | | | | | **10EE62**

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Switch Gear and Protection

Time: 3 hrs.   Max. Marks:100

Note: *Answer any FIVE full questions, selecting*
atleast TWO questions from each part.

PART – A

1 a. State and explain fuse law. With a neat sketch explain the time–current and cut–off characteristics of HRC fuse.   **(10 Marks)**
   b. Draw and explain a line diagram of substation with use of isolating switches. Mention operating instructions and applications of isolating switches.   **(10 Marks)**

2 a. What are Slepian's and Cassie's theorem of arc interruption? Explain with neat sketches. Also explain low resistance or zero point extinction.   **(10 Marks)**
   b. How interruption of capacitive currents takes place in AC circuit breakers? Explain.
                                                                      (10 Marks)

3 a. With a neat sketch explain the construction and working of air break circuit breaker.
                                                                      (10 Marks)
   b. Describe the working principle of SF_6 circuit breaker with the help of a neat sketch. mention the advantages over other type of circuit breakers.   **(10 Marks)**

4 a. Explain the construction and working of a vacuum circuit breaker.   **(10 Marks)**
   b. Describe : i) unit testing   ii) synthetic testing of a circuit breaker.   **(10 Marks)**

PART – B

5 a. What are the requirements of protective relaying? And discuss   i) zones of protection ii) primary and back–up protection.   **(10 Marks)**
   b. Briefly explain the essential qualities and classification of protective relays.   **(10 Marks)**

6 a. Explain in detail with the help of a neat figure the working of non–directional induction type over–current relay.   **(10 Marks)**
   b. Explain the principle of working and operating characteristics of a percentage biased differential relay.   **(10 Marks)**

7 a. What are the important faults that can occur in an alternator during operation? Explain in detail.   **(10 Marks)**
   b. A generator is protected by restricted earth fault protection. The generators ratings 13.2 KV, 10 MVA. 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.   **(10 Marks)**

8 a. With a neat sketch explain the working of a Buchholz relay for transformer protection and state its limitations.   **(10 Marks)**
   b. A three phase power transformer having a line voltage ratio of 400 V to 33 KV is connected in star–delta. The CTs on 400 V side have current ratio as 1000/5. What must be the CT ratio on 33 KV side? Show the star–delta arrangement with CT connections. Assume current on 400 V side of transformer to be 1000 A.   **(10 Marks)**

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Sixth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Switchgear and Protection

Time: 3 hrs.   Max. Marks:100

Note: *Answer any FIVE full questions, selecting atleast TWO questions from each part.*

PART – A

1   a.   Explain the role of isolating switch in a power system.   **(06 Marks)**
    b.   With the help of waveform, explain cutoff characteristic of fuse. Also define the term fusing factor.   **(06 Marks)**
    c.   With the help of diagram, explain the construction and working of HRC fuse.   **(08 Marks)**

2   a.   Discuss the recovery rate theory and energy balance theory of arc interruption in AC circuit breaker.   **(06 Marks)**
    b.   Explain the current chopping phenomenon in circuit breaker.   **(06 Marks)**
    c.   In a 220 KV system, the reactance and capacitance upto the location of circuit breaker is 8Ω and $0.025\mu F$ respectively. A resistance of 600Ω is connected across the contacts of the circuit breaker. Determine i) Natural frequency of oscillation ii) Damped frequency of oscillation iii) Critical value of resistance, which will give no transient oscillation.
                                                                                    (08 Marks)

3   a.   Explain the construction and working of air break circuit breaker with the help of neat diagram.   **(10 Marks)**
    b.   Explain various properties of SF_6 gas.   **(10 Marks)**

4   a.   Explain following tests performed on circuit breaker :
         i) Unit test   ii) Synthetic test   iii) Substitution test   iv) Compensation test
         v) Capacitance test.   **(10 Marks)**
    b.   With neat figure, explain the working of :
         i) Rod gap arrestor   ii) Expulsion type arrestor.   **(10 Marks)**

PART – B

5   a.   With a neat sketch, explain different zones of protection in power system.   **(06 Marks)**
    b.   Explain various methods of backup protection.   **(06 Marks)**
    c.   Explain essential qualities of protective relaying.   **(08 Marks)**

6   a.   Explain the working of percentage differential relay.   **(06 Marks)**
    b.   Explain three stepped distance protection of transmission line.   **(08 Marks)**
    c.   Write a short note on microprocessor based over current relay.   **(06 Marks)**

7   a.   With the help of neat diagram, explain Merz –Price protection of star connected alternator stator windings. Mention its advantages.   **(10 Marks)**
    b.   A 11KV, 3 – phase Alternator has full load rated current of 200A. Reactance of armature winding is 15%. The differential protection system is set to operate on earth fault currents of more than 200A. Find the neutral earthing resistance. which gives earth fault protection to 90% of stator winding.   **(06 Marks)**

    c. Write a short note on Unbalanced loading of alternator and its effects.   **(04 Marks)**

8   a. List the various abnormal operating conditions and how induction motor is protected against these   **(06 Marks)**

    b. What is Phase reversal? What are its effects? How it is prevented?   **(06 Marks)**

    c. A 3 – phase, 11 KV/33 KV, Y - Δ connected power transformer is protected by differential protection. The CTs on LV side have a current ratio of 400/5. What must be the ratio of CTs on HV side? Draw the connection diagram of how CTs are connected on both the sides of the transformer.   **(08 Marks)**

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Sixth Semester B.E. Degree Examination, June/July 2014
Switchgear and Protection

Time: 3 hrs.   Max. Marks:100

Note: *Answer any FIVE full questions, selecting*
atleast TWO questions from each part.

PART – A

1 a. Draw the block diagram of energy management of power system and explain. **(10 Marks)**
   b. With neat sketch describe the working principle of a liquid fuse. **(06 Marks)**
   c. With neat sketch explain cut off characteristics of HRC fuse. **(04 Marks)**

2 a. Discuss the recovery rate theory and energy balance theory of arc interruption in a.c. circuit breaker. **(10 Marks)**
   b. Discuss the phenomenon of inductive current chopping in a circuit breaker. **(10 Marks)**

3 a. Explain the working of air blast circuit breaker with reference to i) Axial blast; ii) Cross blast. **(10 Marks)**
   b. With neat sketch explain the construction and working of non-puffer type SF_6 breaker. **(10 Marks)**

4 a. With neat circuits explain two types of synthetic test on circuit breakers. **(10 Marks)**
   b. With a neat sketch, explain expulsion type lightning arrester. What are the advantages and disadvantages of the above? **(10 Marks)**

PART – B

5 a. Explain the concept of primary and back up protection. **(06 Marks)**
   b. Explain with the help of neat diagram, the construction and working of non directional induction type over current relay. Draw and explain its time current characteristics. **(10 Marks)**
   c. The current ratings of an over current relay is 5A. It has a PSM = 2, TSM = 0.3, CT ratio = 400/5, Fault current = 4000A. Determine the time of operation of the relay assuming normal IDMT characteristics. **(04 Marks)**

PSM	2	4	5	8	10	20
Operating time (s)	10	5	4	3	2.8	2.4

6 a. Explain the construction, working, torque equation and operating characteristics of reactance relay. **(10 Marks)**
   b. With a neat sketch, explain the construction and working of Buchholz relay. **(10 Marks)**

7 a. Which are the abnormal running conditions may exists in a generator? Explain in brief. **(10 Marks)**
   b. The natural point of a 11kV alternator is earthed through a resistance of 12Ω, the relay is set to operate when there is out of balance of 0.8A. The C.T.S. have a ratio of 2000/5. What percentage of the winding is protected against earth faults? What must be the minimum value of earthing resistance required to give 90% of protection to each phase? **(10 Marks)**

8 a. With a basic circuit diagram, explain harmonic restraint relay protection for transformer. **(10 Marks)**
   b. With the relevant Sketches explain i) Ground fault protection; ii) Phase fault protection of induction motor. **(10 Marks)**

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Sixth Semester B.E. Degree Examination, June/July 2015

Switchgear and Protection

Time: 3 hrs.   Max. Marks:100

Note: *Answer FIVE full questions, selecting
at least TWO questions from each part.*

PART – A

1 a. Define switchgear, Distinguish between isolating and load breaking switch. **(04 Marks)**
   b. Explain why silver is used as fuse material inspite of its high cost. **(06 Marks)**
   c. With a neat sketch explain the construction and working principle of HRC fuse with tripping device. **(10 Marks)**

2 a. Explain the current interruption in A.C circuit breakers with neat waveforms and define the terms restriking voltage and recovery voltage. **(10 Marks)**
   b. With a neat diagram and necessary waveforms, explain the phenomenon of interruption of capacitive currents in a circuit breaker. **(10 Marks)**

3 a. With a neat sketch explain the construction and working of minimum oil circuit breaker. **(10 Marks)**
   b. With a neat circuit diagram explain the short circuit test layout on circuit breakers. **(10 Marks)**

4 a. Explain the working principle, disadvantages and advantages of horn – gap arrestors. **(10 Marks)**
   b. What are the types of lightning strokes? Explain each of them. **(06 Marks)**
   c. Distinguish between fuse and circuit breaker. **(04 Marks)**

PART – B

5 a. Explain the essential qualities of protective relaying. **(10 Marks)**
   b. With a neat diagram explain the zones of protection in typical power system. **(10 Marks)**

6 a. With a neat sketch, explain the principle of three stepped distance protection of transmission line. **(10 Marks)**
   b. Differentiate between IDMT overcurrent relay and extremely inverse time overcurrent relay characteristics. **(04 Marks)**
   c. Determine the actual time of operation of a 5A, 3seconds overcurrent 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 4000A. Time of operation is 3.5s for the estimated value of PSM. **(06 Marks)**

7 a. Explain the protection scheme for stator inter turn faults and rotor earth fault of a generator. **(10 Marks)**
   b. Describe the loss of excitation protection in a generator and its characteristics. **(10 Marks)**

8 a. With a neat circuit diagram, explain the Merz – price protection scheme for star – delta transformers. **(10 Marks)**
   b. With a neat circuit diagram explain single phasing preventer used for Induction motor. **(10 Marks)**

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Sixth Semester B.E. Degree Examination, June/July 2016
Switchgear and Protection

Time: 3 hrs.   Max. Marks:100

Note: 1. *Answer any FIVE full questions, selecting*
atleast TWO questions from each part.
2. *Missing data, if any, may be suitably assumed.*

PART – A

1 a. State any five differences between a circuit breaker and a fuse.   **(05 Marks)**
   b. With a neat sketch explain the construction and working of a HRC fuse.   **(08 Marks)**
   c. In a 220 KV system having a line to ground capacitance of 0.015 µF and an inductance of 3.5H, determine the voltage appearing across the pole of the circuit breaker if a magnetizing current of 6.5A (instantaneous) is interrupted. Determine also the value of the resistance to be used across the contacts to eliminate the restriking voltage.   **(07 Marks)**

2 a. Explain the principle of DC circuit breaking indicating the V – I characteristics and relevant operating zones.   **(05 Marks)**
   b. For a 132 KV system, the reactance and capacitance up to the location of the circuit breaker is 3 Ω and 0.015 µF respectively. calculate :
   i) Frequency of transient oscillation
   ii) Maximum value of restriking voltage across breaker contacts
   iii) Maximum RRRV.   **(07 Marks)**
   c. A 50 Hz 3 – phase alternator with grounded neutral has an inductance of 1.6 mH per phase and is connected to bus bar through a circuit breaker. The capacitance to earth between the alternator and circuit breaker is 0.003 µF per phase. The circuit breaker opens when rms value of current is 7500A. Determine : i) Maximum RRRV ii) time for maximum RRRV iii) Frequency of oscillations.   **(08 Marks)**

3 a. Explain the working of an air blast circuit breaker with reference to :
   i) Axial blast ii) cross blast.   **(08 Marks)**
   b. Name any ten significant advantages of SF_6 breakers.   **(06 Marks)**
   c. Explain short circuit breaker test layout with a single line diagram.   **(06 Marks)**

4 a. What are the advantages of synthetic testing of circuit breakers?   **(08 Marks)**
   b. Explain direct and indirect lightening strokes.   **(08 Marks)**
   c. State any four essential requirements of a 'Surge Diverter'.   **(04 Marks)**

PART – B

5 a. With a diagram, explain the zones of protection in a typical power system.   **(08 Marks)**
   b. Name any six essential characteristics of a protective relay.   **(06 Marks)**
   c. Determine the actual time of operation of a 5A, 3 second over current relay having a current setting of 125% and a time multiplier of 0.6 connected to a supply circuit through a 400/5 CT when the circuit carries a fault current of 4000A. The operation time of the relay is 3.5 sec. for the estimated value of PSM.   **(06 Marks)**

6 a. Describe the operation of the following relays with neat sketches :
   i) shaied pole type induction relay ii) watt hour meter type induction relay.   **(12 Marks)**
   b. Explain the working principle and characteristics of an impedance relay.   **(08 Marks)**

7   a. Explain the Merz – Price protection for Y – connected alternator. What are the advantages?

(10 Marks)

     b. A synchronous generator rated for 20 KV protected by circulating current system having neutral grounded through a resistance of 15Ω. The differential protection relay is set to operate when there is an out – of – balance current of 3A. The CTs have a ratio of 1000/5A. Determine,

       i) Percentage of unprotected winding

      ii) Value of earth resistance to achieve 75% protection of winding.   **(10 Marks)**

8   a. Explain the working of a Buchholtz's relay for transformer protection with neat diagram.

(10 Marks)

     b. Explain single phasing preventer for induction motor with a diagram.   **(10 Marks)**

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Sixth Semester B.E. Degree Examination, June/July 2017
Switch Gear and Protection

Time: 3 hrs.   Max. Marks:100

Note: *Answer any FIVE full questions, selecting atleast TWO questions from each part.*

PART – A

1 a. Draw the single line diagram to connect a CB, Isolator, Earthing switches and write the sequence of operation while opening and closing of a circuit. **(06 Marks)**
   b. With neat sketch describe the working principle of a liquid fuse. **(06 Marks)**
   c. Explain the cut-off characteristics and time – current characteristics of a fuse. **(08 Marks)**

2 a. Explain recovery rate theory related to current zero method of arc interruption. **(06 Marks)**
   b. Derive an expression for restriking voltage and rate of rise of restriking voltage of circuit breaker. **(07 Marks)**
   c. For a 132KV system, the reactance and capacitance upto the location of the circuit breaker is 3Ω and 0.015 μF respectively. Calculate the following :
     i) The frequency of transient oscillation.
     ii) Maximum value of restriking voltage across the contacts of the circuit breaker and
     iii) Maximum value of rate of rise of restriking voltage. **(07 Marks)**

3 a. With a neat sketch, explain the operating principle of axial air blast circuit breaker. **(06 Marks)**
   b. Sketch and explain the working principle of buffer type of sulphur hexa fluoride circuit breaker. **(06 Marks)**
   c. Explain the procedure adopted in unit test and synthetic testing of circuit breaker. **(08 Marks)**

4 a. Explain the construction and working of a vacuum circuit breaker. **(10 Marks)**
   b. What are the types of lightning strokes? Explain each of them. **(06 Marks)**
   c. State the essential requirements of a surge diverters. **(04 Marks)**

PART – B

5 a. What is a relay? Define i) Pickup level   ii) Burden   iii) Chop out, with respective to relay. **(04 Marks)**
   b. State and briefly explain the characteristics of good protective relying. **(08 Marks)**
   c. With a neat sketch, explain the working of induction type directional over current relay. **(08 Marks)**

6 a. Explain the working principle and characteristics of an impedance relay. **(08 Marks)**
   b. With a suitable diagram, explain a negative sequence relay and mention its applications. **(08 Marks)**
   c. What are the advantages of microprocessor based protective relays over electromagnetic and static relays? **(04 Marks)**

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7   a. Explain the protection of a generator against :
        i) Loss of excitation   ii) Stator inter turn fault and   iii) Over speeding.   **(12 Marks)**
    b. The neutral point of a 10,000V alternator is earthed through a resistance of 10Ω, the relay is set to operate when there is an out of balance current of 1A. The CT's have a ratio of 1000/5. What percentage of the winding is protected against fault to earth and what must be the minimum value of earthing resistance to give 90% protection to each phase winding?
        (08 Marks)

8   a. Describe the harmonic restraints relay use to protect the transformer.   **(08 Marks)**
    b. Explain single phasing in induction motors. How motor is protected from single phasing?
        (08 Marks)
    c. List the various abnormal conditions against which large induction motor has to be protected.   **(04 Marks)**

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Sixth Semester B.E. Degree Examination, Dec.2015/Jan.2016
Switchgear and Protection

Time: 3 hrs.   Max. Marks:100

Note: *Answer FIVE full questions, selecting*
at least TWO questions from each part.

PART – A

1 a. Explain the construction and working of a HRC fuse with a neat sketch. List the advantages and disadvantages. **(10 Marks)**
   b. Write a short note on energy management of power. **(05 Marks)**
   c. Explain difference between isolating switch and load breaking switch. **(05 Marks)**

2 a. What is Resistance switching? Derive an expression for critical value of resistance to be added to circuit breaker. **(08 Marks)**
   b. Explain in detail, two theories of arc interruption in circuit Breakers. **(06 Marks)**
   c. In a 132KV system, the reactance and capacitance up to the location of the circuit breaker is 3Ω and 0.015 respectively. Calculate the following :
      i) The frequency of transient oscillation
      ii) Maximum value of restriking voltage across the contacts of the circuit Breaker and
      iii) Maximum value of rate of rise restriking voltage. **(06 Marks)**

3 a. Explain the working of an air blast circuit breaker with reference to
      i) Axial blast   ii) Cross blast **(12 Marks)**
   b. Explain the properties of SF_6 gas. **(08 Marks)**

4 a. With a neat diagram explain the short circuit test on circuit breaker. **(08 Marks)**
   b. With a neat diagram, explain any one type of synthetic testing of circuit Breaker. **(06 Marks)**
   c. Explain the phenomenon of lightning discharge. **(06 Marks)**

PART – B

5 a. Explain the concept of primary and back up protection. **(06 Marks)**
   b. What are the essential qualities of a protective relay? Explain them briefly. **(10 Marks)**
   c. What is Relay? Define : i) Pickup level ii) burden iii) dropout with respect to relays. **(04 Marks)**

6 a. With a neat sketch, explain the working of induction type directional over current relay. **(10 Marks)**
   b. Explain with a neat circuit, the working of voltage balance differential relay. **(05 Marks)**
   c. Explain the working principle of an impedance Relay. **(05 Marks)**

7 a. Draw and explain the Merz – Price protection of alternator stator windings, state its advantage (Y and Δ connected alternators). **(10 Marks)**
   b. A 6.6KV, star connected alternator has a transient reactance of 2Ω per phase and negligible winding resistance. It is protected by circulating current Merz – Price protection. The alternator neutral is earthed through the resistance of 7.5Ω. The relays are set to operate when there is out of balance current of 1 ampere in secondary of 500/5 amper current transformers. How much % of winding is protected against earth fault? **(10 Marks)**

8 a. With the basic circuit diagram, explain the harmonic restraint relay protection for a transformer. **(08 Marks)**
   b. Explain single phasing in induction motors. How motor is protected from single phasing. **(08 Marks)**
   c. List the various abnormal conditions against which large induction motor has to be protected. **(04 Marks)**

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