

Enrollment No.....



Faculty of Engineering
End Sem Examination May-2024
EE3CO46 Power System Protection

Programme: B.Tech.

Branch/Specialisation: EE

Duration: 3 Hrs.**Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

- Q.1 i. The operator ' λ ' rotates with an angle _____ in the _____ direction. **1**
 (a) 120° ; clockwise direction
 (b) 60° ; clockwise direction
 (c) 60° ; anti clockwise direction
 (d) 120° ; anti clockwise direction
- ii. What is the value of zero sequence impedance in line-to-line faults? **1**
 (a) $Z_0 = 1$ (b) $Z_0 = 0$ (c) $Z_0 = 3Z_n$ (d) $Z_0 = \infty$
- iii. The stability of arc in vacuum depends upon: **1**
 (a) The contact material only
 (b) The contact material and its vapour pressure
 (c) The circuit parameters only
 (d) The combination of (b) and (c)
- iv. SF_6 gas has excellent heat transfer properties because of its: **1**
 (a) Higher molecular weight
 (b) Low gaseous viscosity
 (c) Higher dielectric strength
 (d) The combination of (a) and (b)
- v. The shape of the disc of an induction relay is: **1**
 (a) Circular (b) Spiral (c) Elliptic (d) None of these
- vi. Mho relay is normally used for the protection of: **1**
 (a) Long transmission line (b) Medium length lines
 (c) Short length lines (d) No length criterion

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- vii. Failure of prime mover results in: **1**
 (a) Alternator behaves as synchronous motor
 (b) Alternator behaves as an induction generator
 (c) Alternator behaves as Induction motor
 (d) No change in the performance
- viii. Merz prize system is used for the protection of: **1**
 (a) Transformers
 (b) Transformer and transmission line
 (c) Alternators
 (d) Transformers and alternators
- ix. _____ is the PSM of relay with a relay setting of 150%, if the fault current is 1500A and CT ratio is 150/5. **1**
 (a) 3.33 (b) 12.37 (c) 6.67 (d) 10.96
- x. In case of transmission line voltage surge first counter by: **1**
 (a) Step down transformer
 (b) Lightning arrestors
 (c) Switchgear
 (d) Relays
- Q.2 i. What are symmetrical and unsymmetrical faults in power system? **3**
 Give example of symmetrical and unsymmetrical faults.
- ii. Derive an expression for the sequence impedances of transmission lines. **7**
- OR iii. A 25 MVA, 13.2 kV alternator with solidly grounded neutral has a subtransient reactance of 0.25 p.u. The negative and zero sequence reactances are 0.35 and 0.1 p.u. respectively. A single line to ground fault occurs at the terminals of an unloaded alternator; determine the fault current and the line-to-line voltages. Neglect resistance. **7**
- Q.3 i. Explain the following terms- **4**
 (a) Restriking voltage
 (b) Recovery voltage
- ii. Discuss the operating principle of SF₆ circuit breaker. What are its advantages over other circuit breaker? **6**
- OR iii. Explain the concept of current chopping and resistance switching in circuit breaker **6**

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- Q.4 i. Explain the following terms as applied to protective relays: **2**
 (a) Reach (b) Pick up level
- ii. Explain the basic principle of operation of a percentage differential relay. **3**
- iii. Explain the construction, working principle and characteristics of reactance relay type distance relay. **5**
- OR iv. Explain the construction, working principle of induction cup. **5**
- Q.5 i. What are the various abnormal conditions in synchronous generator? Explain anyone. **3**
- ii. Explain the restricted earth fault protection and inter turn fault protection for alternators. **7**
- OR iii. A 3-phase 66/11 kV star-delta connected transformer is protected by Merz-price Protection System. The CTs on the LT side have a ratio of 420/5 amps. Show that the CTs on the HT side will have a ratio of 70 : 5/3 . **7**
- Q.6 Attempt any two:
- i. Explain the construction and working principle of valve type lighting arrester. **5**
- ii. Explain differential protection scheme for the protection of bus bar. **5**
- iii. What is meant by 3-zone protection? Explain their principle of operation for these schemes. **5**

Marking Scheme

EE3CO46(T)- Power System Protection

Q.1	i)	The operator 'λ' rotates with an angle _____ in the _____ direction (d) 120°; Anti Clockwise Direction	1
	ii)	What is the value of zero sequence impedance in line to line faults? (b) $Z_0 = 0$	1
	iii)	The stability of arc in vacuum depends upon: (d) The combination of (b) and (c)	1
	iv)	SF ₆ gas has excellent heat transfer properties because of its: (d) A combination of (a) and (b)	1
	v)	The shape of the disc of an induction relay is: (b) Spiral	1
	vi)	Mho relay is normally used for the protection of: (a) Long transmission line	1
	vii)	Failure of prime mover results in: (a) Alternator behaves as synchronous motor	1
	viii)	Merz prize system is used for the protection of: (d) Transformers and Alternators	1
	ix)	_____ is the PSM of relay with a relay setting of 150%, if the fault current is 1500A and CT ratio is 150/5. (c) 6.67	1
	x)	In case of transmission line voltage surge first counter by: (b) Lightning arrestors	1
Q.2	i.	What are symmetrical and unsymmetrical faults in power system? Give example of symmetrical and unsymmetrical faults. definition 02 Marks example 01 Marks	3
	ii.	Derive an expression for the sequence impedances of transmission lines. Derivation 05 Marks Diagram 01 Marks Matrix 01 Marks	7
	OR iii.	A 25 MVA, 13.2 kV alternator with solidly grounded neutral has a subtransient reactance of 0.25 p.u. The negative and zero sequence reactances are 0.35 and 0.1 p.u. respectively. A single line to ground fault occurs at the terminals of an unloaded alternator; determine the fault current and the line-to-line voltages. Neglect resistance. fault current 03 Mark Impedance diagram 02 Mark	7

		line voltage	02Marks	
Q.3	i.	Explain the terms (i) restriking voltage (ii) recovery voltage	02 Marks Each	4
	ii.	Discuss the operating principle of SF ₆ circuit breaker. What are its advantages over other circuit breaker. for principle 03 Marks Diagram 02 Marks Advantage 01 Marks		6
OR	iii.	Explain the concept of current chopping and resistance switching in circuit breaker	03 Mark Each	6
Q.4	i.	Explain the following terms as applied to protective relays: (a) Reach (b) Pick up Level - One Mark for each term		2
	ii.	Explain the basic principle of operation of a percentage differential relay. for explaining principle of operation 02 Marks Diagram 01 Marks		3
	iii.	Explain the working principle and characteristics of reactance relay type distance relay. working principle - 02 Marks Torque equation- 01 Marks Characteristic-diagram(R-X) 02 Marks		5
OR	iv.	Explain the construction, working principle of induction cup and induction disc relay. - Construction 01 Marks - Working Principle 02 Marks - Diagram 02 Marks		5
Q.5	i.	What are the various abnormal conditions in synchronous generator? Explain any one. for naming abnormal condition 01 Marks for explaining any one 02 Marks		3
	ii.	Explain the restricted earth fault protection and inter turn fault protection for alternators. 3.5 Marks each		7
OR	iii.	A 3-phase 66/11 kV star-delta connected transformer is protected by Merz-price Protection System. The CTs on the LT side have a ratio of 420/5 amps. Show that the CTs on the HT side will have a ratio of $70 : 5/\sqrt{3}$. 3.5 Marks for each primary and secondary current		7
Q.6		Attempt any two:		
	i.	Explain the construction and working principle of valve type		5

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lighting arrester.

Construction

02 Marks

Diagram

01 Marks

Principle

02 Marks

ii. Explain differential protection scheme for the protection of Bus **5**

Bar

for explanation

03 Marks

diagram

02 Marks

iii. What is meant by 3-zone protection? Explain their principle of **5**

operation for these schemes

for explanation

04 Marks

diagram

01 Marks

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