SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

VI SEMESTER

PEE103-Substation Engineering and Automation

Regulation – 2023

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Prepared by

Mr.S.Balaji, Assistant Professor (Sr.G) / EEE

UNIT I-SUBSTATION DESIGN DEVELOPMENT

Substation Introduction and Classifications, Different Types of bus bar switching schemes for Substation. Standards and Practices, Factors Influencing Substation Design - Altitude, Ambient Temperature, Earthquake and seismic zones, pollution and corrosion etc., Testing of Electrical Equipment, Concept and development of Single Line Diagram. Requirement of substation calculation.

PART – A

Q. No	Questions	BT Level	Competence	Course Outcome
1	Define electrical substation.	BTL1	Remembering	CO1
2	State the primary functions of a power substation.	BTL1	Remembering	CO1
3	Define single line diagram (SLD).	BTL1	Remembering	CO1
4	List different classifications of substations.	BTL1	Remembering	CO1
5	Define bus bar.	BTL1	Remembering	CO1
6	State the purpose of a bus coupler.	BTL2	Understanding	CO1
7	Define sectionalized bus system.	BTL1	Remembering	CO1
8	What is meant by redundancy in substation design?	BTL2	Understanding	CO1
9	Define reliability of power supply.	BTL1	Remembering	CO1
10	State the need for future expansion in substations.	BTL2	Understanding	CO1
11	Define insulation coordination.	BTL1	Remembering	CO1
12	State the importance of insulation coordination.	BTL2	Understanding	CO1
13	Define pollution level with respect to substations.	BTL1	Remembering	CO1
14	What is meant by seismic consideration in substation design?	BTL2	Understanding	CO1
15	Define statutory clearance.	BTL1	Remembering	CO1
16	State the importance of statutory clearances.	BTL2	Understanding	CO1
17	Define load demand of a substation.	BTL1	Remembering	CO1
18	State the factors influencing substation location.	BTL2	Understanding	CO1
19	Define switchyard.	BTL1	Remembering	CO1
20	Define control room.	BTL1	Remembering	CO1
21	What is meant by rated voltage of substation equipment?	BTL1	Remembering	CO1
22	Define rated current.	BTL1	Remembering	CO1
23	State the role of standards in substation design.	BTL2	Understanding	CO1
24	Define auxiliary supply in substations.	BTL1	Remembering	CO1

PART - B				
Q.No	**Questions**	**BT Level**	**Competence**	**Course Outcome**
1	Explain the classification of substations based on service requirement and construction.	BTL2	Understanding	CO1
2	Explain various bus bar schemes used in substations and compare their merits.	BTL4	Analyzing	CO1
3	Develop a single line diagram for a 132/33 kV substation supplying an industrial load.	BTL3	Applying	CO1
4	Discuss the factors affecting selection of substation location.	BTL4	Analyzing	CO1
5	Explain the concept of insulation coordination in substations.	BTL2	Understanding	CO1
6	Explain the need for redundancy and reliability in EHV substations.	BTL4	Analyzing	CO1
7	Explain statutory clearances applicable to EHV substations.	BTL2	Understanding	CO1
8	A substation supplies 20 MW load at 0.85 power factor. Calculate the line current at 110 kV.	BTL3	Applying	CO1
9	Explain the importance of standards and codes in substation design.	BTL2	Understanding	CO1
10	Analyze the advantages and limitations of double bus double breaker scheme.	BTL4	Analyzing	CO1
11	Explain testing and commissioning procedures of substations.	BTL2	Understanding	CO1
12	Explain planning aspects for future expansion of substations.	BTL2	Understanding	CO1
13	A 40 MVA, 132 kV substation feeds a load at 0.9 power factor. Calculate the rated current.	BTL3	Applying	CO1
14	Explain safety practices adopted in substations.	BTL2	Understanding	CO1
15	Analyze the effect of altitude and pollution on insulation design.	BTL4	Analyzing	CO1
16	Explain reliability indices used for performance evaluation of substations.	BTL2	Understanding	CO1
17	Calculate bus bar current for a substation supplying 30 MW at 0.95 power factor and 110 kV.	BTL3	Applying	CO1

UNIT II-SUBSTATION EQUIPMENT

Selection and sizing of main substation equipment: Selection of Substation Equipments Transformer, Isolator, Circuit Breaker, surge arrestor, Instrument transformers, classification of equipment with a practical overview, and the performance parameters. Classifications of MV Switchgear and Key Design Parameters, MV/LV Switchgear construction and design of control scheme. Station Auxiliary equipment: Diesel Generator System, Basics of AC/DC Auxiliary Power System & Sizing of Aux. Transformer, DC System Components, Battery Sizing & charger Sizing, DG Set Classification, and sizing. Introduction to gas insulated substation: Operating principle of GIS, Advantage over AIS, construction of GIS.

PART - A

Q. No	Questions	BT Level	Competence	Course Outcome
1	Define power transformer.	BTL1	Remembering	CO2
2	State the function of circuit breaker.	BTL1	Remembering	CO2
3	Define isolator.	BTL1	Remembering	CO2
4	Define surge arrester.	BTL1	Remembering	CO2
5	What is meant by short circuit rating?	BTL1	Remembering	CO2
6	Define making capacity of a circuit breaker.	BTL1	Remembering	CO2
7	Define breaking capacity of a circuit breaker.	BTL1	Remembering	CO2
8	Define instrument transformer.	BTL1	Remembering	CO2
9	Differentiate CT and PT.	BTL2	Understanding	CO2
10	Define station auxiliary supply.	BTL1	Remembering	CO2
11	Define DC auxiliary system.	BTL1	Remembering	CO2
12	Define battery.	BTL1	Remembering	CO2
13	State the purpose of battery charger.	BTL2	Understanding	CO2
14	Define GIS.	BTL1	Remembering	CO2
15	Define AIS.	BTL1	Remembering	CO2
16	State advantages of GIS.	BTL2	Understanding	CO2
17	Define SF_6 gas.	BTL1	Remembering	CO2
18	Define arc extinction.	BTL1	Remembering	CO2
19	Define bus duct.	BTL1	Remembering	CO2
20	Define DG set.	BTL1	Remembering	CO2
21	State the need for station transformer.	BTL2	Understanding	CO2
22	Define equipment rating.	BTL1	Remembering	CO2
23	What is name plate data?	BTL1	Remembering	CO2
24	State importance of equipment selection.	BTL2	Understanding	CO2

PART - B

1	Explain construction and working principle of SF_6 circuit breaker.	BTL2	Understanding	CO2
2	A 132 kV circuit breaker has a symmetrical fault current of 25 kA. Calculate its breaking capacity in MVA.	BTL3	Applying	CO2
3	Explain criteria for selection of power transformers in substations.	BTL2	Understanding	CO2
4	Determine the rated current of a 50 MVA, 220/110 kV transformer.	BTL3	Applying	CO2
5	Explain selection and application of surge arresters in EHV substations.	BTL2	Understanding	CO2
6	Calculate the making capacity of a circuit breaker given a symmetrical breaking current of 20 kA.	BTL3	Applying	CO2
7	Compare AIS and GIS substations with respect to space, cost and reliability.	BTL4	Analyzing	CO2

8	Explain DC auxiliary supply scheme used in substations.	BTL2	Understanding	CO2
9	A 220 V DC system supplies 12 kW for 5 hours. Determine the battery capacity in Ah considering 80% efficiency.	BTL3	Applying	CO2
10	Explain selection of CTs and PTs for protection of 33 kV feeders.	BTL2	Understanding	CO2
11	Explain bus duct arrangements adopted in substations.	BTL2	Understanding	CO2
12	Analyze advantages of GIS substations for urban installations.	BTL4	Analyzing	CO2
13	Explain the requirement and sizing of DG set for substation emergency supply.	BTL2	Understanding	CO2
14	Calculate short circuit current at a 33 kV bus given system impedance.	BTL3	Applying	CO2
15	Explain station auxiliary AC supply system.	BTL2	Understanding	CO2
16	Analyze the philosophy of equipment selection for EHV substations.	BTL4	Analyzing	CO2
17	Explain maintenance practices followed for substation equipment.	BTL2	Understanding	CO2

UNIT III - PROTECTION AND SUBSTATION AUTOMATION

Power System protection, Overcurrent and Earth Fault protection and coordination. Distribution Feeder Protection, Transformer – Unit/Main Protection, Familiarization of NUMERICAL Relays, distance/differential protection for transmission line. Substation Automation: Evolution of Substation Automation, Communication System Fundamentals-Protocol fundamental and choosing the right protocol. Substation integration and automation functional architecture, Substation signal list - DI, DO, AI, AO– Bay Control Unit (BCU), Remote Terminal Unit RTU.

PART - A

Q. No	Questions	BT Level	Competence	Course Outcome
1	Define power system protection.	BTL1	Remembering	CO3
2	State the objectives of protection.	BTL1	Remembering	CO3
3	Define relay.	BTL1	Remembering	CO3
4	Define overcurrent relay.	BTL1	Remembering	CO3
5	Define earth fault relay.	BTL1	Remembering	CO3
6	Define differential protection.	BTL1	Remembering	CO3
7	Define distance protection.	BTL1	Remembering	CO3
8	Define relay coordination.	BTL1	Remembering	CO3
9	What is meant by pick-up current?	BTL1	Remembering	CO3
10	Define plug setting multiplier.	BTL1	Remembering	CO3
11	Define time multiplier setting.	BTL1	Remembering	CO3
12	Define numerical relay.	BTL1	Remembering	CO3
13	State advantages of numerical relays.	BTL2	Understanding	CO3
14	Define breaker failure protection.	BTL1	Remembering	CO3
15	Define feeder protection.	BTL1	Remembering	CO3
16	Define transformer protection.	BTL1	Remembering	CO3
17	Define substation automation.	BTL1	Remembering	CO3
18	Define SCADA.	BTL1	Remembering	CO3
19	Define RTU.	BTL1	Remembering	CO3
20	Define BCU.	BTL1	Remembering	CO3
21	Define IEC 61850.	BTL1	Remembering	CO3
22	State benefits of IEC 61850.	BTL2	Understanding	CO3
23	Define DI signal.	BTL1	Remembering	CO3
24	Define DO signal.	BTL1	Remembering	CO3

PART - B

1	Explain objectives and principles of power system protection.	BTL2	Understanding	CO3
2	Explain operating characteristics of overcurrent relays.	BTL2	Understanding	CO3
3	Determine plug setting multiplier for an overcurrent relay given feeder current and fault current.	BTL3	Applying	CO3
4	Calculate relay operating time for a given fault current and time multiplier setting.	BTL3	Applying	CO3
5	Explain relay coordination using time-current characteristics.	BTL3	Applying	CO3
6	Explain transformer differential protection scheme.	BTL3	Applying	CO3
7	Explain distance protection of transmission lines.	BTL2	Understanding	CO3
8	Compare numerical relays with electromechanical relays.	BTL4	Analyzing	CO3

9	Explain feeder protection schemes adopted in substations.	BTL2	Understanding	CO3
10	Calculate fault current at a feeder end given system parameters.	BTL3	Applying	CO3
11	Explain breaker failure protection scheme.	BTL2	Understanding	CO3
12	Explain architecture of substation automation system.	BTL2	Understanding	CO3
13	Explain IEC 61850 communication architecture.	BTL2	Understanding	CO3
14	Analyze advantages of substation automation.	BTL4	Analyzing	CO3
15	Explain role of RTU and BCU in substation automation.	BTL2	Understanding	CO3
16	Analyze protection philosophy of modern EHV substations.	BTL4	Analyzing	CO3
17	Calculate current setting for an overcurrent relay for given load conditions.	BTL3	Applying	CO3

UNIT IV - SUBSTATION DESIGN & LAYOUT ENGINEERING

Layout aspects of Outdoor Air Insulated Substation and GIS: Statutory Clearances, Equipment Layout engineering aspects for Outdoor Substation/GIS and related calculations, and guide lines, Cable routing layout, Erection Key Diagram (EKD), switchyard earthing design as per IEEE80, Importance and Types of Earthing, Earthing Design, Types of Earthing Material, Direct stroke Lightning Protection for switchyard with IS/ IEC 62305. LV Cables - Power & Control, MV Cables, Methods for Cable Installation, Practical aspects of Cable Sizing, Cable accessories, Illumination System Design.

PART – A

Q. No	Questions	BT Level	Competence	Course Outcome
1	Define earthing.	BTL1	Remembering	CO4
2	State the purpose of earthing.	BTL2	Understanding	CO4
3	Define earth resistance.	BTL1	Remembering	CO4
4	Define step voltage.	BTL1	Remembering	CO4
5	Define touch voltage.	BTL1	Remembering	CO4
6	Define earthing grid.	BTL1	Remembering	CO4
7	What is soil resistivity?	BTL1	Remembering	CO4
8	Define lightning protection.	BTL1	Remembering	CO4
9	Define lightning mast.	BTL1	Remembering	CO4
10	Define shield wire.	BTL1	Remembering	CO4
11	Define statutory clearance.	BTL1	Remembering	CO4
12	State the need for statutory clearance.	BTL2	Understanding	CO4
13	Define AIS layout.	BTL1	Remembering	CO4
14	Define GIS layout.	BTL1	Remembering	CO4
15	Define cable trench.	BTL1	Remembering	CO4
16	Define control cable.	BTL1	Remembering	CO4
17	Define MV cable.	BTL1	Remembering	CO4
18	Define illumination system.	BTL1	Remembering	CO4
19	State the purpose of illumination.	BTL2	Understanding	CO4
20	Define earth electrode.	BTL1	Remembering	CO4
21	Define earthing conductor.	BTL1	Remembering	CO4
22	Define bonding.	BTL1	Remembering	CO4
23	Define safety clearance.	BTL1	Remembering	CO4
24	Define earth mat.	BTL1	Remembering	CO4
	PART - B			
1	Explain the need and objectives of earthing in substations.	BTL2	Understanding	CO4
2	Explain design procedure of earthing grid as per IEEE 80 standard.	BTL3	Applying	CO4
3	Calculate earth resistance for a given soil resistivity and electrode dimensions.	BTL3	Applying	CO4
4	Calculate touch and step voltages for a substation earthing system.	BTL3	Applying	CO4
5	Explain lightning protection system adopted for EHV substations.	BTL2	Understanding	CO4
6	Analyze safety aspects of earthing system in substations.	BTL4	Analyzing	CO4
7	Explain layout design considerations for AIS substations.	BTL2	Understanding	CO4
8	Compare AIS and GIS layout requirements.	BTL4	Analyzing	CO4
9	Explain statutory clearances applicable to substation layout.	BTL2	Understanding	CO4

10	Calculate conductor size required for earthing grid.	BTL3	Applying	CO4
11	Explain cable routing and trench design in substations.	BTL2	Understanding	CO4
12	Explain illumination requirements of switchyard and control room.	BTL2	Understanding	CO4
13	Calculate spacing between earth conductors in an earthing grid.	BTL3	Applying	CO4
14	Explain soil resistivity measurement methods.	BTL2	Understanding	CO4
15	Analyze effectiveness of lightning protection system.	BTL4	Analyzing	CO4
16	Calculate number of earth electrodes required for a substation.	BTL3	Applying	CO4
17	Explain safety clearances and fencing requirements in substations.	BTL2	Understanding	CO4

UNIT V - INTERFACE ENGINEERING

Civil & Structural Engineering – Interfacing Concepts of Substations - Familiarization of site development plan, equipment supports structures, foundation for equipment, familiarization of control building and substation building, infrastructure development, Mechanical System- Fire Detection, Alarm System and Fire Suppression System for transformer, Heating, Ventilation and Air-conditioning (HVAC) for Substation.

PART - A

Q.No	Questions	BT Level	Competence	Course Outcome
1	Define interface engineering.	BTL1	Remembering	CO5
2	Define control building.	BTL1	Remembering	CO5
3	Define civil works in substations.	BTL1	Remembering	CO5
4	Define structural engineering.	BTL1	Remembering	CO5
5	Define equipment foundation.	BTL1	Remembering	CO5
6	Define fire protection system.	BTL1	Remembering	CO5
7	Define fire detection system.	BTL1	Remembering	CO5
8	Define fire suppression system.	BTL1	Remembering	CO5
9	Define transformer fire.	BTL1	Remembering	CO5
10	Define HVAC system.	BTL1	Remembering	CO5
11	State the purpose of HVAC.	BTL2	Understanding	CO5
12	Define ventilation system.	BTL1	Remembering	CO5
13	Define oil drainage system.	BTL1	Remembering	CO5
14	Define alarm system.	BTL1	Remembering	CO5
15	Define safety interlock.	BTL1	Remembering	CO5
16	Define marshalling kiosk.	BTL1	Remembering	CO5
17	Define control panel.	BTL1	Remembering	CO5
18	Define cable cellar.	BTL1	Remembering	CO5
19	Define fire wall.	BTL1	Remembering	CO5
20	Define sprinkler system.	BTL1	Remembering	CO5
21	Define smoke detector.	BTL1	Remembering	CO5
22	Define cooling system.	BTL1	Remembering	CO5
23	State need for interface coordination.	BTL2	Understanding	CO5
24	Define infrastructure development.	BTL1	Remembering	CO5

PART - B

1	Explain interface engineering and its importance in substations.	BTL2	Understanding	CO5
2	Explain civil and structural coordination required in substations.	BTL2	Understanding	CO5
3	Explain foundation design considerations for substation equipment.	BTL3	Applying	CO5
4	Explain fire detection system used for power transformers.	BTL2	Understanding	CO5
5	Analyze fire safety requirements in substations.	BTL4	Analyzing	CO5
6	Explain HVAC system requirements for substation control rooms.	BTL2	Understanding	CO5
7	Calculate cooling load for a control room with given dimensions and heat load.	BTL3	Applying	CO5
8	Explain ventilation requirements in substation buildings.	BTL2	Understanding	CO5

9	Explain oil drainage and firefighting system for substations.	BTL2	Understanding	CO5
10	Analyze interface issues between electrical and civil works in substations.	BTL4	Analyzing	CO5
11	Explain alarm and interlock systems used in substations.	BTL2	Understanding	CO5
12	Calculate ventilation air requirement for a control room.	BTL3	Applying	CO5
13	Explain safety systems adopted in substations.	BTL2	Understanding	CO5
14	Analyze effectiveness of HVAC systems in substations.	BTL4	Analyzing	CO5
15	Explain infrastructure development planning for substations.	BTL2	Understanding	CO5
16	Calculate transformer oil quantity required for fire protection design.	BTL3	Applying	CO5
17	Explain coordination between protection and fire safety systems.	BTL2	Understanding	CO5

Course Outcome:

CO1: Acquiring conceptual clarity in the key deciding factors involved in substation design and operation.

CO2: Interpret fundamental theories of the sizing and selection of equipment which forms part of substation.

CO3: Recognize the significance of composite layout design aspects of the substation with different services and the challenges including statutory clearances.

CO4: Identify key concepts of Interdisciplinary aspects involved in substation design.

CO5: Articulate the basic ideas of substation automation system and different communication protocol involved for efficient operation of a substation.