GUJARAT TECHNOLOGICAL UNIVERSITY

BE-4 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

Subject Name & Code:

Power System - I (3140914)

Unit 1: Conventional Generation, Load Curves and Tariffs

Repeated Questions:

1. **Define/Explain: Load Factor, Demand Factor, Diversity Factor.**
   - Appeared in: **S24 (Q1a, 03 marks)**, **S23 (Q1a, 03 marks)**, **W25 (Q1a, 03 marks)**.
2. **Define/Explain: Load Curve, Load Duration Curve, Base Load, Tariff.**
   - Appeared in: **S25 (Q1a-i,iii, 03 marks)**, **W24 (Q1a, 07 marks)**, **W22 (Q1a, 03 marks)**.
3. **Compare Steam Power Plant and Hydroelectric Power Plant.**
   - Appeared in: **S23 (Q1b, 04 marks)**, **S22 (Q1c, 07 marks)**, **W25 (Q1c, 07 marks)**.
4. **Explain the schematic arrangement/components of a Steam Power Plant.**
   - Appeared in: **S24 (Q1c, 07 marks)**, **S23 (Q1c, 07 marks)**, **W23 (Q1b, 04 marks)**.
5. **Explain the schematic arrangement/components of a Nuclear Power Plant/Reactor.**
   - Appeared in: **S24 (Q1b, 04 marks)**, **S23 (Q5c, 07 marks)**, **S22 (Q2c, 07 marks)**, **W25-OR (Q2c, 07 marks)**.

Other Important Questions:

1. **Discuss the components of a nuclear reactor with their functions. (S24 - Q1b, 04 marks)**
2. **Explain the schematic arrangement of a Gas Turbine Power Plant. (S22 - Q3a, 03 marks)**
3. **What is the main difference between open cycle and combined cycle gas power plant? (S22 - Q3a, 03 marks)**
4. **Why is a starting motor used in a gas turbine power station? (S22 - Q3a, 03 marks)**
5. **Give the advantages and disadvantages of a Hydro Power Plant. (W24 - Q1a, 03 marks)**
6. **Give the advantages and disadvantages of a Gas Power Plant. (W23 - Q3a, 03 marks)**
7. **Write the points considered during the site selection of a steam power plant. (S23 - Q1c, 07 marks)**
8. **What do you understand by base load plant and peak load plant? (W23-OR - Q3b, 04 marks)**
9. **Draw a typical layout of the power system between generation and use of electrical power. (W23 - Q1c, 04 marks)**
10. **Discuss three-part tariff. (S22 - Q4a, 03 marks)**
11. **Discuss maximum demand tariff. (W23-OR - Q5a, 03 marks)**
12. **A factory load consists of... Find the annual electrical charges... (S24-OR - Q5c, 07 marks)**
13. **Solve an equation for the most economical value of power factor which may be attained by a consumer. (W22 - Q1c, 07 marks), (W25-OR - Q5c, 07 marks)**

Unit 2: Introduction to Wind and Solar Power Generation

Repeated Questions:

1. **Explain/Draw the schematic of a Solar Photovoltaic (PV) System and its V-I characteristics.**
    - Appeared in: **S24-OR (Q2c, 07 marks)**, **W24 (Q1b, 04 marks)**, **W23 (Q3b, 04 marks)**.
2. **Compare/Classify Horizontal Axis Wind Turbine (HAWT) and Vertical Axis Wind Turbine (VAWT).**
    - Appeared in: **S24-OR (Q5c, 07 marks)**, **W24 (Q3b, 04 marks)**, **S22-OR (Q4b, 04 marks)**.
3. **Explain the types/variable speed generators for wind power generation (e.g., SCIG, WRIG, DFIG).**
    - Appeared in: **S24 (Q2c, 07 marks)**, **S25 (Q2b, 04 marks)**, **W22 (Q2b, 04 marks)**.
4. **Compare Stand-alone and Grid-connected Solar PV systems.**
    - Appeared in: **S25-OR (Q2c, 07 marks)**, **W25 (Q2c, 07 marks)**.

Other Important Questions:

1. **Give the classification of wind turbine power plants. (S24 - Q2a, 03 marks)**
2. **Discuss the comparison of different types of solar collectors. (S24 - Q2b, 04 marks)**
3. **Explain Concentrated Solar Power (CSP) plant operation and working.**
4. **Explain various components of a Wind Energy Conversion System (WECS) with a diagram. (W25 - Q2b, 04 marks)**
5. **Write site selection criteria for wind mills. (W23-OR - Q3a, 03 marks)**
6. **Compare fixed speed and variable speed wind turbines. (S24-OR - Q5c, 07 marks)**

Unit 3: Electrical Supply Systems

Repeated Questions:

1. **Compare AC and DC supply/systems.**
    - Appeared in: **S23-OR (Q3a, 03 marks)**, **S22-OR (Q3a, 03 marks)**, **W22-OR (Q5c, 07 marks)**.
2. **Explain/Discuss the classification/types of distribution systems with diagrams.**
    - Appeared in: **S24 (Q3c, 07 marks)**, **W24 (Q2c, 07 marks)**, **S23-OR (Q3c, 07 marks)**, **W23-OR (Q5c, 07 marks)**.
3. **Compare feeder, distributor, and service mains. (S24-OR - Q3a, 03 marks)**
4. **Explain the power supply scheme with a necessary line diagram. (S24 - Q3a, 03 marks)**

Other Important Questions:

1. **Classify various AC supply systems in terms of the number of phases and wires. (S25-OR - Q5a, 03 marks)**
2. **Consider an AC distributor AB with concentrated loads... Analyze the system for computation of voltages and voltage drops... (S25 - Q5c, 07 marks)**
3. **A 2-wire dc street mains AB, 600 m long is fed from both ends... find the minimum consumer voltage. (W23-OR - Q5c, 07 marks)**

Unit 4: Power Factor and Power Factor Improvement

Repeated Questions:

1. **Define Power Factor. Discuss the causes and disadvantages of low power factor.**
    - Appeared in: **S24 (Q3b, 04 marks)**, **W24 (Q3a, 03 marks)**, **S23 (Q5b, 04 marks)**, **S22-OR (Q4a, 03 marks)**, **W25-OR (Q5a, 03 marks)**.
2. **Discuss/Enlist the methods for power factor improvement.**
    - Appeared in: **S24-OR (Q3c, 07 marks)**, **W24-OR (Q2c, 07 marks)**, **W23 (Q5b, 04 marks)**, **S22 (Q5a, 03 marks)**.

Other Important Questions:

1. **A synchronous motor improves the power factor of a load of 200 kW from 0.8 lagging to 0.9 lagging... Find (i) leading kVAR, (ii) kVA rating, (iii) motor PF. (S23-OR - Q2c, 07 marks)**
2. **An alternator supplies a load of 100 kW at 0.8 lagging PF... If PF is raised to unity, how much more real power can be supplied? (S25 - Q1b, 04 marks)**

Unit 5: Mechanical Features and Design of Overhead Lines

Repeated Questions:

1. **Define sag. Derive the expression for sag when supports are at equal and unequal levels.**
   - Appeared in: **S23 (Q5c, 07 marks)**, **S22-OR (Q5c, 07 marks)**, **W25-OR (Q3c, 07 marks)**, **W22-OR (Q2c, 07 marks)**.
2. **Define and explain String Efficiency. What are the methods to improve it?**
   - Appeared in: **S23 (Q2c, 07 marks)**, **S24-OR (Q5b, 04 marks)**, **W25-OR (Q3b, 04 marks)**, **W23 (Q2c, 07 marks)**.
3. **List the main components of overhead lines and types of insulators.**
   - Appeared in: **S23 (Q5a, 03 marks)**, **W23 (Q1a, 03 marks)**.

Other Important Questions:

1. **Consider a string of three suspension insulators... Derive expressions for voltages across discs and string efficiency. (S25 - Q1c, 07 marks)**
2. **A 220 kV line has a sag of 3m... Evaluate the length of the span. (S25 - Q2a, 03 marks)**
3. **An overhead line has a span of 220 m... Calculate the maximum sag. (W25 - Q3b, 04 marks)**
4. **A transmission line has a span of 150 m... calculate the sag and vertical sag. (W23-OR - Q2c, 07 marks)**
5. **In a 66 kV line with three insulator units... Calculate voltage distribution and string efficiency. (W22 - Q2c, 07 marks)**
6. **A 3-phase line with three-disc insulators... The potential across top and middle units are 8 kV and 11 kV... Calculate ratio, line voltage, and string efficiency. (S22-OR - Q2c, 07 marks)**
7. **Each line of a 3-phase system is suspended by a string of 3 insulators... voltage across line unit is 8 kV... Find line to neutral voltage and string efficiency. (W25-OR - Q3c, 07 marks)**
8. **Show that in a string of suspension insulators, the disc nearest to the conductor has the highest voltage. (W22 - Q2a, 03 marks)**
9. **What are the factors affecting sag? (S22 - Q4b, 04 marks)**
10. **Derive sag during the effect of wind and ice loading. (S22-OR - Q5c, 07 marks), (W24-OR - Q3c, 07 marks)**
11. **A high voltage transmission line... Calculate (a) Sag and (b) Vertical sag. (W24-OR - Q3c, 07 marks)**

Unit 6: Transmission Line Parameters

Repeated Questions:

1. **Derive the expression for inductance/capacitance of a single-phase two-wire transmission line.**
   - (Inductance) Appeared in: **S24-OR (Q4b, 04 marks)**, **W22-OR (Q3b, 04 marks)**.
   - (Capacitance) Appeared in: **S24-OR (Q4b, 04 marks)**, **S23 (Q4b, 04 marks)**, **W24 (Q4b, 04 marks)**.
2. **Derive the expression for inductance/capacitance of a three-phase line with symmetrical/equilateral spacing.**
   - (Inductance) Appeared in: **S25 (Q3b, 04 marks)**, **W24 (Q4c, 07 marks)**.
   - (Capacitance) Appeared in: **S25-OR (Q4c, 07 marks)**.
3. **Define/Explain Self GMD (GMR) and Mutual GMD (GMD).**
   - Appeared in: **W25 (Q4a, 03 marks)**, **W24 (Q4a, 03 marks)**, **W23 (Q4b, 04 marks)**.
4. **What is transposition? Explain its necessity and effect.**
   - Appeared in: **W25 (Q3a, 03 marks)**, **W24-OR (Q4a, 03 marks)**, **S22 (Q5a, 03 marks)**, **W22 (Q3a, 03 marks)**.

Other Important Questions:

1. **Represent a transmission line with distributed and lumped parameters. (W25 - Q2a, 03 marks)**
2. **A three-phase 50 Hz, 132 kV line... Evaluate capacitance to neutral and charging current. (S25 - Q3c, 07 marks)**
3. **Consider Fig.1 of a double circuit line... evaluate equivalent self GMD, mutual GMD, and inductance. (S25-OR - Q3c, 07 marks)**
4. **Calculate inductance per phase per km for equilateral and horizontal spacing. (S23-OR - Q2c, 07 marks)**
5. **Derive the expression for inductance of a double-circuit transmission line. (W25-OR - Q4c, 07 marks)**
6. **A 3-phase, 50 Hz transmission line... Calculate capacitance per km when conductors are transposed. (W24-OR - Q4c, 07 marks)**
7. **Calculate capacitance of a 100 km, 3-phase line with conductors at corners of an equilateral triangle. (S23-OR - Q3c, 07 marks), (W22 - Q3b, 04 marks)**
8. **Derive the equation for inductance of a three-phase line with unsymmetrical spacing, assuming transposition. (W23-OR - Q4c, 07 marks)**
9. **Explain the concept of internal flux linkage. (W25-OR - Q3a, 03 marks)**
10. **Derive expression for external inductance of an infinitely long conductor. (S25-OR - Q4c, 07 marks)**
11. **Explain the effect of earth on capacitance. (S22-OR - Q5b, 04 marks), (W24-OR - Q4b, 04 marks)**
12. **Deduce expression for line-to-neutral capacitance for 3-phase lines with symmetrical and unsymmetrical transposed placement. (W22-OR - Q3c, 07 marks)**
13. **Draw configuration of a bundle conductor and analyze its effect. (W25 - Q1b, 04 marks)**
14. **Define bundle conductor and list its advantages. (W22-OR - Q3a, 03 marks)**
15. **What is Bundled Conductor? Discuss its advantages. (S24 - Q5a, 03 marks)**

Unit 7: Underground Cables

Repeated Questions:

1. **Explain the construction of an underground cable with a neat sketch.**
   - Appeared in: **S22 (Q2a, 03 marks)**, **W23-OR (Q4a, 03 marks)**, **W22 (Q4c, 07 marks)**.
2. **What is meant by grading of cables? Compare/Explain the methods (Capacitance & Intersheath).**
   - Appeared in: **S25-OR (Q3a, 03 marks)**, **S24 (Q4b, 04 marks)**, **W25 (Q4a, 03 marks)**, **W22-OR (Q4b, 04 marks)**.
3. **State the properties/characteristics of insulating materials for cables. Name some materials.**
   - Appeared in: **S23 (Q2a,b, 03+03 marks)**, **S22 (Q2b, 04 marks)**, **W22 (Q4b, 04 marks)**.
4. **Classify underground cables (according to construction/voltage).**
   - Appeared in: **S24 (Q4a, 03 marks)**, **W23 (Q4a, 03 marks)**, **W22-OR (Q4a, 03 marks)**, **W24 (Q5a, 03 marks)**.

Other Important Questions:

1. **Clarify the function of: (i) metallic sheath, (ii) bedding, (iii) armouring. (S25 - Q3a, 03 marks)**
2. **A single-core underground cable has a conductor radius of 1 cm and internal sheath radius of 2 cm... Determine the capacitance for 1 km length. (S25-OR - Q4b, 04 marks)**
3. **Prove that the insulation resistance of a single-core cable is given by $R = (\rho/2\pi l) \ln(r_2/r_1)$. (S25-OR - Q4b, 04 marks)**
4. **Derive the condition for the most economical size of conductor in an underground cable. (S22 - Q4c, 07 marks), (W22-OR - Q4c, 07 marks)**
5. **Apply the concept of capacitance for grading of a cable. (W25 - Q4b, 04 marks)**
6. **Explain cables for 3-phase service.**

Unit 8: Substations

Repeated Questions:

1. **Define substation. Explain its classification in detail based on different parameters.**
   - Appeared in: **S24 (Q4c, 07 marks)**, **S23 (Q5b, 04 marks)**, **W24 (Q5c, 07 marks)**.
2. **Draw and explain a Pole-Mounted Substation.**
   - Appeared in: **S25 (Q5b, 04 marks)**, **S22 (Q1b, 04 marks)**, **W25 (Q5b, 04 marks)**.
3. **List/Enlist various equipment used in a substation/transformer substation.**
   - Appeared in: **S23 (Q4a, 03 marks)**, **S22 (Q1a, 03 marks)**, **S24 (Q5b, 04 marks)**, **W24 (Q5a, 03 marks)**, **W22 (Q5a, 03 marks)**.
4. **Compare Indoor and Outdoor substations. (S23 - Q3a, 03 marks)**

Other Important Questions:

1. **Draw a single-line diagram of a 66/11 kV substation and label each equipment. (W25 - Q5a, 03 marks)**
2. **Explain bus-bar arrangements in substations (Single, Duplicate).**
   - (Duplicate) Appeared in: **S25-OR (Q5c, 07 marks)**.
   - (Single) Appeared in: **W22 (Q5b, 04 marks)**.
3. **Sketch a duplicate bus-bar system and analyze its operation under fault condition. (S25-OR - Q5c, 07 marks)**
4. **Draw the layout and schematic connection diagram of a pole-mounted distribution substation. (S25 - Q5b, 04 marks)**

Unit 9: Neutral Grounding

Repeated Questions:

1. **What is Neutral Grounding? List the advantages of Neutral Grounding.**
   - Appeared in: **S23-OR (Q3b, 04 marks)**, **W22 (Q5a, 03 marks)**.
2. **List/Explain the different methods of Neutral Grounding (Solid, Resistance, Reactance, etc.).**
   - Appeared in: **S22-OR (Q3b, 04 marks)**, **W24 (Q5c, 07 marks)**, **W25-OR (Q5b, 04 marks)**.
3. **Compared to ungrounded neutral, state advantages/disadvantages when a single line-to-ground fault occurs.**
   - (Advantages) Appeared in: **S25-OR (Q4a, 03 marks)**.
   - (Disadvantages) Appeared in: **S25 (Q4a, 03 marks)**.
4. **Differentiate between neutral earthing and general earthing. (S24-OR - Q4a, 03 marks)**

Other Important Questions:

1. **Explain: (i) Voltage transformer earthing, (ii) Grounding transformer. (W25 - Q5c, 07 marks)**
2. **Explain transformer grounding. (W22 - Q5b, 04 marks)**
3. **Calculate the inductance and inductive reactance of a Peterson coil for a 132 kV line... (S25-OR - Q5b, 04 marks)**
4. **Why is earthing necessary in a power system? How can it be classified? (W23 - Q5a, 03 marks)**
5. **Explain solid grounding with its advantages and disadvantages. (S22-OR - Q3b, 04 marks), (W25-OR - Q5b, 04 marks)**
6. **Explain resistance grounding with a necessary diagram. (W24 - Q5c, 07 marks)**

Mixed/Cross-Unit Numerical & Derivation Questions

(These questions often combine concepts from multiple units, especially Unit 6)

1. **Derive an equation for the volume of conductor in case of a 3-phase 3-wire system and a 3-phase 4-wire system. (S22-OR - Q3c, 07 marks), (W22-OR - Q5c, 07 marks)**
2. **A single-phase 20 km line is 6 m above ground... Calculate: (i) Capacitance between conductors with ground effect, (ii) Capacitance between phase and neutral with ground, (iii) Capacitance neglecting ground. (S24-OR - Q4c, 07 marks)**
3. **Evaluate an expression for electric potential (i) at a charged single conductor, (ii) at a conductor in a group of charged conductors. (W22 - Q3c, 07 marks)**

Summary of Most Frequently Asked Topics (High Priority):

1. **Definitions:** Load Factor, Demand Factor, Diversity Factor, Tariff, String Efficiency, Sag, Power Factor, GMD/GMR, Grading.
2. **Comparisons:** Steam vs. Hydro Plant, HAWT vs. VAWT, AC vs. DC Systems, Overhead vs. Underground, Stand-alone vs. Grid-connected PV.
3. **Schematic/Working:** Steam Power Plant, Nuclear Power Plant, Solar PV System & Cell, Underground Cable Construction, Pole-Mounted Substation.
4. **Derivations:** Sag (Equal/Unequal level), Inductance/Capacitance of 1-Phase & 3-Phase (Symmetrical) lines, String Efficiency for 3-disc unit.
5. **Lists/Methods:** Power Factor Improvement, Neutral Grounding Methods, Substation Equipment, Cable Insulating Materials.
6. **Numericals:** On Sag, String Efficiency, Line Capacitance/Inductance, Power Factor Correction, Tariff Calculation.

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