DW_JUT

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Practice the sample paper covered both important questions and exam patterns

Subject: Transmission and Distribution (EEE302) **Full Marks: 70** **Time: 3 Hours**

Instructions:

- Question No. 1 is compulsory. (7 MCQs, 2 Marks each)
- Answer any FOUR questions from the remaining (Q.2 to Q.7).
- Q.2 to Q.6 carry 14 marks each (Divided into A and B, 7 Marks each).
- Q.7 consists of Short Notes (Answer any FOUR, 3.5 Marks each).

Q.1 Choose the correct option (Compulsory - 7 x 2 = 14 Marks)

i) Which of the following is usually NOT a standard generating voltage?

a. 6.6 kV
b. 11 kV
c. 33 kV
d. 440 V

ii) The phenomenon of rise in receiving end voltage of an open-circuited or lightly loaded line is called:

a. Seeback effect
b. Ferranti effect
c. Raman effect
d. Skin effect

iii) The sag of a transmission line is least affected by:

a. Weight of the conductor
b. Tension in the conductor
c. Length of span
d. Current passing through the conductor

iv) Which insulator is used at dead ends and on straight lines as a suspension type for voltages 33kV and above?

a. Pin type
b. Disc type
c. Shackle type
d. Stay type

v) The main function of a capacitor bank in a substation is to:

a. Improve the power factor
b. Decrease the voltage
c. Increase the current
d. Reduce harmonics

vi) Feeder is designed mainly from the point of view of:

a. Current carrying capacity
b. Voltage drop
c. Operating voltage
d. Frequency

vii) In a short transmission line, which of the following line constants is neglected?

a. Resistance
b. Inductance
c. Capacitance
d. None of the above

Answer any FOUR questions from Q.2 to Q.7

Q.2 A) Compare HVAC and HVDC transmission systems in detail. *(7 Marks)*

Q.2 B) What is Sag in overhead lines? Derive the expression for sag when supports are at equal levels. *(7 Marks)*

Q.3 A) Explain the construction of a 3-core underground cable with a neat sketch. *(7 Marks)*

Q.3 B) Explain the working of Radial and Ring Main distribution systems. Which one is better and why? *(7 Marks)*

Q.4 A) Explain the phenomenon of Corona. What are the factors affecting it and how can it be reduced? *(7 Marks)*

Q.4 B) A short 3-phase transmission line has a series line impedance per phase of (15 + j20) ohms. The load at the receiving end is 10 MW at 33 kV and 0.8 power factor lagging. Calculate the voltage regulation. *(7 Marks)*

Q.5 A) Draw and explain the single-line diagram of an AC distribution system showing feeders, distributors, and service mains. *(7 Marks)*

Q.5 B) Compare indoor and outdoor substations. *(7 Marks)*

Q.6 A) Derive the expression for voltage regulation and transmission efficiency for a short transmission line using a vector diagram. *(7 Marks)*

Q.6 B) Explain the various types of insulators used in overhead transmission lines. *(7 Marks)*

Q.7 Write short notes on any FOUR of the following (4 x 3.5 = 14 Marks)

A. Skin effect

B. Trivector energy meter

C. ACSR conductors

D. XLPE cables

E. Capacitor banks in substations

SOLUTIONS FOR SAMPLE PAPER 1

MCQ Answer Key

i) d, **ii)** b, **iii)** d, **iv)** b, **v)** a, **vi)** a, **vii)** c

Model Answers for Long Questions

Q.2 A) HVAC vs HVDC:

- **HVAC:** Requires 3 conductors, has skin effect, charging current exists, high corona loss, intermediate substations are cheaper, synchronous operation required.
- **HVDC:** Requires 2 conductors, no skin effect, no charging current, lower corona loss, converter stations are expensive at both ends, no synchronization problems.

Q.2 B) Sag in overhead lines:

Sag is the vertical distance between the point of support and the lowest point of the conductor.

Derivation: Let l = length of span, w = weight per unit length, T = tension. Taking a point P(x,y) on the curve. By taking moments about the lowest point O, $T \times y = (w \times x) \times (x/2)$. Therefore, $y = wx^2 / 2T$. At the support, $x = l/2$, so Sag $S = wl^2 / 8T$.

Q.3 A) 3-Core Underground Cable:

Consists of Core/Conductor (usually stranded aluminum/copper), Paper Insulation, Lead Sheath (to prevent moisture), Bedding (jute/hessian to protect sheath), Armouring (galvanized steel wire for mechanical protection), and Serving (outermost fibrous layer).

Q.3 B) Radial vs Ring Main:

- **Radial:** Feeders radiate from the substation and feed distributors at one end only. Simple, low initial cost, but low reliability (fault on feeder cuts off all consumers).
- **Ring Main:** Distributor forms a closed loop fed at one or more points. High reliability (if one section fails, power flows from the other side), less voltage drop. Ring main is better for reliability.

Q.4 A) Corona:

Phenomenon: The bluish luminance, hissing noise, and production of ozone gas in an overhead transmission line when the voltage exceeds the critical disruptive voltage.
Factors: Line voltage, conductor size (roughness increases corona), spacing between conductors (larger spacing reduces corona), atmospheric conditions (worse in rain/fog).
Reduction: By increasing conductor size (using ACSR/bundled conductors) or increasing spacing between conductors.

Q.4 B) Numerical Solution:

Load P = 10 MW = 10×10^6 W
V_r = 33 kV = 33000 V
cos φ = 0.8
Receiving end current I = P / ($\sqrt{3} \times V_r \times \cos \varphi$) = 10,000,000 / (1.732 × 33000 × 0.8) = 218.69 A.
Impedance Z = 15 + j20 Ω. (R = 15 Ω, X = 20 Ω).
Voltage drop per phase $\Delta V = I (R \cos \varphi + X \sin \varphi)$ = 218.69 (15 × 0.8 + 20 × 0.6) = 218.69 (12 + 12) = 5248.56 V.
Receiving end phase voltage V_{rn} = 33000 / √3 = 19052.5 V.
Sending end voltage $V_s = V_{rn} + \Delta V$ = 19052.5 + 5248.56 = 24301.06 V.
% Voltage Regulation = $((V_s - V_{rn}) / V_{rn}) \times 100$ = (5248.56 / 19052.5) × 100 = 27.54%.

Q.5 A) AC Distribution System:

The single-line diagram consists of the main substation, primary feeders (usually 11kV) radiating outward, distribution transformers stepping down to 415V/240V, secondary distributors running along streets, and service mains tapping off to individual consumer energy meters.

Q.5 B) Indoor vs Outdoor Substations:

- **Indoor:** Used up to 11kV/33kV, requires less space, high building cost, safe from weather, fault location is difficult.
- **Outdoor:** Used for 33kV and above, requires more space, lower cost, exposed to weather, easy to locate faults and expand.

Q.6 A) Voltage Regulation & Efficiency (Short Line):

Equivalent circuit has R and X in series. $V_s = V_r + I(R \cos \varphi_r + X \sin \varphi_r)$.
% Regulation = $[I(R \cos \varphi_r + X \sin \varphi_r) / V_r] \times 100$.
Efficiency = Output Power / Input Power = $(V_r \times I \times \cos \varphi_r) / (V_r \times I \times \cos \varphi_r + I^2R)$.

Q.6 B) Types of Insulators:

- **Pin type:** Up to 33kV, mounted on pins on cross-arms.
- **Suspension type:** >33kV, discs connected in series (string). If one disc fails, only that is replaced.
- **Strain/Disc type:** Used at dead ends, sharp curves to take tension.
- **Shackle type:** Used for low voltage (LT) distribution lines.

Short Answer Solutions (Q.7)

A) Skin effect: Tendency of AC current to concentrate near the surface of the conductor. Increases effective resistance.

B) Trivector energy meter: Measures Active (kWh), Reactive (kVARh), and Apparent (kVAh) power simultaneously. Used for industrial energy accounting.

C) ACSR conductors: Aluminum Conductor Steel Reinforced. Outer strands are aluminum (conductivity), inner core is steel (mechanical tensile strength).

D) XLPE cables: Cross-Linked Polyethylene. Used for high voltage underground cables, capable of withstanding higher temperatures and stress than PVC.

E) Capacitor banks: Installed at substations in parallel to improve the power factor of the system by supplying leading reactive power.
