Hall Ticket Number: **14EE705/A**

IV/IV B.Tech (Regular\Supplementary) DEGREE EXAMINATION

November, 2019 **Electrical and Electronics Engineering**

Seventh Semester

Electrical Power Distribution Systems Engineering

Time: Three Hours **Maximum:** 60 Marks

Answer Question No.1 compulsorily. (1X12 = 12 Marks)

Answer ONE question from each unit. (4X12=48 Marks)

1 Answer all questions (1X12=12 Marks)

a) What is distribution system?
b) What is meant by load forecasting?
c) Define diversity factor.
d) Write the any two applications of the distribution transformer.
e) What are the advantages of mono graphs of determining regulation?
f) Define feeder.
g) List the different types of common faults that occur in a distribution system.
h) What is the principle of sectionalizer?
i) List various factors effecting the selection of secondary voltage levels.
j) What are the disadvantages of low power factor?
k) List various ways to improve overall voltage regulation.
l) Compare Shunt & Series compensation.

UNIT I

2 a) Explain the characteristics of residential, industrial and commercial loads 4M

b) The annual peak load of substation is 3500kW. The annual energy supplied to the primary feeder circuit is 20×10^6 kWh. 8M

Find: i) The annual average power demand ii) The annual load factor

(OR)

3 a) Briefly explain about distribution system planning process with diagram. 6M

b) Define tariff and Explain about maximum diversified demand method. 6M

UNIT II

4 a) What is distribution transformer & what are the types of Distribution Transformers? 6M

b) Explain the different factors to be considered to decide the ideal location for a substation. 6M

(OR)

5 a) Draw the single line diagram of 33-kV / 11-kV substation and explain the purpose of each component. 6M

b) How is the rating of distribution substation decided? Explain 6M

UNIT III

6 a) Explain voltage drop and power loss of a uniformly distributed load. 8M

b) Give the factors which will affect the selection of conductor size of feeder 4M

(OR)

7 a) What are the objectives of distribution system protection? What is the data required for selecting a protective device 6M

b) Discuss the co-ordination procedure between fuse and a circuit breaker 6M

UNIT IV

8 a) Explain the Voltage drop and power loss calculations in single phase two wire with ungrounded system 4M

b) Explain with help of phasor diagram of a series and parallel capacitors in distribution system. 8M

OR)

9 a) Explain the practical procedure to determine the best capacitor location. 6M

b) Describe different types of equipment for voltage control with neat diagrams 6M

1 X 12 = 12 M

a)**What is distribution system?**

In general, the distribution system is the electrical system between the substation fed by the transmission system and the consumer end. It generally consists of feeders, distributors

b)**what is meant by load forecasting?**

In general, the distribution system is the electrical system between the substation fed by the transmission system and the consumer end. It generally consists of feeders, distributors

c)**Define diversityfactor?**

Diversity factor is the ratio of the sum of the individual non-coincident maximum loads of various subdivisions of the system to the maximum demand of the complete system. The diversity factor is almost always larger than 1 since all components would have to be on simultaneously at full load for it to be one.

d)**Write the any two applications of distribution transformer?**

In order to distribute the power generated from the power generation plant to remote locations, these transformers are used. Basically, it is used for the distribution of electrical energy at low voltage is less than 33KV in industrial purpose and 440v-220v in domestic purpose.

e) **What are the advantages of mono graphs of determining regulation?**

It is the representation practical values in monographic scale.

f) **Define Feeder?**

Feeder is "voltage power line transferring power from a distribution substation to the distribution transformers" In an electrical wiring circuit in a building which Feeder is a "wire/line that carries power from a transformer or switch gear to a distribution panel.

g) **List the different types of common faults that occur in distribution system?**

Open Circuit Faults. These faults occur due to the failure of one or more conductors,Short Circuit Faults,Symmetrical and Unsymmetrical Faults,Fuse,Circuit Breaker,Protective Relays,Lighting Arrestor.

h)**What is the principle of sectionalizer?**

Sectionizers are protective devices that are used in medium voltage distribution systems to automatically isolate faulted sections once an upstream recloser or breaker has interrupted the fault current. The self contained protective devices are usually installed downstream of a recloser in the distribution circuit.

i)**List the various factors effecting the selection of secondary voltage level?**

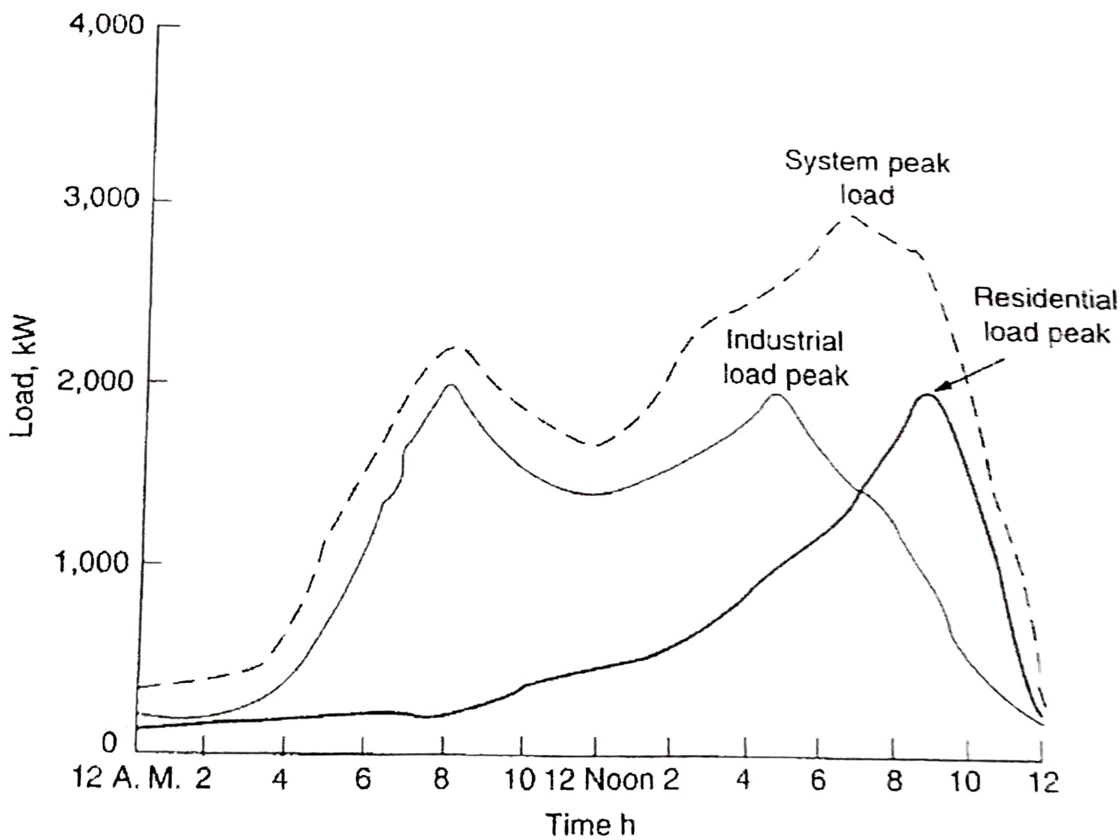
Type and size of the load to be served.,Distance to which power is to be transmitted.,Future Load Growth.,Equipment availability for fault isolation.,Permissible **voltage** regulations.Cost of utilization and service system equipment.

j)What are the disadvantages of low power factor?
Large kVA rating and size of Electrical Equipments,Greater conductor size and cost,Poor Voltage regulation.,High Transmission losses and hence poor efficiency.

k)List various ways to improve overall voltage regulation?
Use of generator voltage regulators, Application of voltage-regulating equipment in the distribution substations, Application of capacitors in the distribution substation. Balancing of the loads on the primary feeders, Increasing of feeder conductor size. Changing of feeder sections from single-phase to multiphase.Transferring of loads to new feeders. Installing of new substations and primary feeders, Increase of primary voltage level. Application of voltage regulators on the primary feeders, Application of shunt capacitors on the primary feeders. Application of series capacitors on the primary feeders.

l)Compare Shunt & series compensation?
Series and **Shunt** VAR **compensation** techniques are used to modify the natural electrical characteristics of electric power system. **Series compensation** modifies the reactance parameter of the transmission or distribution system, while **shunt compensation** changes the equivalent load impedance.

2a) 2a)Explain the characteristics of residential,industrial,commercial loads? 4M



(2)

(b)

the annual peak load of substation is = 3500 KW

the total annual energy supplied to the primary feeder circuit is = 20×10^6 KWh

(i) the annual average power demand :-

$$\text{Annual } P_{av} = \frac{\text{total annual energy}}{\text{year}}$$

$$= \frac{20 \times 10^6 \text{ KWh/yr}}{8760 \text{ h/yr}}$$

$$= 2283.105 \text{ KW}$$

(ii) annual load factor is

$$F_{ld} = \frac{\text{annual average load}}{\text{peak monthly demand}} = \frac{2283 \text{ KW}}{3500 \text{ KW}} = 0.652$$

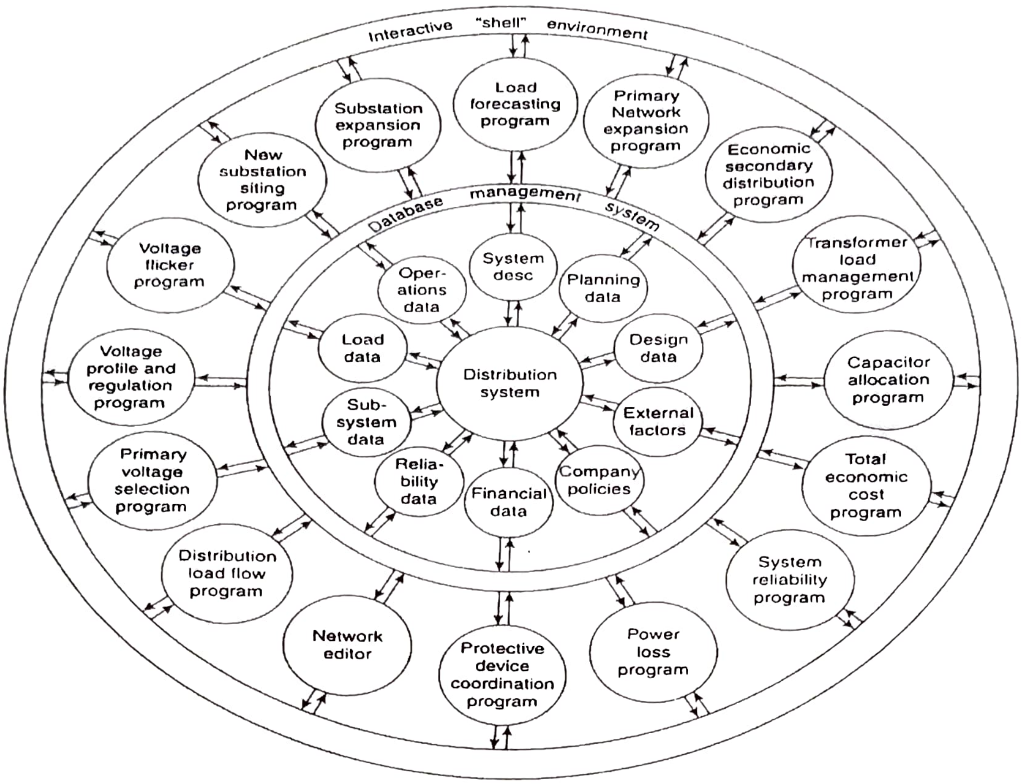
$$\therefore \text{annual load factor} = \frac{\text{total annual energy}}{\text{annual peak load} \times 8760}$$

$$= \frac{20 \times 10^6 \text{ KWh/yr}}{3500 \text{ KW} \times 8760} = \frac{20 \times 10^6}{30{,}660{,}000}$$

$$= \underline{\underline{0.652}}$$

3a)Briefly explain about Distribution system planning process with diagram 6M

3+3·



3b) Define tariff and maximum diversified demand method? 6M

Tarif:

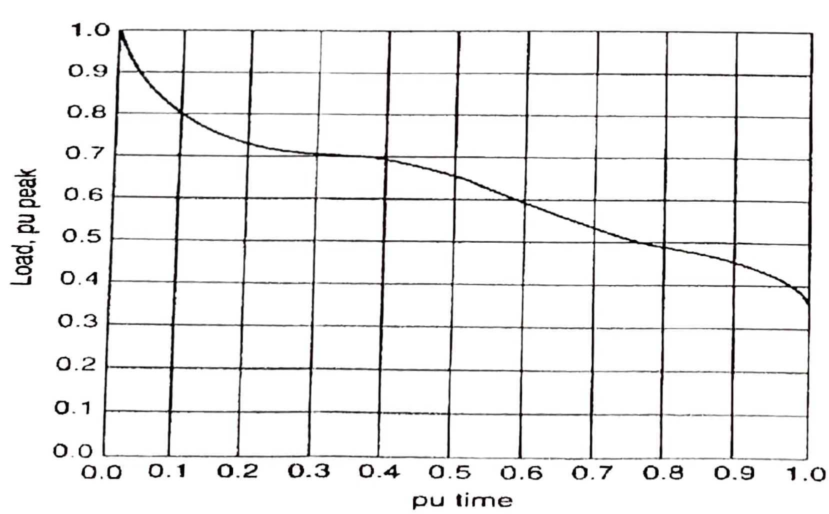
2M

Tariff refers to the amount of money the consumer has to pay for making the power available to them at their homes. Tariff system takes into account various factors to calculate the total cost of the electricity.

Max Diversified demand:

4M

It is the demand of the composite group,as a whole of somewhat unrelated loads the specified period of time.It is the maximum sum of contributions of the individual demand to the diversified demand



4a)What is distribution transformer & what are types distribution transformers? 6M

Distribution transformers can be classified as :

(i)dry type,................ .(a)air-cooled
(b)air-insulated

(ii) liquid filled type ...... (a)oil-filled
(b)interteen-filled

Distribution transformers in over head distribution system categorized as :

(1) conventional transformer
(2) completely self protecting (CSP)
3) completely self protecting for secondary banking (CSP)

Distribution transformers in underground distribution system categorized as :

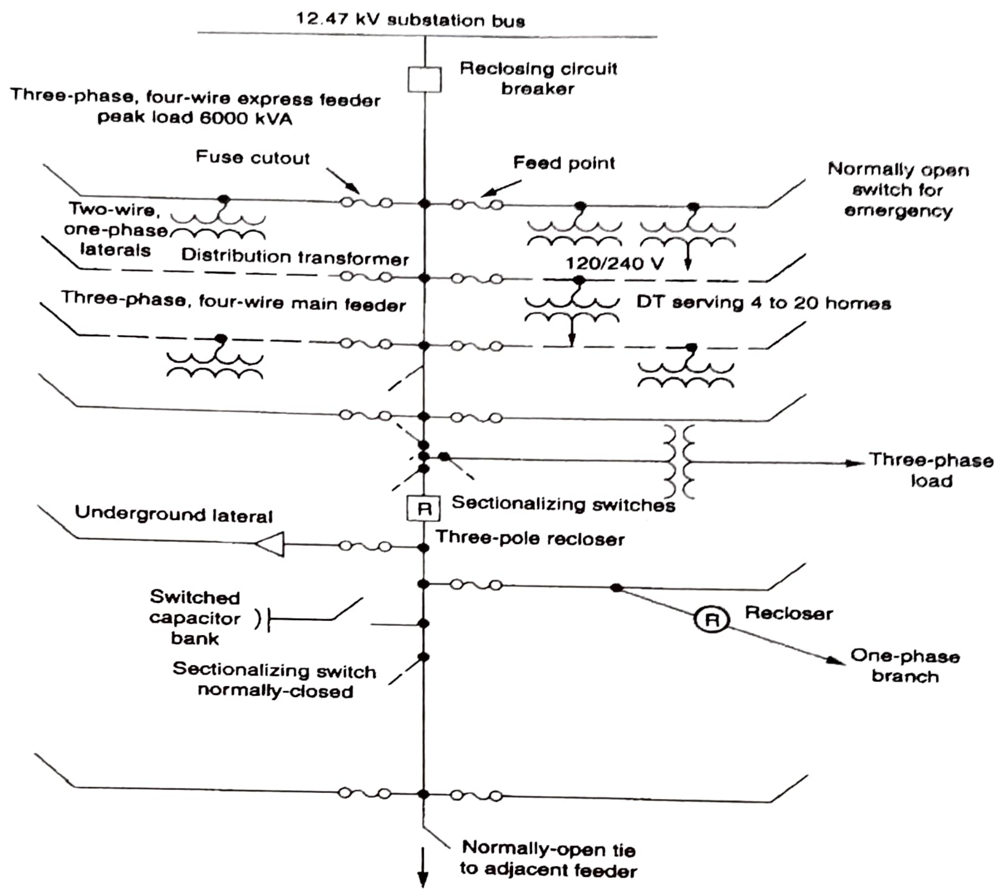
(1). Subway transformers
(2).low cost residential transformers
(3).network transformers.

4b) Explain different factors to be considered to decided the ideal location of substation? 6M

1. Locate the substation as much as feasible close to the load center of its service area, so that the addition of load times distance from the substation is minimum.
2. Locate the substation such that proper voltage regulation can be obtainable without taking extensive measures.
3. Select the substation location such that it provides proper access for incoming subtransmission lines and outgoing primary feeders and also allows for future growth.
4. The selected substation location should provide enough space for the future substation expansion.
5. The selected substation location should not be opposed by land use regulations, local ordinances, and neighbors.
6. The selected substation location should help to minimize the number of customers affected by any service discontinuity.
7. Other considerations, such as adaptability, emergency, etc.

5a)Draw the single line diagram 33kv/11kv substation and explain the purpose of of each component?

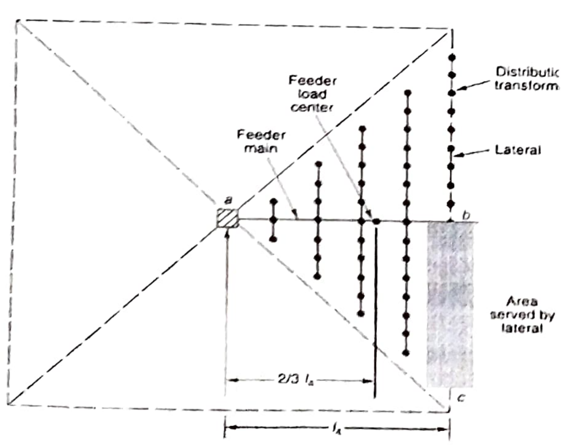
6M



Residential area: Approximately 1000 homes per square mile
Feeder area: 1 to 4 mi^2 depending on load density
15 to 30 single-phase laterals per feeder
150 to 500 MVA short-circuit available at substation bus

5b) how the rating of substation is decided ? Explain

6M



$$\%VD_{ac} = \%VD_{ab} + \%VD_{bc}. \qquad \text{.............(1)}$$

$$S_4 = A_4 \times D \text{ kVA} \qquad \text{..................................(2)}$$

$$S_4 = l_4^2 \times D \text{ kVA} \qquad \text{..(3)}$$

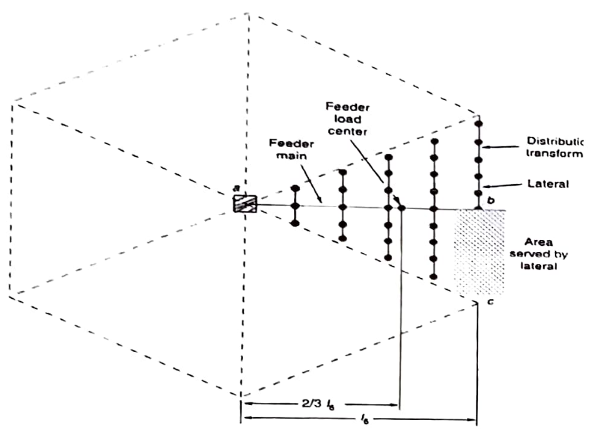
Since

$$A_4 = l_4^2 \qquad \text{..(4)}$$

$$\%VD_{4,\text{main}} = \frac{2}{3} \times l_4 \times K \times S_4 \qquad \text{..................................(5)}$$

Substitute 3 in 5

$$\%VD_{4,\text{main}} = 0.667 \times K \times D \times l_4^3. \qquad \text{..................(6)}$$



$$A_6 = \frac{l_6}{\sqrt{3}} \times l_6$$

$$= 0.578 \times l_6^2 \qquad \text{..................................(1)}$$

$$S_6 = A_6 \times D \text{ kVA} \qquad \text{.............................(2)}$$

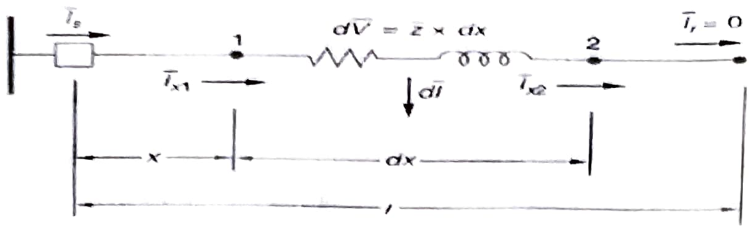
$$S_6 = 0.578 \times D \times l_6^2 \qquad \text{..............................(3)}$$

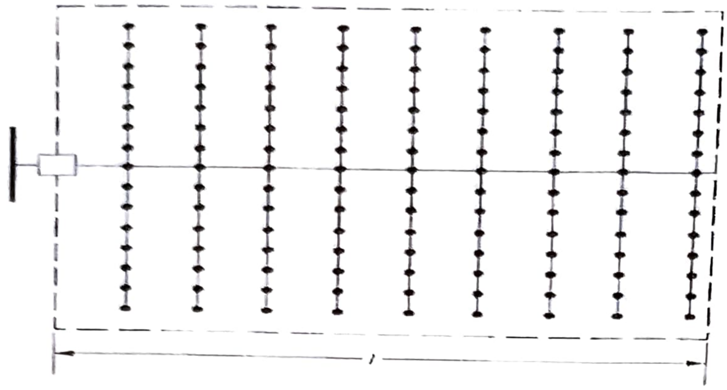
$$\%VD_{6,\text{main}} = \frac{2}{3} \times l_6 \times K \times S_6 \qquad \text{................(4)}$$

Sub eqn 3 into 4

$$\%VD_{6,\text{main}} = 0.385 \times K \times D \times l_6^3. \qquad \text{.............................(5)}$$

6a) Explain voltage drop and power loss of a uniformly distributed load? 8M





$I_{x1} = I_{x2} + dI$ — (1)

$I_{x2} = I_{x1} - dI$ — (2)

Sub (1) in (2) $I_{x2} = I_{x1} - dI \cdot \frac{dx}{dx}$

$= I_{x1} - \frac{dI}{dx} \cdot dx$

$I_{x2} = I_{x1} - K \cdot dx$. $K = \frac{dI}{dx}$ — (3)

$I_{x2} = I_{x1} - K \cdot dI$

$I_{x1} = I_{x2} + K \cdot dI$

∴ the total feeder

$I_r = I_s - K \times l$ — (4)

$I_s = I_r + K \times l$ — (5)

when $x = l$

$I_r = I_s - K \times l = 0$.

$K = \frac{I_s}{l}$ — (6)

$x = l$.

$I_r = I_s - K \times x$ (7)

Sub ⑥ in ⑦

$$I_r = I_s\left(1-\frac{x}{l}\right)$$

$$I_x = I_r$$

$$\therefore I_x = I_s\left(1-\frac{x}{l}\right) \quad -⑧$$

differential series voltage drop can be.

$$I_s = \begin{cases} I_r = 0 & at\ x = l \\ I_r = I_s & at\ x = 0 \end{cases}$$

$$\therefore \bar{dv} = I_x \times Z \cdot dx \quad -⑨$$

⑧ in ⑨

$$\bar{dv} = I_s \times Z\left(1-\frac{x}{l}\right)dx \quad -⑩$$

the differential power loss can be.

$$dP_{ls} = I_x^2 \times r\,dx \quad -⑪$$

⑧ in ⑪

$$dP_{ls} = \left[I_s\left(1-\frac{x}{l}\right)\right]^2 r \cdot dx.$$

the series voltage drop V_{Dx} because of I_x current at any point x on the

$$V_{Dx} = \int_0^x dV \quad ⑫$$

⑩ in ⑫

$$V_{Dx} = \int_0 I_s \times Z\left(1-\frac{x}{l}\right)dx$$

$$V_{Dx} = I_s \times Z \times x\left(1-\frac{x}{2l}\right)$$

the total series voltage drop ΣV_{Dx} $x = l$ is

$$\Sigma V_{Dx} = I_s \times Z \times l\left(1-\frac{l}{2l}\right)$$

$$\Sigma V_{Dx} = \frac{1}{2} Z \times l \times I_s$$

the total copper loss/phase.

$$\Sigma P_{ls} = \int_0^l dP_{ls}$$

$$\Sigma P_{ls} = \frac{1}{3} I_s^2 \times r \times l$$

$$x = l/2, \quad x = l/3$$

6b)give the factors which will factors affect the selection of conductor size of feeder? 4M

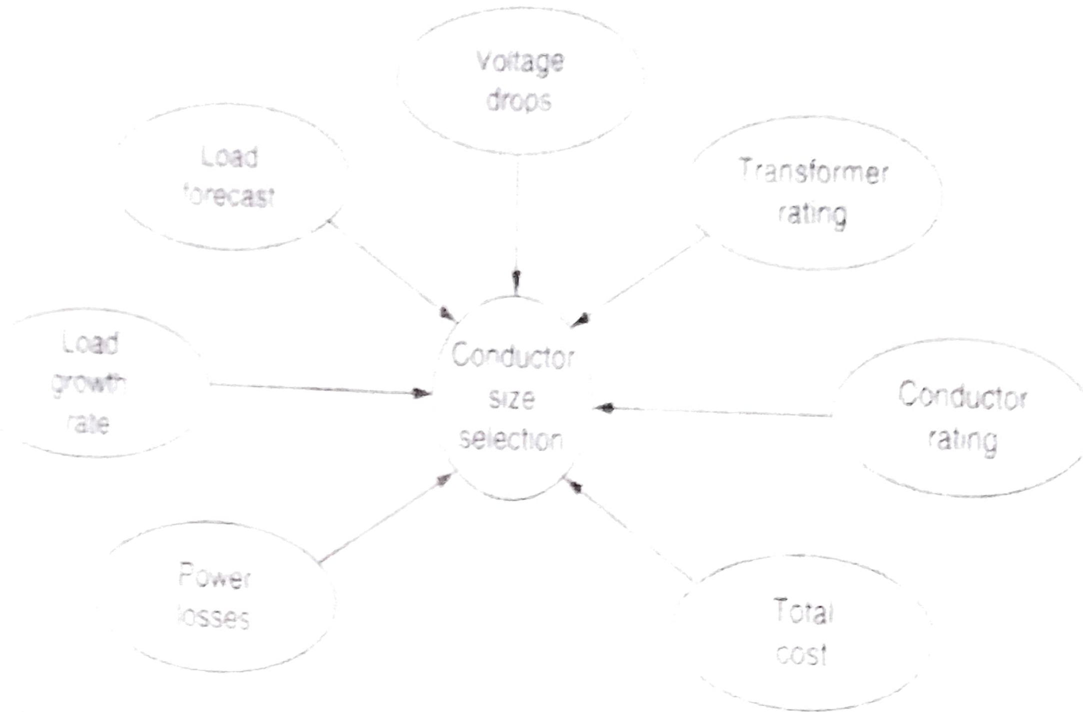


FIGURE 5.13 Factors affecting conductor size selection.

7a) what are the objectives of distribution system protection?what is the data required for selecting a protective device? 6M

Objects of distribution system protection

(1)The main objectives of distribution system protection are

(i)to minimize the number of consumers affected by the fault

(ii) to minimize the duration of a fault .

(2) The secondary objectives of distribution system protection are

(i)to eliminate safety hazards as fast as possible

(ii)to limit service outages to the smallest possible segment of the system

(iii)to protect the consumers apparatus

(iv)to protect the system from unnecessary service interruptions and disturbances

(v)to disconnect faulted lines ,transformers, or other r apparatus

(3) overhead distribution system are two types electrical faults

(i) transient fault

(ii) permanent faults.

7b)Discuss the coordination procedure between fuse and circuit braker? 6M

The fuse-to-circuit-breaker (*overcurrent relay*) coordination is somewhat similar to the fuse-to-recloser coordination. In general, the reclosing time intervals of a circuit breaker are greater than those of a recloser. For example, 5 sec is usually the minimum reclosing time interval for a circuit breaker, whereas the minimum reclosing time interval for a recloser can be as small as ½ sec. Therefore, when a fuse is used as the backup or protected device, there is no need for heating and cooling adjustments. Thus, to achieve a coordination between a fuse and circuit breaker. The minimum melting time curve of the fuse is plotted for a phase-to-phase fault on the secondary side. If the minimum melting time of the fuse is approximately 135% of the combined time of the circuit breaker and related relays, the coordination is achieved. However, when the fuse is used as the protecting device, the coordination is achieved if the relay operating time is 150% of the total clearing time of the fuse.

In summary, when the circuit breaker is tripped instantaneously, it has to clear the fault before the fuse is blown. The fuse has to clear the fault before the ciruit breaker trips on time-delay operations. Therefore it is necessary that the relay characteristic curve, at all values of current up to the maximum current available at the fuse location. lie above the total clearing characteristic curve of the fuse. Thus, it is usually customary to leave a margin between the relay and fuse characteristic curves to include a safety factor of 0.1 to 0.3 + 0.1 sec for relay overtravel time.

A sectionalizing fuse installed at the riser pole to protect underground cables does not have to coordinate with the instantaneous trips as underground lines are usually not subject to transient faults. On looped circuits the fuse size selected is usually the minimum size required to serve the entire load of the loop, whereas on lateral circuits the fuse size selected is usually the minimum size required to serve the load and coordinate with the transformer fuses, keeping in mind the cold pickup load.

8a)Explain voltage drop power loss calculation in single phase two wire with ungrounded system 6M

8a)

$$S_{1\phi} = S_{3\phi}$$

$$V_s \times I_{1\phi} = 3 \times V_s \times I_{3\phi}$$

$$I_{1\phi} = 3 \times I_{3\phi}.$$

$$VD_{3\phi} = I_{3\phi} (R \cos\theta + X \sin\theta)$$

$$VD_{1\phi} = I_{1\phi} (K_R R \cos\theta + K_X X \sin\theta)$$

Where Kr=2 & kx=2

$$VD_{1\phi} = I_{1\phi} (2R \cos\theta + 2X \sin\theta)$$

$$VD_{1\phi} = 6 \times I_{3\phi} (R \cos\theta + X \sin\theta)$$

$$\frac{VD_{1\phi}}{VD_{3\phi}} = 6.0$$

$$\frac{VD_{pu,\,1\phi}}{VD_{pu,\,3\phi}} = 2\sqrt{3} = 3.46$$

$$P_{LS,\,1\phi} = I_{1\phi}^2\,(2R)$$

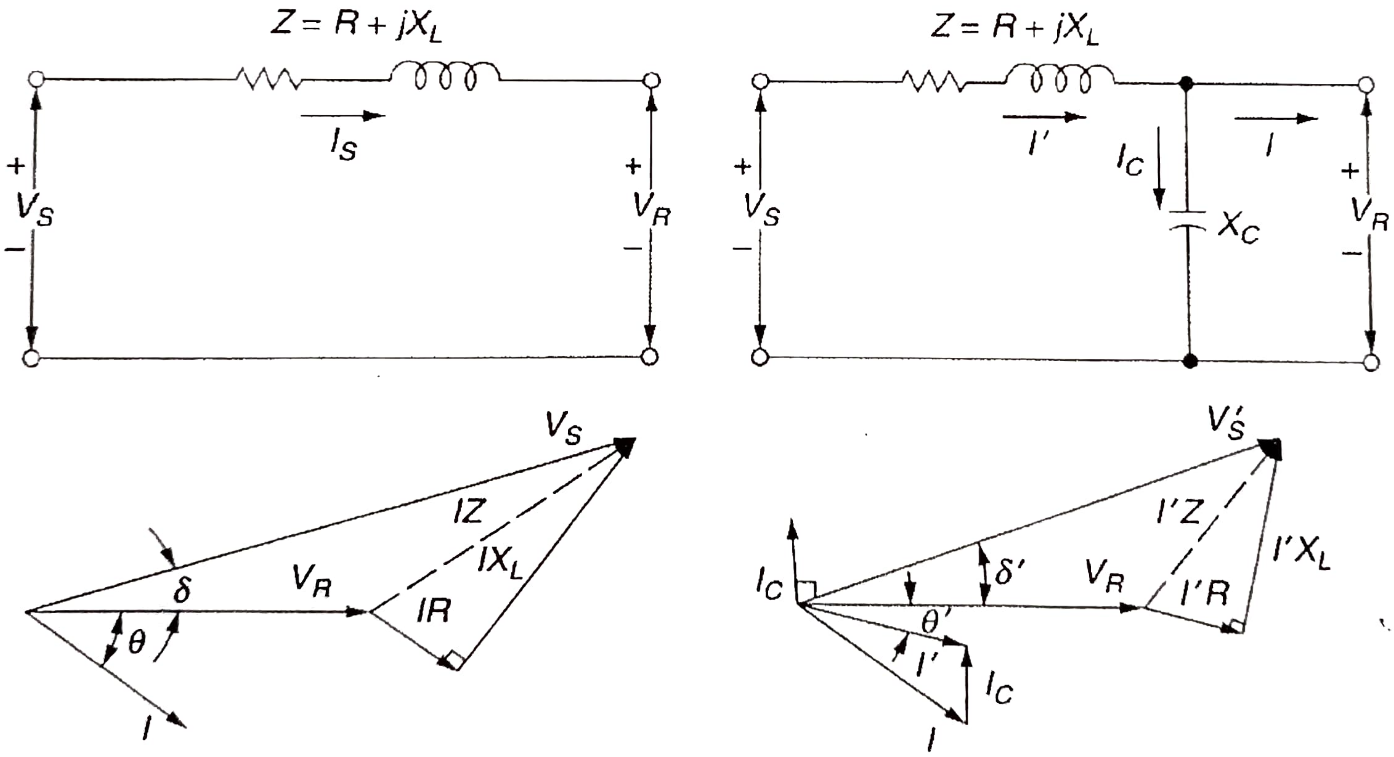
$$P_{LS,\,3\phi} = 3 \times I_{3\phi}^2\,R$$

$$P_{LS,\,1\phi} = (3 \times I_{3\phi})^2\,(2R)$$

$$\frac{P_{LS,\,1\phi}}{P_{LS,\,3\phi}} = 6.0.$$

8b)Explain with help of phasor diagram of series and parallel capacitors in distribution system.? 8M

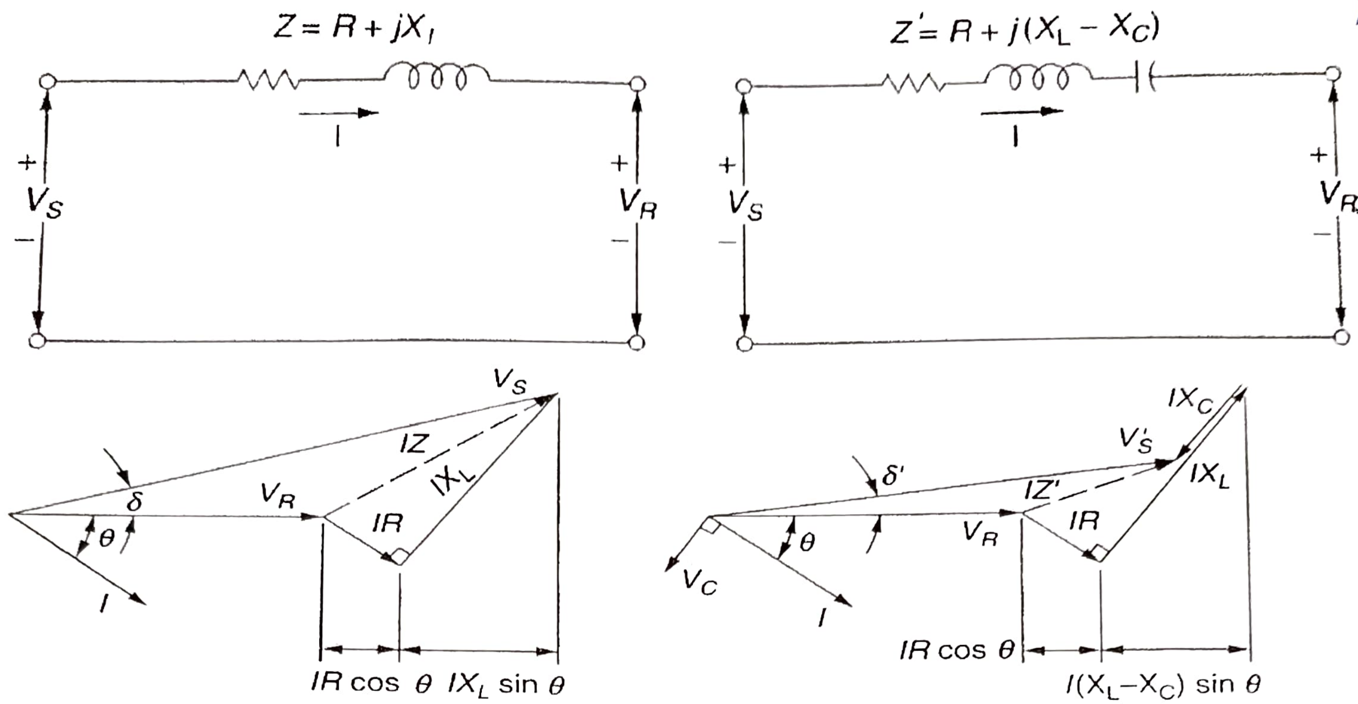
HM



$$VD = I_R R_R + I_X X_L - I_c X_L$$

$$VR = I_c X_L.$$

Series compensation



$$\mathrm{VD} = IR\cos\theta + IX_L\sin\theta$$

$$\mathrm{VD} = IR\cos\theta + I(X_L - X_c)\sin\theta$$

9a) Explain the practical procedure to determine the best capacitor location? 6M

1. Collect the following circuit and load information:

   (*a*) Any two of the following for each load: kilovoltamperes, kilovars, kilowatts, and load power factor,
   (*b*) Desired corrected power of circuit,
   (*c*) Feeder circuit voltage,
   (*d*) A feeder circuit map which shows locations of loads and presently existing capacitor banks.

2. Determine the kilowatt load of the feeder and the power factor.
3. From Table 8.1, determine the kilovars per kilowatts of load (i.e., the correction factor) necessary to correct the feeder circuit power factor from the original to the desired power factor. To determine the kilovars of capacitors required, multiply this correction factor by the total kilowatts of the feeder circuit.
4. Determine the individual kilovoltamperes and power factor for each load or group of loads.

5. To determine the kilovars on the line, multiply individual load or groups of loads by their respective reactive factors that can be found from Table 8.1.
6. Develop a nomograph to determine the line loss in watts per thousand feet due to the inductive loads tabulated in steps 4 and 5. Multiply these line losses by their respective line lengths in thousands of feet. Repeat this process for all loads and line sections and add them to find the total inductive line loss.
7. In the case of having presently existing capacitors on the feeder, perform the same calculations as in step 6, but this time subtract the capacitive line loss from the total inductive line loss. Use the capacitor kilovars determined in step 3 and the nomograph developed for step 6 and find the line loss in each line section due to capacitors.
8. To find the distance to capacitor location, divide total inductive line loss by capacitive line loss per thousand feet. If this quotient is greater than the line section length

   (*a*) Divide the remaining inductive line loss by capacitive line loss in the next line section to find the location;
   (*b*) If this quotient is still greater than the line section length, repeat step 8a.

9. Prepare a voltage profile by hand calculations or by using a computer program for voltage profile and load analysis to determine the circuit voltages. If the profile shows that the voltages are inside the recommended limits, then the capacitors are installed at the location of minimum loss. If not, then use engineering judgment to locate them for the most effective voltage control application.

9b) Describe different types of equipment for voltage control with neat diagram? 6M

1. Use of generator voltage regulators
2. Application of voltage-regulating equipment in the distribution substations
3. Application of capacitors in the distribution substation
4. Balancing of the loads on the primary feeders
5. Increasing of feeder conductor size
6. Changing of feeder sections from single-phase to multiphase
7. Transferring of loads to new feeders
8. Installing of new substations and primary feeders
9. Increase of primary voltage level
10. Application of voltage regulators on the primary feeders
11. Application of shunt capacitors on the primary feeders
12. Application of series capacitors on the primary feeders

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