CENTRE C
THE LEARNING CENTRE
ELECTRICAL

QUIZ – ANSWER KEY

QUIZ NO: 108

TOPIC: ELECTRICAL ENGINEERING

DATE: 24/09/2022

1. With 100 % inductive shunt compensation, the voltage profile is flat for ?

   [A] With 100 % inductive shunt compensation, the voltage profile is flat for

   [B] 50 % loading on the line

   [C] Zero loading of the line

   [D] Any of the above

   Answer: C

   <u>Explanation:-</u>

   The virtual shunt impedance Loading is given as:

$$P_C' = P_C\sqrt{\frac{1-\gamma_{sh}}{1-\gamma_{se}}}$$

Where

Υ_{sh} is degree of Shunt compensation

Υ_{se} is the degree of Series compensation

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- It is clear that a fixed degree of series compensation and capacitive shunt compensation decreases the virtual surge impedance of the line.
- However, inductive shunt compensation increases the virtual surge impedance and decreases the virtual surge impedance loading of the line. **If inductive shunt comp. is 100%, the virtual surge impedance becomes infinite and loading zero.**

2. The corona loss on a particular system at 50 Hz is 1.2 kW/phase per km. The corona loss on the same system with supply frequency 60 Hz will be ?

   [A] 1 kW/phase/km

   [B] 0.5 kW/phase/km

   [C] 0.667 kW/phase/km

   [D] 1.36 kW/phase/km

   Answer: D

Explanation:-

Given-

$f_1 = 50$ Hz

$f_2 = 60$ Hz

$P_{L1} = 1.2$ kW / km / phase

Corona Loss (P_L) ∝ (f + 25)

P2/P1=(f2+25)/(f1+25)

P2=[(60+25)/(50+25)]×P1

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P_2 = 1.36 kW/phase/km

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3. A voltage of 1000 kV is applied to an overhead line with its receiving end open. If the surge impedance of the line is 500 ohm, then the total surge power in the line is ?

   [A] 2000 MW

   [B] 1000 MW

   [C] 10000 MW

   [D] 200 MW

   Answer: A

   Explanation:-

- **Surge impedance loading (SIL):**
- Surge impedance loading is defined as the power load in which the total reactive power of the lines becomes zero. The reactive power generated by the shunt capacitance is consumed by the series inductance of the line.
- Surge Impedance Loading is given as
- $SIL = V^2/Z_c MW$
- Where
- Z = Surge impedance = 500 Ω
- V = Line Voltage = (1000×10^3)
- $SIL = (1000 \times 10^3)^2/500$
- **SIL = 2000 MW**

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4. The main criterion for selection of the size of a distribution for a radial distribution system is ?

[A] The station is located in the center of the load

[B] Corona loss

[C] Temperature loss

[D] Capital Cost

Answer: A

Explanation:-

The main criterion for the selection of the size of a distribution for a radial distribution system is station is located in the center of the load.

According to the scheme of connection, the distribution system may be classified as:

(a) Radial system

(b) Ring main system

(c) Inter-connected system

Radial System

1. If a distributor is connected to the supply system from one end only, it is called a radial system of distribution.
2. This is also true for the feeders i.e. if a feeder is connected to the supply system from one end only that feeder is called a radial feeder.
3. The main characteristic of a radial distribution system is that the power flow is in only one direction.
4. There are combinations of one distributor and one feeder, connecting that distributor to the substation.

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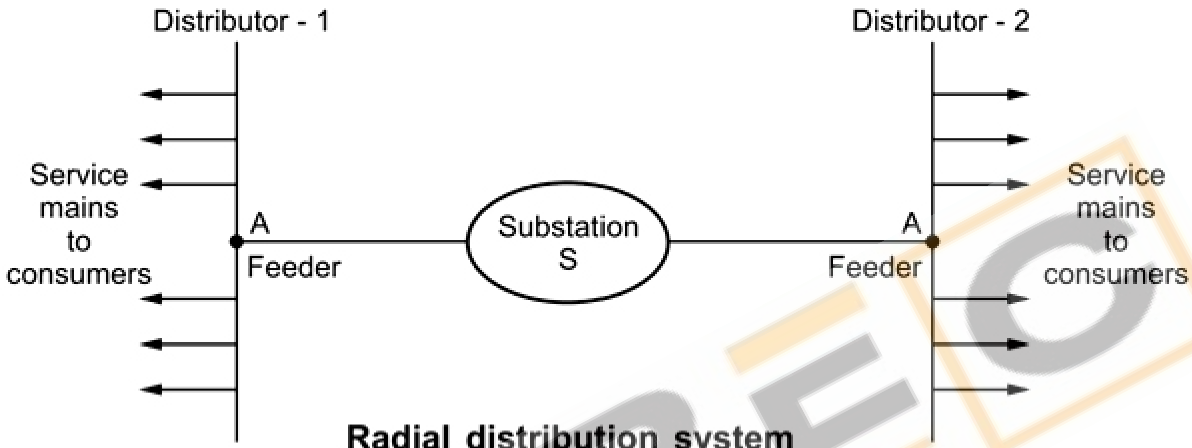
5. In distributor 1 is connected only at one end to the substation through a feeder at point A. Similarly, the other feeder is feeding distributor 2, only at one point B.



Radial distribution system

Advantage of Radial System

- Simple in operation
- Low initial cost
- Useful when the generation is low voltage
- **Radial system is preferred only when the station is located in the center of the load**

In a radial distribution system, for a given length (l) and area of cross-section (A), the resistance of the conductor is given by

R=fracrholA

Voltage drop is given by **V = IR**

In order to reduce the voltage drop, the size of the conductor must be increased (for a fixed given length) so that the resistance of the conductor is reduced. Hence rated voltage can be maintained at the load terminal.

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Disadvantages of Radial System

1. The end of the distributor near to the substation gets heavily loaded.
2. When load on the distributor changes, the consumers at the distant end of the distributor face serious voltage fluctuations.
3. As consumers are dependent on a single feeder and distributor, a fault on any of these two causes interruption in supply to all the consumers connected to that distributor.

5. If an induction machine is run at above synchronous speed, it acts as ?

[A] Synchronous Generator

[B] Induction Generator

[C] Induction motor

[D] Synchronous Motor

Answer: B

Explanation:-

- **If an induction motor runs at above synchronous speed with a supply connected to it, it works as an Induction generator.**
- To run an induction machine as the generator it slips must be less than zero that is negative slip (-1 < S < 0) it is also called the regenerative action of an induction motor.
- In generator operation, a prime mover (turbine or engine) drives the rotor above the synchronous speed therefore for generator
  $N_r >> N_s$
  $S = N_s – N_r/Ns$
- The supply here works simply as an exciter of the machine and instead of supplying any electrical energy, it receives electric energy generated from the machine.
- When the speed of the induction motor is increased above its rated speed, the e.m.f and slip of current frequency will develop in the rotor winding but with the

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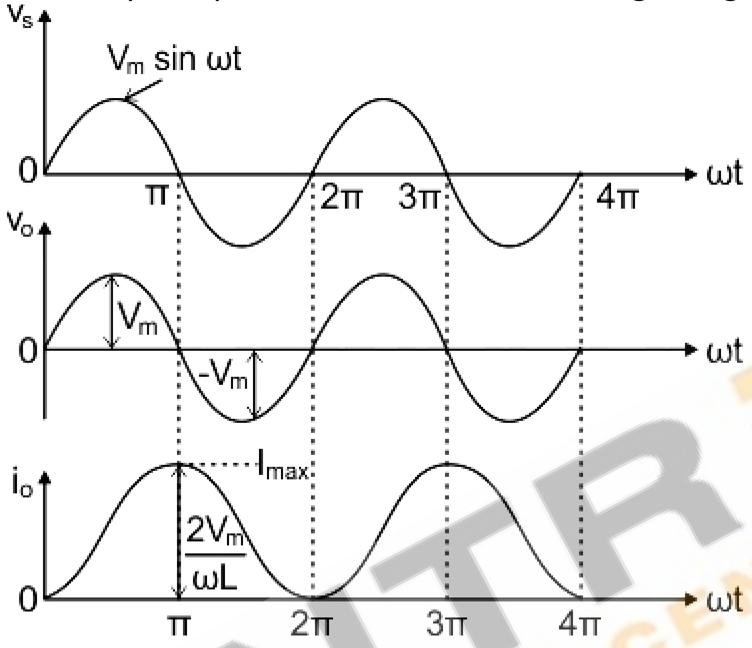
opposite direction as compared to the direction when it’s operating below synchronous speed.

- The torque slip characteristics of motoring and generating action is given below



6. The low voltage winding of a 400/230 V, 1-phase, 50 Hz transformer is to be connected to a 25 Hz, the supply voltage should be ?

[A] 230 V

[B] 250 V

[C] 115 V

[D] 100 V

Answer: C

Explanation:-

To maintain the magnetizing current of the transformer at the same level the ratio of voltage to frequency must be the same. i.e

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Given

F_1 = 50 Hz

F_2 = 25 Hz

V_1 = 230 V

V_2 = ?

V/F=Constant

$V_2/F_2=V_1/F_1$=Constant

$V_2=230\times(25/50)$

V_2 = 115 V

7. Which of the following method are used to minimize the Corona losses?
   [A] Decreasing supply frequency
   [B] Using smooth conductor
   [C] Using hollow conductor
   [D] All of the above

Answer: D

Explanation:-

Corona loss is given by

$$P_c = \frac{244(f+25)}{\delta}\sqrt{\frac{r}{D}}(V-V_0)^2 \times 10^{-5} \text{ (kW/phase/km)}$$

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Where

f = Supply frequency

δ = Air density factor

r = Radius of the conductor

D = Distance between the conductors

V = Operating voltage of the transmission line

Vo = Critical disruptive voltage

- Corona loss increases with frequency.
- Corona loss increases very fast with an increase in system voltage since the loss is dependent on $(V – V_o)^2$

Method of reducing corona

The corona loss can be reduced by using:

Conductors with large diameters: The voltage at which the corona occurs can be increased by increasing the size of the conductor and hence, the corona loss can be reduced.

The frequency of supply: Corona loss decrease as the supply frequency decrease.

The distance between the two conductors: To prevent corona spacing between the conductors must be increased.

Air Pressure: In hilly areas, the corona effect is more dominant due to reduced pressure.

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Hollow conductors: These are used to increase the effective diameter of the conductor without using any additional material. Since corona loss is inversely proportional to the diameter of the conductor, corona loss decreases with an increase in the diameter.

Using Smooth conductor: Since corona loss is higher at sharp corners of the conductors, due to the presence of the highly non-uniform field, increasing the conductor radius as a whole can reduce the corona effect significantly. More the imperfections on the conductor surface more will be Corona.

Bundled conductors: These are made up of two or more sub-conductors and are used as single-phase conductors. When using two or more sub-conductors as one conductor, the effective diameter of the conductor increases, resulting in reduced corona loss.

8. Shunt compensation in EHV line is resorted to ?

[A] Improve power factor
[B] Reduce fault current
[C] Improve stability
[D] Increase current

Answer: A

<u>Explanation:-</u>

Shunt Compensation: In this type of compensation, either shunt inductors or shunt capacitors are used. They are connected between each line and neutral to reduce the effect of shunt susceptance of the line.

Shunt inductors are also known as shunt reactors. It absorbs the reactive power from the lines and controls the voltage of the line when the line is at no load or is lightly loaded. They are connected at both the ends of transmission lines.

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Advantages of Shunt Reactor

1. With the help of shunt capacitor banks, reactive power is injected into the line to maintain the voltage within the limits at heavy loads. The shunt capacitors are connected near the load terminals.
2. Shunt compensation at no-load also keeps the receiving end voltage within limits which would otherwise be quite high because of the Ferranti Effect. Thus reactors should be introduced as the load is removed for proper voltage control.
3. The shunt capacitors are used across an inductive load so as to provide part of the reactive VARs required by the load to keep the voltage within desirable limits.
4. The shunt reactors are kept across capacitive loads or in light load conditions, to absorb some of the leading VARs for achieving voltage control. Capacitors are connected either directly to a bus or through the tertiary winding of the main transformer and are placed along the line to minimize losses and the voltage drop.
5. For the same voltage boost, the reactive power capacity of a shunt capacitor is greater than that of a series capacitor. **The shunt capacitor improves the pf of the load while the series capacitor has hardly any impact on the pf**. Series capacitors are more effective for long lines for the improvement of system stability.
6. A **shunt reactor** is an absorber of reactive power, thus improve the voltage profile and hence energy efficiency of the system.

Note:-

Thus, we see that in both series and shunt compensation of long transmission lines it is possible to transmit large amounts of power efficiently with a flat voltage profile. The proper types of compensation should be provided in proper quantity at appropriate places to achieve the desired voltage control.

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9. The insulation of modern EHV and UHV lines is designed based on ?
   [A] Corona
   [B] Radio interface
   [C] Lightning voltage
   [D] Switching voltage

Answer: D

Explanation:-

The insulation of modern EHV and UHV lines is designed based on switching voltage.

Switching Overvoltage

Switching overvoltage is characterized by large amplitude, high-frequency oscillation, strong damping, and short duration. It is caused by switching off circuit breakers or system fault, including the overvoltages after normal switching operations, such as the closing of lines, transformers, reactors, and post-fault reclosing of a line, and the overvoltages as a result of tripping, a fault, or fault clearing. Switching overvoltages may have different degrees of effects on the insulation of electrical equipment and protection equipment, primarily depending on their amplitude, wave shape, and duration.

Insulation Co-ordination

- The amplitude of switching overvoltages is a key factor for designing the insulation of EHV and UHV equipment. The insulation coordination procedure is based on the insulation strength characteristics.

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- Insulation strength is characterized by a discharge probability function since every applied impulse magnitude is associated with a probability of flashover.
- Switching overvoltage waves in real systems have irregular waveshapes.
- The switching surge overvoltage is thought of two components, one basic wave having a low-frequency component and the other one is the superimposed wave with rapid variations with time.
- The effect of different arresters needs to be studied, since installing arresters is an important way to suppress switching overvoltages in EHV and UHV transmission lines.
- The most common temporary overvoltages occur in the healthy phases of a system during phase-to-earth faults.
- Switching overvoltages appear in the power systems due to switching of load and/or fault currents, and they cannot be avoided.
- Insulation Coordination is a series of steps used to select the dielectric strength of equipment in relation to the operating voltages and transient overvoltages which can appear on the system for which the equipment is intended.
- Thus Insulation coordination is an art to decide the insulation level of the equipment.

10. A long overhead transmission line is terminated by its characteristic impedance. Under this operating condition, the ratio of the voltage to the current at different points along the line will ?

[A] Remain the same at all points

[B] Remain same at the two ends, but be higher between the two ends being maximum at the center of the line

[C] Progressively increase from the sending end to the receiving end

[D] The progressively increase from the receiving end to the sending-end

Answer: A

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Explanation:-

A long overhead transmission line is terminated by its characteristic impedance. Under this operating condition, the ratio of the voltage to the current at different points along the line will remain the same at all points.

The two important electrical properties of symmetrical network are:

1. Characteristic impedance (Z_o)
2. Propagation constant.

Characteristic Impedance (Z_o)

1. Characteristic impedance is a fine and useful concept of the transmission line.
2. When no part of the power sent down an infinite line returns no reflection, there is no loss of power.
3. When a line that is terminated at its characteristic impedance, behaves as an infinite line, it will also have no reflection.
4. A long overhead lossless power transmission line is terminated with its characteristic impedance. It indicates that the reflection coefficient is zero.
5. When a line is terminated in its characteristic impedance, it is said to be correctly terminated or termed as a non-resonant line.
6. **The characteristic impedance of a uniform transmission line is defined as the steady-state vector ratio of the voltage to the current at the input of an infinite line.**

Electrical energy on a length of a line equals $CV^2/2$

Where

C = Capacitance
V = magnitude of the traveling voltage wave

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The magnetic energy of the length of the line is equal to $LI^2/2$

Where

L = Inductance of the line
I = Magnitude of the traveling current wave

frac $CV^2 2$=*frac* $LI^2 2$

Hence

Frac VI=*sqrt frac* LC

Hence in the surge impedance loading, the ratio of traveling voltage to the traveling current is determined by the ratio of L and C and in surge impedance, the voltage and current are in the same phase at any point along the line.