Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1	**Attempt any FIVE of the following**	**10 Marks**
a)	**State the meaning of Single line diagram**	
Ans:	**Meaning of Single line diagram: (Or equivalent)** **(2 Marks)** The single line diagram of a power system is the network which shows the main connections and arrangement of the system components along with their data (such as output rating, voltage, resistance and reactance, etc.). **OR** In power engineering, a one-line diagram or single-line diagram (SLD) is a simplified notation for representing a three-phase power system. Electrical elements such as circuit breakers, transformers, capacitors, bus bars, and conductors are shown by standardized schematic symbols.	
b)	**State the classification of transmission lines depending on length of transmission lines.**	
Ans:	**According to Length of Transmission line:** **(2 Marks)** a) Short Distance Transmission Line - (up to 50 KM) b) Medium Distance Transmission Line - (up to 50 to 150 KM) c) Long Distance Transmission Line - (above 150 KM)	

OR

1) **Short Transmission Line: -** The length of Short transmission Line is up to **50KM** and its line voltage is less than **20 KV**

2) **Medium Transmission Line: -** The length of Medium transmission Line is up to **50KM- 150KM** and its line voltage is between **20KV to** 100 **KV**

3) **Long Transmission Line: -** The length of Long transmission Line is above **150KM** and its line voltage is above **100K**

OR

1) **Short Transmission Line: -** The length of Short transmission Line is up to **80KM** and its line voltage **is less than 20 KV**

2) **Medium Transmission Line: -** The length of Medium transmission Line is up to **80KM- 200KM** and its line voltage is between **20KV to 100 KV**

3) **Long Transmission Line: -** The length of Long transmission Line is above **200KM** and its line voltage is above **100KV**

c) State the type of distribution substation.

Ans: **The classification of distribution substation.**

(Any Four point expected: 1/2 Mark each, Total 2 Marks)

1. Pole mounted distribution substation
2. Plinth mounted distribution substation
3. Compact/prefabricated distribution substation
4. Underground distribution substation
5. Indoor distribution substation
6. Outdoor distribution substation
7. Mobile distribution substation

d)	**List different transmission line components used for power transmission. (any four)**
Ans:	**Following are the Transmission line components used for power transmission line:-** **(Any Four components are expected: 1/2 Mark each, Total 2 Marks)** 1. Supporting structure (pole) 2. Line insulator 3. Overhead conductor 4. 'V' Cross arm 5. Top pin support 6. Two Pin Cross arm 7. Four pin cross arm 8. Stay set (Stay wire of 7/8 or 7/10 SWG) 9. Lighting arrestors 10. Guarding wires 11. Continuous earth wire 12. Cables 13. Fuses and Isolating switches 14. Different types of fabrication Clamp (A-type, B-Type) 15. Bird guards 16. Vibration damper 17. Jumpers
e)	**State features of wireless power transmission.**
Ans:	**Features of wireless power transmission:** **(Any four point expected: 1/2 Mark each, Total 2 Marks)** 1. Energy delivered anywhere in the world 2. Zero fuel cost

3. Less losses
4. Less use of copper wires
5. More efficiency
6. Minimum long-range environmental impact

OR

Features of wireless power transmission:

(Any Four point expected: 1/2 Mark each, Total 2 Marks)

1. An electrical distribution system, based on this method would eliminate the need for an inefficient, costly, and capital intensive grid of cables, towers, and substations.
2. It will rid the landscape of wires, cables, and transmitting towers.
3. The electrical energy can be economically transmitted without wires to any terrestrial distance, so there will be no transmission and distribution loss.
4. More efficient energy distribution systems and sources are needed by both developed and under developed nations.
5. To transmit wireless power to any distance without limit. It makes no difference what the distance is.
6. The power failure due to short circuit and fault on cables would never exist in the transmission.
7. Power theft would be not possible at all.

f)	**State line parameters of transmission line.**
Ans:	**Following are the of Line parameters of transmission line:** **(2 Marks)**

1. Resistance
2. Inductance
3. Capacitance

g) Define voltage regulation and Transmission Efficiency.

Ans:

Define voltage regulation of transmission line: **(1 Marks)**

Voltage regulation is nothing but voltage drop in transmission line expressed in % of receiving end voltage

$$\% \textbf{ Regulation} = \frac{Sending\ \ End\ \ Voltage - \text{Re}ceiving\ \ End\ \ Voltage}{\text{Re}ceiving\ \ End\ \ Voltage} \times 100$$

$$\%regulation = \frac{No\ load\ receiving\ end\ voltage\ -\ \ Full\ load\ receiving\ end\ voltage}{Full\ load\ receiving\ end\ voltage} 100\%$$

Define Transmission efficiency:- **(1 Marks)**

$$Transmission\ \ Efficency\ \ = \frac{Output\ \ power\ \ \ at\ receiving\ \ \ end}{Input\ \ power\ \ \ at\ sending\ \ \ end} \times 100$$

$$\eta_{\ T}\ \% = \frac{Output\ (P_R)\ (Load\ (power)\ at\ reciving\ \ end)}{Output\ (P_R) + Total\ \ losses} \times 100$$

Where, P_R is o/p power at receiving end

OR

% Efficiency =

$$\frac{P_R}{P_R + I^2 R_T} \times 100 \quad ------\text{for} - 1 - \text{Phase} \qquad \text{Where, } R_T \text{ is total resistance}$$

OR

% Efficiency =

$$\frac{P_R}{P_R + 3\, I^2 R_{ph}} \times 100 \quad ------\text{for} - 3 - \text{Phase} \qquad \text{Where, R is resistance of per phase}$$

OR

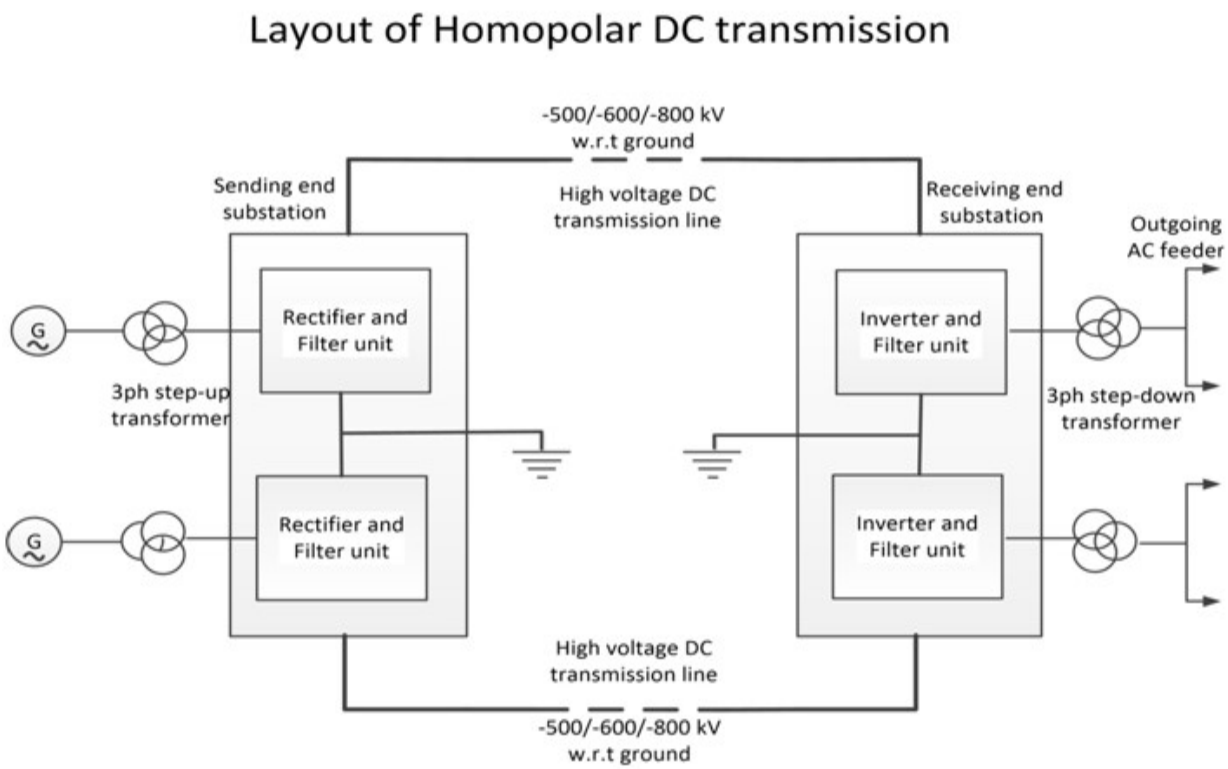
$$\textbf{\% Efficiency} = \frac{output\ \ power}{output\ \ power + total\ \ copper\ \ losses} \times 100$$

Q. 2 **Attempt any THREE of the following** **12 Marks**

a) **Differentiate between overhead transmission and underground transmission.**

Ans: **(Any Four points expected: 1 Mark each, Total 4 Marks)**

S.No	Points	Overhead line	Underground cable
1	Capital cost	Less	More
2	Erecting cost	Less	More
3	Time require for completion of work	Less	More
4	Flexibility	More flexibility	No flexibility
5	Future expansion in voltage level	System voltage can be increased easily	System voltage cannot be increased
6	Overload capacity	More	Less
7	Fault finding	Easy	Difficult
8	Charging Current	Less	More
9	Chances of fault	More	Less
10	Chances of accident	More	No chances of accident
11	Safety	Less	More
12	Radio interference	Produces radio interferences	Not produces radio interferences
13	Short cute route	Difficult	Possible
14	Theft Of energy	More possibility	Less possibility
15	Voltage drop	More	Less
16	Power factor	Less	More
17	Reliability	Less	More
18	Life	Less	More
19	Space consumed	Space consumed	No space consumed
20	Appearance	Not good	Very good

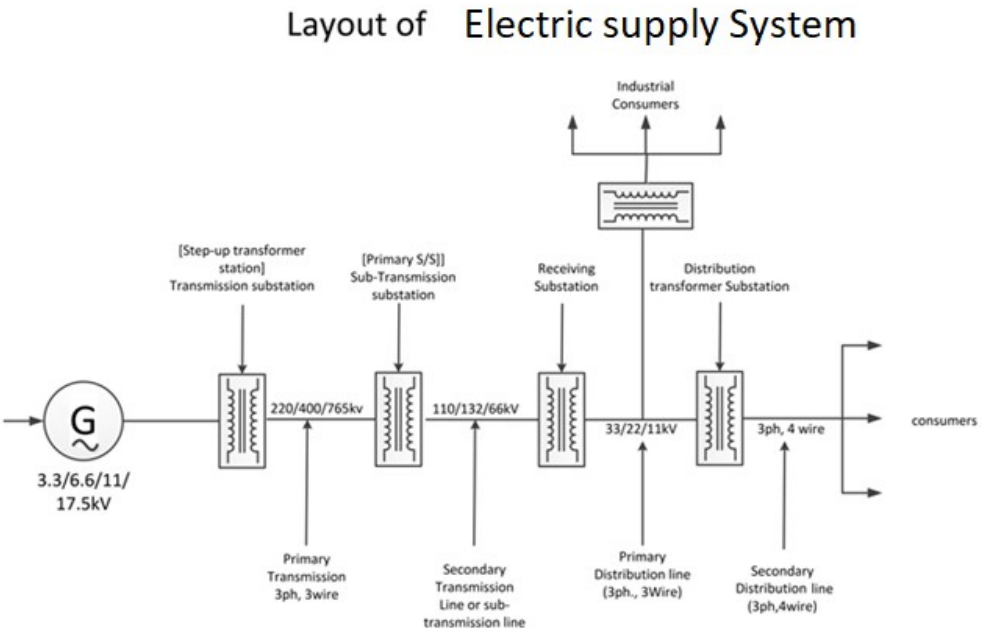
b)	**Draw the layout of Homo polar transmission line.**
Ans:	**layout of Homo polar HVDC transmission with polarity of overhead conductor:** **(4 Marks)**  **OR Equivalent Figure**
c)	**State the advantages of use of high voltage in transmission of Electric power.**
Ans:	**Advantages:** **(Any Four points expected: 1 Mark each, Total 4 Marks)** 1. As Transmission voltage increases, current decreases. 2. As current decreases, cross section of conductor decreases. 3. As cross section of conductor decreases, its weight decreases. 4. As weight of the conductor decreases, design of tower becomes lighter in weight. 5. As current decreases, cross section of bus bar and size of switch gear contact etc. reduces. 6. Due to above advantages, Transmission cost per KM decreases 7. As transmission voltage increases. A current decreases, so copper losses in transmission line reduces. 8. As copper losses reduces, transmission efficiency increases 9. As current reduces, voltage drop in transmission line reduces. 10. As voltage drop in transmission reduces, voltage regulation becomes better

(improved).

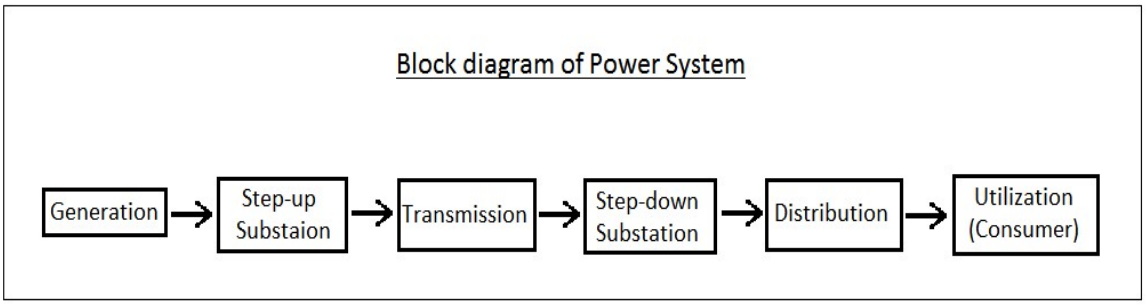
11. As efficiency and regulation of transmission line gets improved, so performance of transmission line increases
12. As transmission voltage increases power handling capacity of transmission line increases
13. Due to high voltage transmission line, successful interconnection of transmission line is possible than low voltage.

d) Draw the layout of power system indicating Generation, Transmission and distribution parts.

Ans: **Single line diagram of AC electric transmission and distribution system : (4 Mark)**



OR



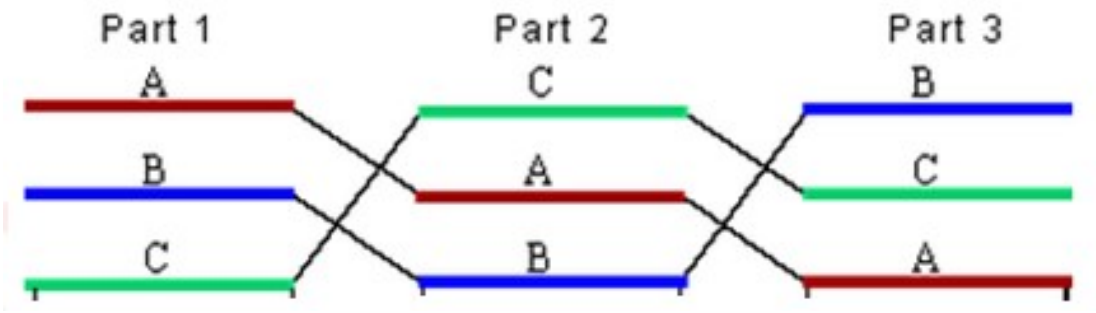
OR

or equivalent figure

Q.3	Attempt any THREE of the following	12 Marks
a)	Draw the diagram representing transposition of conductor and state its importance.	

Ans: **(Figure : 2 Mark Importance of Transposition: 2 Mark , Total 4 Marks)**

Figure of transposition of conductor: (2 Marks)



OR Equivalent Figure

Transposition of conductor means exchanging the position of 3 phases (R-Y-B) at regular interval.

Each phase occupies 3 different positions consequently on line support (Tower) as shown in fig.

OR

Transposition of line conductors means changing the positions of 3 phases on the line supports twice over the total length of the line

The Importance of transposition of conductors: (2 Marks)

Due to transposition of conductor voltage at receiving end between any two phases are same

i.e. $V_{ry} = V_{yb} = V_{rb}$

b)	State the standard voltage in India for Generation, transmission distribution system.

Ans: **Standard voltage in India for Generation, transmission distribution system: (4 Marks)**

1. Generation Voltage :

3.3KV, 6.6KV,11KV and 17.5 KV

2. Transmission voltage :- (Any four voltage magnitude are expected)

400KV, 765 KV (750 KV) , 220 KV, 132 KV, 110 KV, 33 KV, 22KV, 11 KV for long distance line it may be 66 KV

OR

	➢ **Primary Transmission voltage :-** ▪ 220 KV, 400KV, 765 KV (750 KV) ➢ **Secondary Transmission:** ▪ 220 KV, 132 KV, 110 KV ➢ **Primary Distribution:** 33 KV, 22KV, 11 KV for long distance line it may be 66 KV 3. **Distribution voltage :-** **OR Secondary Distribution:** for 3-phase, 400/440 Volt, for single phase 230 Volt
c)	**List the factors to be considered while designing feeders and distribution with their functions in brief.**
Ans:	**(Factor of Feeder: 2 Marks & Distribution : 2 Marks, Total 2 Marks)** **Following factors are to be considered while designing the Feeder.** **(Any Two factors are expected: 1 Mark each)** **1) Current carrying capacity of conductor:-** Conductor should have high current carrying capacity. While voltage drop consideration is relatively not so important It is because voltage drop in feeder can be adjusted with the help of tapings of distribution transformer manually or by using AVR (Automatic Voltage Regulator) **2) Need:** Depending upon application design of distribution system should be selected i.e. whether continuity of supply is important or not so important Example: 1) Use Radial distribution system in rural area 2) Use Ring main distribution system in urban area 3) Use Grid distribution system where continuity of supply is important. e.g. Supply to - electric traction, TV broadcasting centre, AIR, telephone exchange, major hospitals, important government buildings and major industries **3) Availability of power:** It should be available whenever needed **4) Maintenance:** It should be low, easy, less costly & less time consuming.

5) Power Factor of load should be consider while designing

Following factors are to be considered while designing a distributor:- (Any Two factors are expected: 1 Mark each)

1. While designing the distributor voltage drop calculation is important.
2. Voltage drop in distribution system should be maintained within permissible limit (± 6%).
3. Layout should be simple in design.
4. It should have less initial cost
5. Make the distribution system with minimum distribution losses.
6. From safety point of view distribution system should maintain proper clearances.
7. Select the cross section of conductor from the result of load densities present & future.
8. While selecting cross section of conductor P.F. of the load should be consider.
9. Power should be available to consumers whenever needed.
10. A steady, non-fluctuating, quality supply (Pure sine wave) should be available to consumers.
11. Distribution system should not be over loaded.
12. Distribution system lay out should not affect the appearance of locality.
13. Before installation of distribution system proposed widening of the road in the near future are to be kept in mind
14. Fault on nearest distribution system should not affect stability of existing distribution system.

d)	**State advantages and disadvantages of radial distributor system.**
Ans:	**(Advantages : 2 Marks & disadvantages: 2 Marks, Total : 4 Marks)** **Advantages of radial distributor system: (Any Two point expected)** 1. Design of layout is simple. 2. Capital cost & Erecting cost is less as there is only one feeder. 3. Time required for completion of work is less. **Disadvantages of radial distributor system: (Any Two point expected)** 1. No reliability to maintain supply to consumers when there is fault on feeder. 2. No reliability to maintain supply to consumers when there is maintenance on feeder. 3. Voltage fluctuations are more.
Q.4	**Attempt any THREE of the following 12 Marks**
a)	**List classification of distributor system with their advantages each. (any two)**
Ans:	**(4 Marks)** **According to scheme of connection there are three types of distribution systems: -** 1.Radial (Tree) distribution system 2.Ring mains (Loop) distribution system 3. Grid (interconnected) distribution system **1. Advantages of Radial (Tree) connection scheme:- (1 Marks)** 1. Design of layout is simple. 2. Capital cost & Erecting cost is less as there is only one feeder. 3. Time required for completion of work is less. **2. Advantages of Ring Main System of distribution: (1 Marks)** 1. Supply to distribution transformer center is given through two different Feeders 2. Reliability to maintain supply is more even when there is a fault on any one feeder. 3. Reliability to maintain supply is more even when there was maintenance on any one feeder.

3. Advantages of Grid or interconnected system of distribution:- **(2 Marks)**

1. Supply to distribution transformer center is given through two different generating stations or major generating stations
2. It has highest reliability to maintain supply even when there is a fault on any one feeder
3. It has highest reliability to maintain supply even when there was maintenance on any one feeder.

b) A 3-ph overhead line supported by 6 disc insulators, the potential across the unit is 11 KV. Assuming shunt capacitance between each Insulator and each metal link is of 1/5th of capacitance of insulator. Calculate: (i) line voltage (ii) string efficiency.

Ans: **V_6 = 11 KV**

i) Ratio of capacitance 'm' :-

$$m = \frac{1}{5} = 0.2$$

k = m = 0.2 ---------- **(1/2 Mark)**

ii) $V_6 = V_1 (1 + 15m + 35m^2 + 28m^3 + 9m^4 + m^5)$

$$V_6 = V_1 (1 + 15 \times 0.2 + 35 \times (0.2)^2 + 28 \times (0.2)^3 + 9(0.2)^4 + (0.2)^5)$$

$$11 = 5.638 \; V_1$$

$$V_1 = \frac{11}{5.638}$$

$V_1 = 1.951$ KV

---------- **(1/2 Mark)**

iii) $V_5 = V_1 (1 + 10m + 15m^2 + 7m^3 + 9m^4 + m^5)$

$$V_6 = 1.951 (1 + 10 \times 0.2 + 15 \times (0.2)^2 + 7 \times (0.2)^3 + (0.2)^4)$$

$$V_5 = 1.951 \; (3.365)$$

$V_5 = 7.135$ KV

---------- **(1/2 Mark)**

iv) $V_4 = V_1 (1 + 6m + 5m^2 + m^3)$

$V_4 = 1.951\ (1 + 6 \times 0.2 + 5 \times (0.2)^2 + (0.2)^3)$

$V_4 = 1.951\ \ (2.408)$

$V_4 = 4.69$ KV

---------- (1/2 Mark)

v) $V_3 = V_1\ (1 + 3m + m^2)$

$V_3 = V_1\ (1 + 3 \times 0.2 + (0.2)^2)$

$= 1.951\ (1.64)$

$V_3 = 3.2$ KV

---------- (1/2 Mark)

vi) $V_2 = V1\ (1 + m)$

$V_2 = 1.951\ (1 + 0.2)$

$V_2 = 1.951$ x 1.2

$V_2 = 2.3412$

vii) Voltage across string = Vph $= V_1 + V_2 + V_3 + V_4 + V_5 + V_6$

$= 1.95 + 2.3412 + 3.2 + 4.69 + 7.13 + 11$

$V_{Ph} = 30.3112$ KV

---------- (1/2 Mark)

viii) The line voltage: $V_L = \sqrt{3}\ V_{ph}$

$V_L = \sqrt{3} \times 30.3112$

V_L = 52.50 KV ---------- (1/2 Mark)

ix) String efficiency :-

String % $\eta = \dfrac{votage\,across\,whole\,string\,(Vph = V_L/\sqrt{3}\,)}{n \times voltage\,across\,disc\,nearer\,to\,conductor} \times 100$

$$\text{String } \eta\% \equiv \frac{Vph}{n \times V_n} \times 100$$

$$\text{String } \eta\% \equiv \frac{30.3112}{6 \times 11} \times 100$$

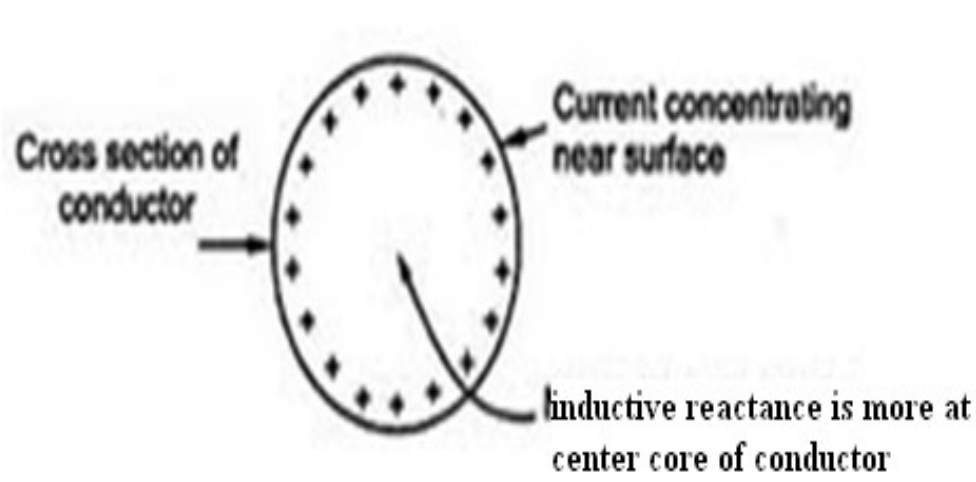
$$\text{String } \eta\% \equiv 45.926\ \%$$

---------- **(1/2 Mark)**

c) State the meaning of skin effect and how can it be minimised.

Ans: **(Meaning : 2 Marks and effect minimized : 2 Marks, Total 4 Marks)**

Meaning of skin effect



OR equivalent figure

When alternating current flows through conductor it has tendency to flow away from center of conductor.

i.e. maximum current density is near skin of conductor and goes on reducing towards centre core is known as skin effect.(Since the inductive reactance (X_L) at the centre of the conductor is more than surface of conductor)

OR

The tendency of alternating current to concentrate near the surface of a conductor is known as skin effect.

Skin effect can be minimized by: (Any two points are expected)

1. Use stranded conductors instead of solid conductors.
2. Use hollow conductors instead of solid conductor.
3. Use ACSR /AAAC conductors for transmission purpose
4. Use D.C. supply whenever possible as Skin effect is absent (Since frequency 0) instead of A.C. supply.

d) Draw the diagram of pin type and suspension type insulators.

Ans: **i) Neat labelled diagram of Pin type Insulator : (2 Marks)**

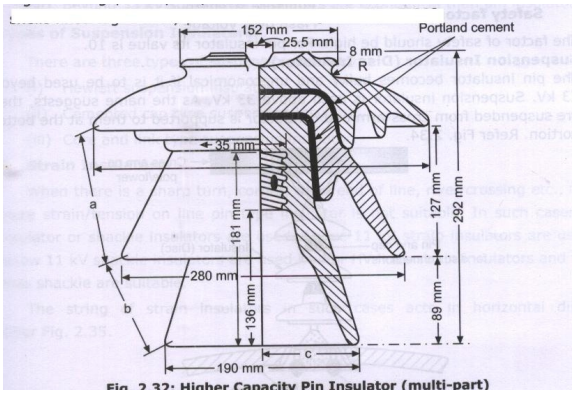
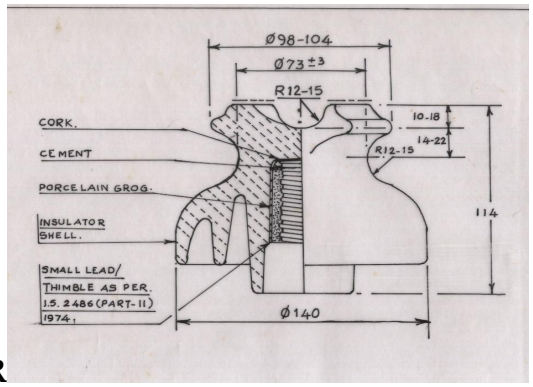


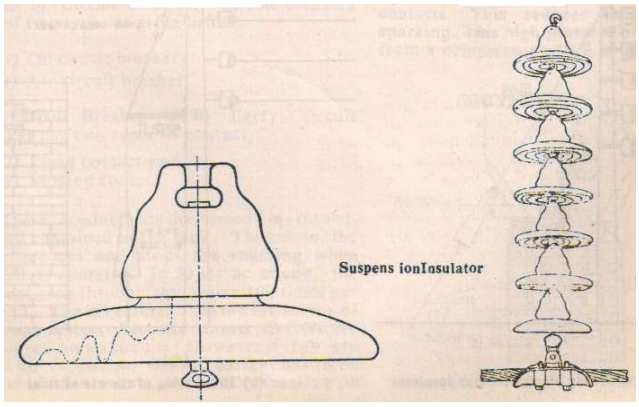
Fig. 2.32: Higher Capacity Pin Insulator (multi-part)

OR



OR Equivalent Figure

ii) Neat labelled diagram of Suspension type Insulator : (2 Marks)



OR Equivalent Figure

e) State the effects of low power factor on efficiency and voltage regulation of short transmission lines.

Ans:

	i) Effect of Low power factor on efficiency:- **(2 Marks)** When power factor of load reduces current drawn by transmission line increases so copper losses in transmission line increases, hence transmission efficiency reduces. **ii) Effect of Low power factor on voltage Regulation:-** **(2 Marks)** When power factor of load reduces current through transmission line increases, so voltage drop in transmission line increases so regulation increases. (Become Poor)
f)	**State the condition for selecting site for distribution substation.**
Ans:	**Following condition should be considered while selecting site for distribution sub-station:-** **1. Near load center :** **(Any four points expected: 1 Mark each, Total 4 Marks)** Sub-station should be located near load center to reduce cost of Transmission and distribution lines and to reduce losses in it. **2. Easy access for transmission Line :** There should be easy access for incoming and outgoing line. **3. Easy access towards sub-station :-** There should be easy access towards sub-station for transportation of equipments and manpower etc. **4. Space(Land) available :** The land proposed for a substation should be normally level and open from all sides & sufficient land should be available for installation of sub-station and future expansion. **5. Atmospheric conditions :** Atmospheric condition in the area of sub-station should be clean and dry also There should be less atmospheric pollution. **6. Cost of land :** Cost of land should be less to reduce capital cost of sub-station. **7. Municipal restriction :** Where municipal restriction will not take any objection for required type building of

sub-station.

8. Staff amenities :

The site should be such that essential amenities must be available to staff like residential quarters, drinking water, school, hospital, public transportation, communication.

9. Bearing capacity of land (Hard land):

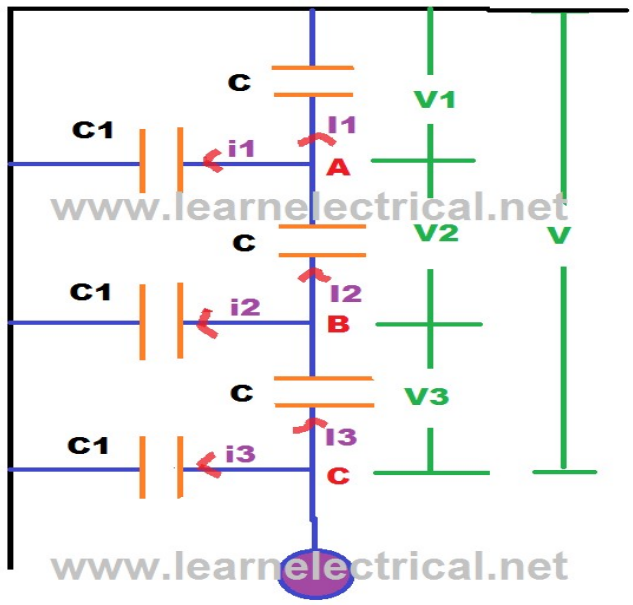
To reduce construction cost of building and for better foundation of equipment's land should have high bearing capacity.

10. Area free from earthquake :

To avoid damage to sub-station area should be free earth quake.

Q.5	**Attempt any TWO of the following**	**12 Marks**
a)	**Derive equation for string efficiency with 3 - disc insulators of suspension type.**	

Ans: Derive equation of String of three Disc insulators of suspension type:- (6 Marks)



Mathematical expression for String Efficiency

Mathematical proof:

Where,

C_1 = Shunt capacitance C = Self capacitance

$$m = K = \frac{C_1}{C} \qquad C_1 = mc$$

Step- I: Applying KCL to node 'A'

$$I_2 = I_1 + i_1$$

$$V_2\,\omega C = V_1\,\omega C + V_1\,\omega C_1 \qquad But, C_1 = mc$$

$$V_2\,\omega C = V_1\,\omega C + V_1\,\omega mc$$

$$\therefore\ V_2 = V_1 + V_1\,m$$

$$\therefore\ V_2 = V_1\ (1+m) \text{ ----------equation-I}$$

Step- II: Applying KCL to node 'B'

$$I_3 = I_2 + i_2$$

$$V_3\,\omega C = V_2\,\omega C + (V_1 + V_2)\,\omega C_1 \qquad But, C_1 = mc \ \ \&\ V_2 = (m+1)\,V_1\omega$$

$$V_3\,\omega C = V_1\ (1+m)\,\omega C + V_1\,\omega mc + V_1\,(1+m)\,\omega C$$

$$V_3 = V_1\ (1+m) + V_1\,m + V_1\,(1+m)\,m$$

$$V_3 = V_1\ (1+m+m+m+m^2)$$

$$V_3 = V_1\ (1+3m+m^2) \text{ ---------- equation - II}$$

$$V = V_1 + V_2 + V_3$$

String Efficiency:-

Unequal potential distribution along a string of suspension insulator is usually expressed in terms of string efficiency.

$$\textbf{String \%}\ \eta = \frac{votage\,across\,whole\,string\,(Vph = V_L/\sqrt{3}\,)}{n \times voltage\,across\,disc\,nearer\ to\ conductor} \times 100$$

	OR **String** $\eta\% = \frac{Vph}{n \times V_n} \times 100$ Where, n = Number of Disc insulators, Vn = Voltage across disc nearer to conductor\
b)	**Define Corona, List its causes and state how it can be avoided. (two each)**
Ans:	**(Definition: 2 Marks, Causes: 2 Marks and corona avoided: 2 Mark, Total 6 Marks)** **Define Corona:** **(2 Marks)** When AC Voltage given across two conductors separated by distance 'd' as shown figure is increased greater than breakdown voltage of air i.e. 30KV/cm, then air around the conductor gets ionized and ionized air is conducting under this condition corona will takes place (form) . During corona following observations are noted: ➢ Luminous violet glow (typically a purple glow) occurs around the conductor. ➢ Hissing or cracking sound will produce. ➢ Ozone gas will produce. (smell the presence of ozone that was produced by the corona) This phenomenon is known as "corona" effect. **The following causes:- (Any Two points are expected)** **(2 Marks)** **1. Magnitude of Voltage :** If voltage across two conductors is greater than 30 KV/cm, i.e. breakdown voltage of air than corona formation starts. Corona will not start if voltage is below 30 KV/cm **2. Distance between two conductor:** If spacing between two conductors is very large as compare to their diameter than there is no possibility of corona formation. Because value of voltage at which corona occurs increases.

3. Size of conductor:

If size (Cross section) of conductor is more, than magnitude of voltage required to occur the corona increases.

4. Condition of conductor & Hardware:

Rough and irregular surface of conductor and hardware will give more corona than solid, smooth body conductor & hardware.

5. Atmospheric Condition:

As corona takes place due to ionization of air so it depends on condition of air so for dry air formation of corona occurs late than in wet air (damp atmosphere condition/ rainy season/thunderstorms/fog air becomes more conductivity)

6. Effect of supply Frequency: Corona loss varies directly as the supply frequency
7. Effect of density of air: Corona loss increases with the decrease in the density of air (The corona loss of transmission line passing through hilly area is higher than that of a similar line in plain due to reduced value of air density at high level /altitude)

Corona effect can be avoided for following way: (Any Two points are expected) (2 Marks)

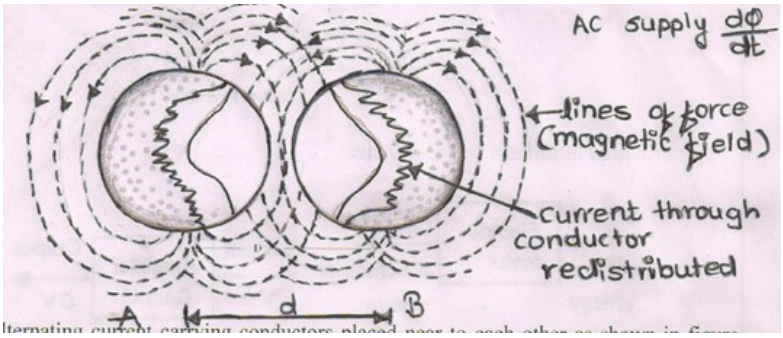
1. By increasing distance between two conductor i.e. by using longer cross arm.
2. By using larger size(diameter) of conductor e.g./ using ACSR, bundled conductor
3. By using smooth body conductor and hardware.

c) State the meaning of ferranti effect and proximity effect.

Ans: **i) Ferranti effect :** **(3 Marks)**

When long distance transmission is lightly loaded or there is no load condition than it is observe that receiving end voltage (V_R) is found to be greater than sending end voltage (V_S). This phenomenon is known as Ferranti effect.

ii) Proximity effect: **(3 Marks)**



Explanation:

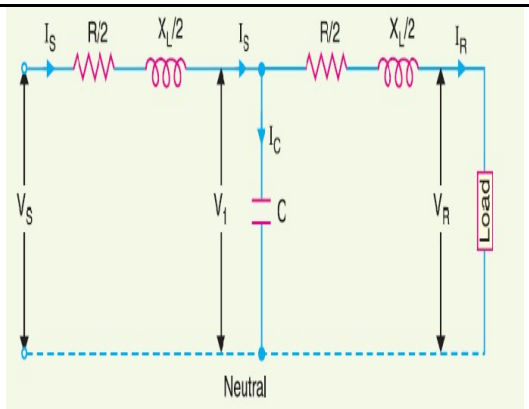
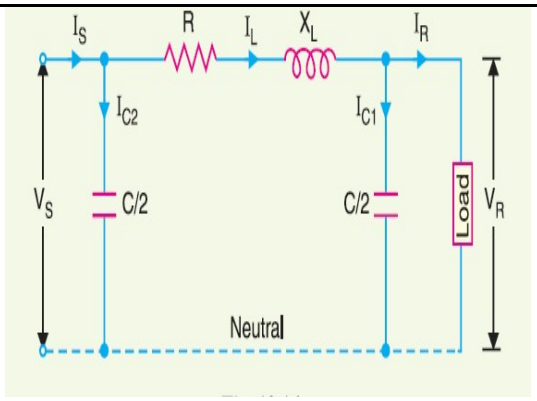
Let two alternating current carrying conductors placed near to each other as shown in figure. Due to electro-magnetic action, flux produced by each conductor links with each other. Due to this super –impose of magnetic field on conductor causes current in each conductor is re-distributed. This is known as proximity effect.

Q.6 **Attempt any TWO of the following** **12 Marks**

a) **Compare nominal - T and nominal - II method of transmission line (Any six points)**

Ans: **(Total: 6 Marks)**

S.No.	Nominal T Method	Nominal π Method
1	It is assume that line capacitance is connected at centre of transmission line	It is assumed that capacitance of transmission line is divided into half of the line capacitance is connected at receiving end & half of capacitance is connected at sending end.
2	It is assume that half of the resistance & reactance per phase are divided in either side of capacitance.	It is assumed that transmission line resistance & reactance per phase is connected in between two half transmission line capacitance
3	Shape of equivalent circuit is like letter 'T' hence its name is nominal 'T' method	Shape of equivalent circuit is like letter 'π' hence its name is nominal 'π' method

	4		
	5	Values of ABCD constants T-equivalent circuits of are as bellows: $\therefore A = D = 1 + \frac{YZ}{2}$ $\therefore B = Z \left[1 + \frac{YZ}{4} \right]$ ohm $\therefore C = Y$ mho	Values of ABCD constants π equivalent circuits of are as bellows: $\therefore A = D = 1 + \frac{YZ}{2}$ $\therefore B = Z$ ohm $\therefore C = Y \left[1 + \frac{YZ}{4} \right]$ mho

b) State the meaning of FACTS and explain in brief d-types facts controller.

Ans: **Flexible AC Transmission System (FACTS):-** **(3 Marks)**

A flexible alternating current transmission system (FACTS) is defined as it is a system composed of static equipment used for the AC transmission of electrical energy. It is meant to enhance controllability and increase power transfer capability of the network. It is generally a power electronics-based system.

OR

A Flexible AC transmission System refers to the system consisting of power electronic devices along with power system devices to enhance the controllability and stability of the transmission system and increase the power transfer capabilities.

D-types facts controller: **(3 Marks)**

- **Series Controllers:** Series Controllers consists of capacitors or reactors which introduce voltage in series with the line. They are basically variable impedance devices. Their major task is to reduce the inductivity of the transmission line. They supply or consume

variable reactive power. Examples of series controllers are SSSC, TCSC, TSSC etc.

- **Shunt Controllers:** Shunt controllers consist of variable impedance devices like capacitors or reactors which introduce current in series with the line. Their major task is to reduce the capacitivity of the transmission line. The injected current is in phase with the line voltage. Examples of shunt controllers are STATCOM, TSR, TSC, SVC.
- **Shunt-Series Controllers:** These controllers introduce current in series using the series controllers and voltage in shunt using the shunt controllers. Example is UPFC.
- **Series-Series Controllers**: These controllers consist of a combination of series controllers with each controller providing series compensation and also the transfer real power along the line. Example is IPFC.

OR

1. Shunt compensation

In shunt compensation, power system is connected in shunt (parallel) with the FACTS. It works as a controllable current source. Shunt compensation is of two types:

2. Shunt capacitive compensation

This method is used to improve the power factor. Whenever an inductive load is connected to the transmission line, power factor lags because of lagging load current. To compensate, a shunt capacitor is connected which draws current leading the source voltage. The net result is improvement in power factor.

3. Shunt inductive compensation

This method is used either when charging the transmission line, or, when there is very low load at the receiving end. Due to very low, or no load – very low current flows through the transmission line. Shunt capacitance in the transmission line causes voltage amplification (Ferranti effect). The receiving end voltage may become double the sending end voltage (generally in case of very long transmission lines). To compensate, shunt inductors are connected across the transmission line. The power transfer capability is thereby increased depending upon the power equation

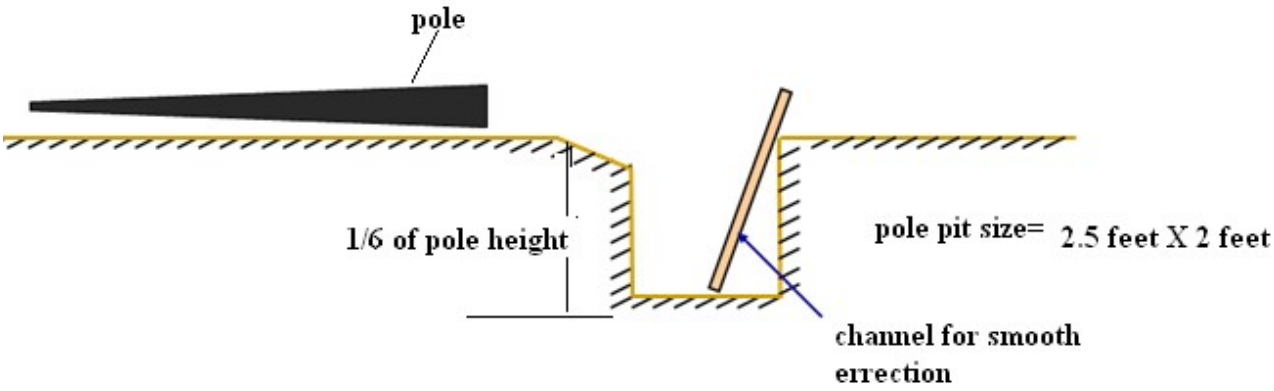
4. Series compensation

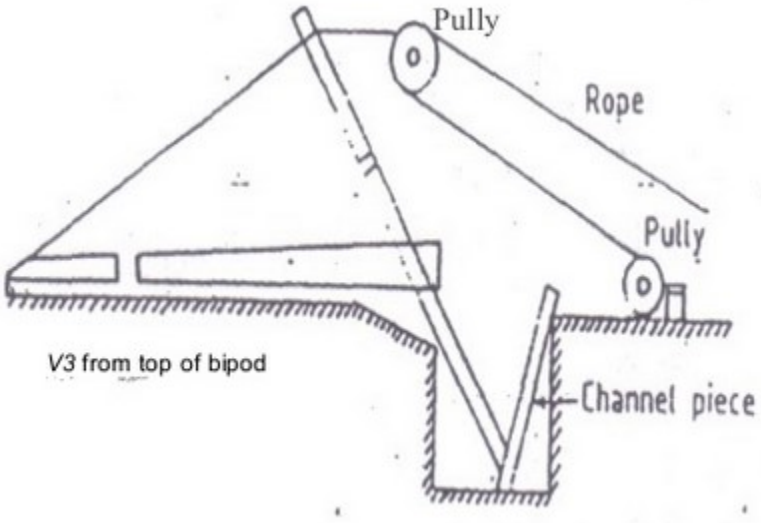
FACTS for series compensation modify line impedance: X is decreased so as to increase the transmittable active power. However, more reactive power must be provided.

c)	**(i) List the properties of line insulators in brief.** **(ii) List the methods of Line Support Erection and explain in brief any one.**
Ans:	**Following are the properties of line insulators: (Any three properties are expected)** **(3 Marks)** **A) Electrical Properties of insulating material:-** 1. It should have high resistance. 2. It should have high breakdown voltage. 3. It should have high dielectric strength. 4. It should have low dielectric loss. 5. It should have low dielectric constant. **B) Mechanical Properties of insulating material:-** 1) It should have high mechanical strength. 2) It should be tough and flexible. 3) It should be light in weight. 4) It should not be porous otherwise it increases moisture holding capacity which reduces insulating property. **C) Chemical Properties of insulating material:-** 1. It should not be hygroscopic (which absorbs moisture). 2. It should have high resistance to acid & alkaline (Chemicals). 3. It should have high resistance to oil. **D) Thermal Properties of insulating material:-** 1. It should have high thermal conductivity. 2. It should be non -inflammable. 3. It should withstand at high temperature. 4. It should have thermal Stability. 5. Co-efficient of thermal expansion should be low. **E) General Properties of insulating material:-** 1. It should have longer life. 2. It should have low cost

ii) Following are the methods of Line Support Erection : **(3 Marks)**

Figure:





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Following are steps require for Erection of pole :-

Step 1:

Preparation before Erection- Depends on type of pole e.g.

- **Wooden Pole :**
  - Top & bottom portion of pole is covered by aluminum cap and underground portion (1/6) of pole height is painted to increase life & remaining portion is well polished

with the help of varnish.

- **Cement Pole** :
  - 1/6 portion of pole height is No preparation is required like wooden pole and steel pole
- **Steel Pole :**
  - 1/6 portion of pole height of steel pole which goes under ground is painted with bituminous paint to protect pole from rusting. Also base plate of mild steel is welded at bottom for better foundation.
- **Steel towers:**
  - Are erected on site by constructing strong foundation (cement concrete foundation)

Step 2:

Prepare a pit on given marking.

Step 3:

Size of pit should be 2.5 feet X 2 feet and depth of pit 1/6 of the pole height.

Step 4:

Rest the pole on channel for smooth and gradual Erection.

Step 5:

Erect a pole in a prepared pit using accessories (such as rope, pole, tripod etc.) and sufficient man power. Now a days machineries are used for Erection of pole.

Step 6:

After Erection of pole, check the alignment before concreting.

Step 7:

Now pour the concreting of ratio 1:4:8 in pole pit.

----------END----------