



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC-27001-2005 Certified)

Winter- 2012 Examinations

Subject Code: 12102

Model Answer

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Important suggestions to examiners:

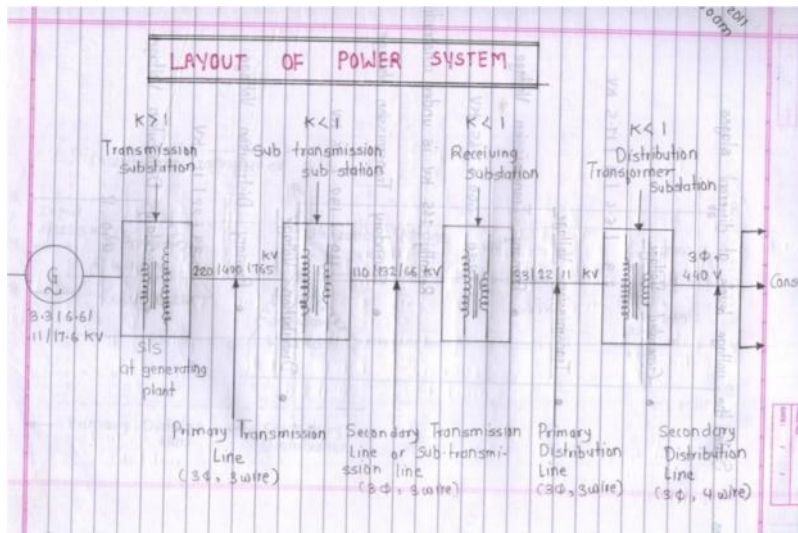
- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance.
- 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) Some of the questions are not clearly indicative of the exact answer expected. In such cases, credit may be given by judgment of relevant answer based on candidate's understanding.

Page No: 1 to 20 Model Answer Paper Solution and Page No: 21 to 22 Question Paper & Summary of Marking Scheme

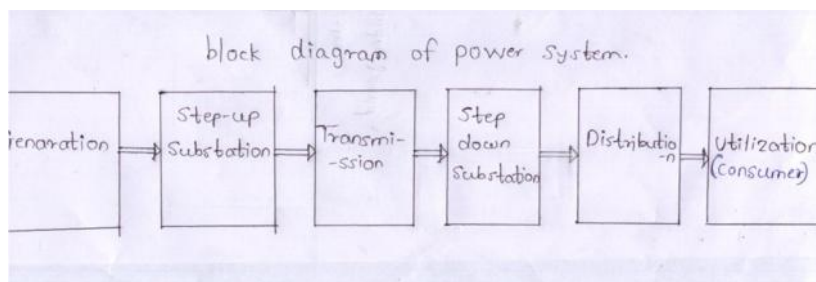
Q.1 A) Attempt any six:

a) Draw a block diagram of power system.

(2 Marks)



OR



or Equivalent fig.



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b) Compare overhead system and underground distribution system on any four points

(2 Marks)

S.No	Points	Overhead system	Underground distribution
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	Chances of fault	More	Less
8	Fault finding	Easy	Difficult
9	Reliability	Less	More
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	Appearance	Not good	Very good
18	Application	For Long distance transmission, For distribution rural and sub urban area.	Short distance transmission & distribution, urban areas, thickly populated area, taking supply in water (ocean) with help of marine cable.

c) State different voltage levels used in transmission of power in India.

(2 Marks)

Standard Transmission voltages in India are 765 KV (750KV), 400KV, 220KV, 132KV, 110KV, 66KV, 33KV, 22KV, 11KV

d) State any four properties of conductor. (Any four point's expected- 1/2 marks each point)

Following are the properties of conductor:-

- i) Material should have high conductivity.
- ii) Material should have sufficiently high mechanical strength.



- iii) It should be flexible for easy handling & storage.
- iv) It should be light in weight for easy handling.
- v) It should have high resistance to corrosion to avoid rusting.
- vi) It should not be brittle.
- vii) Material should have low temperature coefficient of resistance.
- viii) Material should be easily available & less costly.
- ix) It should have high scrap value.

e) State different types of line insulators.

(Write any four 1/2 Marks each)

Types of line insulators: - (Any four Expected)

- i) Pin type insulator
- ii) Suspension or Disc type insulator.
- iii) Strain type insulator.
- iv) Shackle type insulator.
- v) Stay or Guy or Egg type insulator.
- vi) Post insulator

f) Define: i) Transmission efficiency ii) voltage regulation in transmission line

(Each Definition – 1 Marks)

i) Transmission efficiency:-

$$\text{Transmission Efficiency} = \frac{\text{Output}}{\text{Input}}$$
$$\eta_T \% = \frac{\text{Output } (P_R) \text{ (Load (power) at receiving end)}}{\text{Output } (P_R) + \text{Total losses}} \times 100$$

ii) Voltage Regulation of a Transmission Line:-

Regulation is defined as the change in receiving end voltage from no load to full load.

OR

Voltage drop in transmission line ($V_S - V_R$) is expressed as a percentage of receiving end voltage is called 'Voltage regulation'

$$\% \text{ Regulation} = \frac{\text{Sending End Voltage} - \text{Receiving End Voltage}}{\text{Receiving End Voltage}} \times 100$$

OR

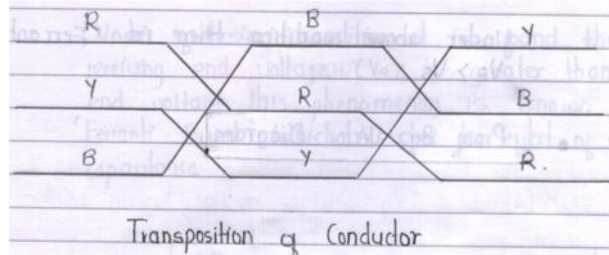
$$\% \text{ Regulation} = \frac{V_S - V_R}{V_R} \times 100$$



g) Explain why transposition of line is done. (Figure – 1 Marks & Reason- 1 Marks)

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 Equivalent fig.

Necessity (Reason):-

- Due transposition of conductor inductance of each line is same due to transposition $L_A = L_b = L_c$, So drop due to inductive reactance in each line is same so voltage at receiving end between any two line become same.
- So to obtain same voltage in any two line at receiving end ($V_{RY} = V_{YB} = V_{RB}$) transposition is necessary.

h) Classify transmission Line. State voltage and length of each line

(2 Marks)

Classification:-

1) According to Voltage level:

- a) High voltage Transmission Line (HV)
- b) Extra High Voltage Transmission Line (EHV)
- c) Ultra High voltage Transmission Line (UHV)

2) According to Distance of Transmission line:

- 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 **100KV**



Q.1 B) Attempt any Two:

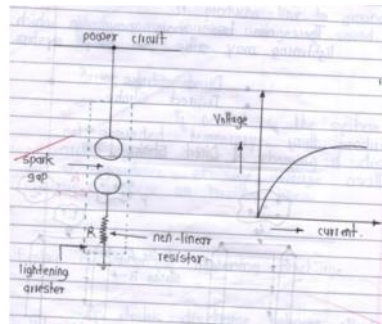
a) Explain how a lighting arrestor protects substation equipments.

(Explanation-3Marks & Figure-1 Marks)

The action of the spark gap lighting arrestor or surge diverter is explained as follows:

- Since the spark gap & non- linear resistance provides very high resistance to normal operating voltage, the lighting arrestor conducts no current to earth or the gap is non- conducting.
- When the over voltage occurs on the system, the air insulation across the gap breaks down & an arc is formed.
- Now the non-linear resistance provides low resistance path for the surge to the ground. In this way, the excess charge is diverted towards the earth & hence equipment is protected against failure.

Figure:-



or Equivalent fig.

b) Explain corona effect. State different factors which affects corona

(Explanation-2 Marks & Factors – 2 Marks)

When AC Voltage given across two conductors is greater than breakdown voltage of air i.e. 30KV/cm, then air around the conductor gets ionized and it becomes conductive. It produces hissing noise. In dark Luminous violet glow is observed and ozone gas is produced. This phenomenon is called as corona.

The Factors affecting corona:- (Explanation not compulsory expected any four factor)

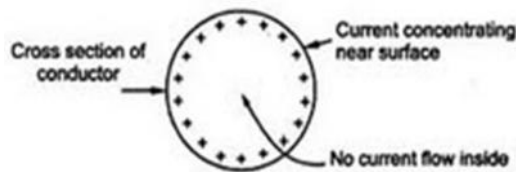
- i) Magnitude of Voltage
- ii) Distance between two conductor
- iii) Size of conductor
- iv) Condition of conductor & Hardware
- v) Atmospheric Condition



c) Explain : i) Skin effect ii) Ferranti effect

(Each Effect- 2 Marks)

i) Skin Effect:-



or Equivalent fig.

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

OR

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

ii) Ferranti effect:-

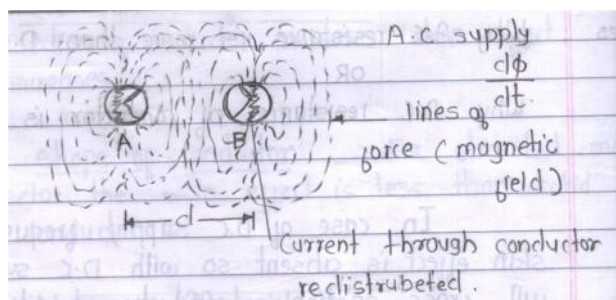
- When there is no load on transmission line ($I_L = 0$) Or
- When there is no load a receiving sub-station or Lightly load Or
- When there is sudden load thrown OFF. Or
- When there is sudden load shading. Or
- When transmission line is open circuited due to load failure.

Under above conditions, it is found that receiving end voltage (V_R) is found to be greater than sending end voltage (V_S). This phenomenon is known as Ferranti effect.

$$V_R > V_S$$

Q.2 Attempt any Four:

a) Explain proximity effect in power system. (Explanation-3 Marks& Figure-1 Marks)(For explanation any three points consider out of following)



or Equivalent fig.

Explanation:

There are two alternating current carrying conductor placed near to each other. Due to electro-magnetic action, flux produced by each conductor links with each other. Due to this current in each conductor is re-distributed. This is known as proximity effect.



Effect: - Due to proximity effect:-

- Cross section of conductor is not utilized fully, so its resistance increases.
- As resistance increases it affects efficiency & regulation.

Depends: - proximity effect depends on following points:-

- Magnitude of voltage and frequency.
- Distance between conductor and size of conductor.
- Resistivity & permeability of conductor material.

Reduced: - proximity effect can be reduced:-

- By increasing the distance between two conductors.
- By using overhead transmission system instead of underground.
- Use DC supply instead of AC supply for transmission.

b) State any four advantages of EHVAC transmission.

(Each advantage-1 Mark)

Advantages of EHVAC Transmission:- (Any four Expected)

- As Transmission voltage increases, current decreases.
- As current decreases, cross section of conductor decreases. [c/s of conductor $\propto I$]
- As cross section of conductor decreases, its weight decreases.
- As weight of the conductor decreases, design of tower becomes lighter in weight.
- As current decreases, cross section of bus bar and size of switch gear contact etc. reduces.
- Due to above advantages, Transmission cost per KM decreases
- As transmission voltage increases. A current decreases, so copper losses in transmission line reduces. (as $Cu.losses \propto I^2$)
- As copper losses reduce, transmission efficiency increases $[Tr. \propto \frac{1}{Cu.loss}]$
- As current reduces, voltage drop in transmission line reduces. [Voltage drop $\propto I$]
- As voltage drop in transmission reduces, voltage regulation becomes better.
- As efficiency and regulation of transmission line gets improved, so performance of transmission line increases

c) State difference between feeder and distributor on any points.

(Any Four points expected- 1 Marks each point)

S.No	Feeder	Distributor
1	It is link between receiving substation & distribution transformer	It is link between distributor transformer substation & consumer
2	It is also called as a High Tension Line	It is also called as a low Tension Line
3	It is a 3-Ph, 3 wire system.(R-Y-B)	It is a 3-Ph, 4 wires system. (R-Y-B-N)
4	Feeder voltage is 11KV/22KV/33KV depending upon load	Distributor voltage is for 3-ph consumer- 440V and 1-Ph consumer- 230V



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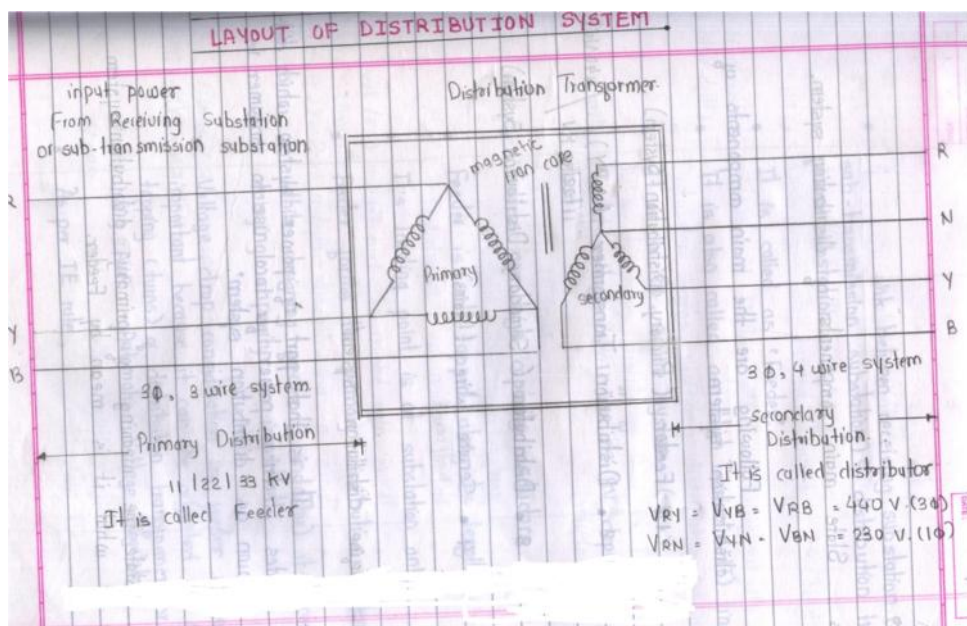
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5	Feeder is high capacity conductors.	Distributors are low capacity conductors
6	Feeder is not tapped along its length	Distributors are tapped throughout its length.
7	Its loading point is at substation only	Distributors loading point is throughout its length.
8	Feeder forms the primary distribution system	Distributors forms secondary distributor system.
9	While designing feeder its current carrying capacity is important	While designing distributor its voltage drop calculation is important.

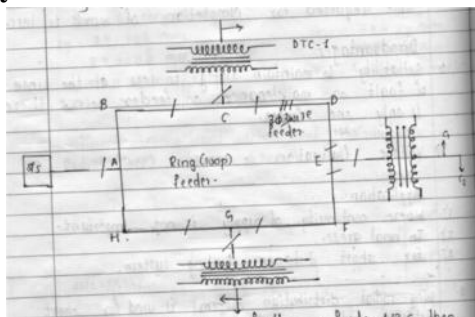
d) Draw a diagram showing primary distribution system and secondary distribution system. (4 Marks)



or Equivalent fig.

e) Explain ring distribution system. State any two advantages of ring distribution system. (Explanation-2 Marks, Figure- 1 Marks & Advantages-1 Marks)

Ring Main System of distribution:



or equivalent diagram consider.



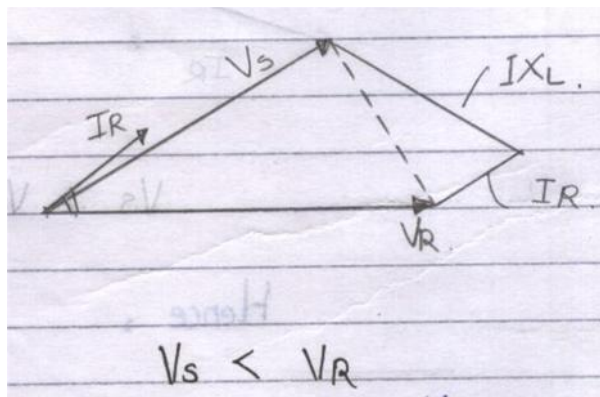
If there is fault on feeder ABC then supply is given to DTC-1 from other side.

There are two feeders to distribution transformer centre which forms a closed loop as shown in layout. Only one feeder is utilized at a time.

Advantages:-

1. Reliability to maintain supply is more.
2. There are less voltage fluctuations at consumer's terminals.

f) Draw phasor diagram of a 11KV, 20 km line having leading power factor. (4 Marks)



or equivalent diagram

Q.3 Attempt any two:-

a) Given Data : $V_3 = 20\text{KV}$

(Give stepwise Marks as mention below)

i) Ratio of capacitance 'm' :-

$$m = \frac{1}{6} = 0.1666$$

$$k = m = 0.1666 \text{ ----- (1Mark)}$$

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

$$\frac{20}{(0.1666)^2 + 3 \times 0.166 + 1} = V_1$$

$$V_1 = 13.11 \text{ KV} \text{ ----- (1 Mark)}$$

$$V_2 = V_1 (1 + m)$$

$$V_2 = 13.11 (1 + 0.1666)$$

$$V_2 = 15.294 \text{ KV} \text{ ----- (1 Mark)}$$

$$\therefore \text{ Voltage across string} = V_{ph} = V_1 + V_2 + V_3 \text{ ----- (1/2Marks)}$$

$$= 13.11 + 15.294 + 20$$

$$V_{ph} = 48.404 \text{ KV} \text{ ----- (1/2Marks)}$$

ii) The line voltage $V_L = \sqrt{3} V_{ph}$ ----- (1/2Marks)

$$V_L = \sqrt{3} \times 48.404$$

$$V_L = 83.83 \text{ KV} \text{ ----- (1Marks)}$$



iii) String efficiency :-

$$\text{String } y \% \equiv \frac{V_{ph}}{y \times V_3} \times 100 \quad \text{-----} \quad \text{(1Mark)}$$

$$\text{String } y \% \equiv \frac{48.404}{3 \times 20} \times 100$$

$$\text{String } y \% \equiv 80.67 \% \quad \text{-----} \quad \text{(1 Mark)}$$

b) i) Explain Sag in transmission.

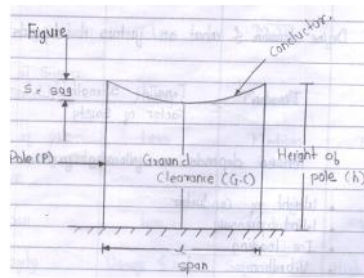
(Explanation-3 Mark & Figure-1 Mark)

ii) State different factors on which spacing between conductors depends

(Any Four points-1 mark to each point)

i) Explain Sag in transmission.

Sag:-



or equivalent diagram

It is vertical distance between lowest point of conductor and top point of support (pole). This is called as Sag or deep

OR

$$\therefore \text{Sag} = \frac{WL^2}{8T}$$

On following Factors Sag is depends:-

- Weight of conductor
- Span
- Tensile Strength
- Temperature Variation
- Wind pressure
- Ice Loading

ii) State different factors on which spacing between conductors depends (Any Four Point)

Following points are considered by keeping spacing between two conductors:-

- It depends on magnitude of voltage i.e. if voltage is high spacing between two conductor is more & vice versa.
- It depends on span i.e. if span is more distance between two conductors is more & vice versa.



- It depends on weight of conductor i.e. for light weight conductor spacing between two conductors should be more than heavy weight conductor.
- It depends on tensile strength of material.
- It depends on wind pressure.
- It depends on weight of ice deposition.
- It depends on safety against flash over.
- To improve string efficiency spacing between two conductors should be large.
- To reduce corona loss the spacing between two conductors should be large.
- To reduce proximity effect spacing between two conductors should be large.

c) Explain effect of poor power factor on efficiency and voltage regulation of transmission line. (Explanation of each effect Efficiency & regulation – 4 Marks)

We know that, $P = VI \cos \phi$ for 1- ϕ and $\sqrt{3} VL I \cos \phi$ for 3- ϕ

When same power is to be transmitted over same distance at same transmission voltage, Then **current is inversely proportional to the power factor.**

Effect of poor power factor on efficiency:-

- When power factor of load reduces current drawn by transmission line increases so copper losses in transmission line increases, hence transmission efficiency reduces & vice versa.

Effect of poor power factor on voltage Regulation:-

- When power factor of load reduces current through transmission line increases, so voltage drop in transmission line (due to resistance & inductive reactance) increases so regulation increases. (Become Poor)

Q.4 Attempt any two:-

a) Given Data:-

(Give stepwise Marks as mention below)

$$P_R = 3\text{MW} = 3000\text{KW} \quad V_R = 33\text{KV} \quad \text{p.f} = 0.85 \text{ lag} \quad R_T = 8 \text{ ohm} \quad X_T = 12 \text{ ohm}$$

$$\text{Power } P = VI \cos \phi$$

$$I \equiv \frac{P}{V \cos \phi} \text{-----} \quad \text{(1Mark)}$$

$$I \equiv \frac{3 \times 10^6}{33 \times 10^3 \times 0.85}$$

$$I \equiv 106.95 \text{ amp} \text{-----} \quad \text{(1Mark)}$$

$$\therefore \cos \phi_R = 0.85 ; \sin \phi_R = 0.53$$

i) Sending end voltage $V_s = V_R + I(R_T \cos \phi_R + X_T \sin \phi_R) \text{-----} \quad \text{(1Mark)}$

$$= 33 \times 10^3 + 106.95 (8 \times 0.85 + 12 \times 0.53)$$

$$= \mathbf{34407.462 \text{ volt}} \text{-----} \quad \text{(1Mark)}$$

$$\text{or } V_s = 34.407 \text{ KV}$$



ii) Sending end Power factor $\cos \phi_s$:

$$\cos \phi_s = \frac{V_R \cos \phi_R + I R_T}{V_S} \text{----- (1Mark)}$$

$$\cos \phi_s = \frac{33 \times 10^3 \times 0.85 + 106.95 \times 8}{34.407 \times 10^3}$$

$$\cos \phi_s = 0.84 \text{ lag} \text{----- (1Mark)}$$

iii) Transmission efficiency :

$$\% \eta_T = \frac{P_R}{P_R + I^2 R_T} \times 100 \text{----- (1Mark)}$$

Total Line Losses: Total Line Losses = $I^2 R_T = (106.95)^2 \times 8 = 91506.42 \text{ W} = 91.50 \text{ KW}$

$$\% \eta_T = \frac{3 \times 10^6}{3 \times 10^6 + 91.50 \times 10^3} \times 100$$

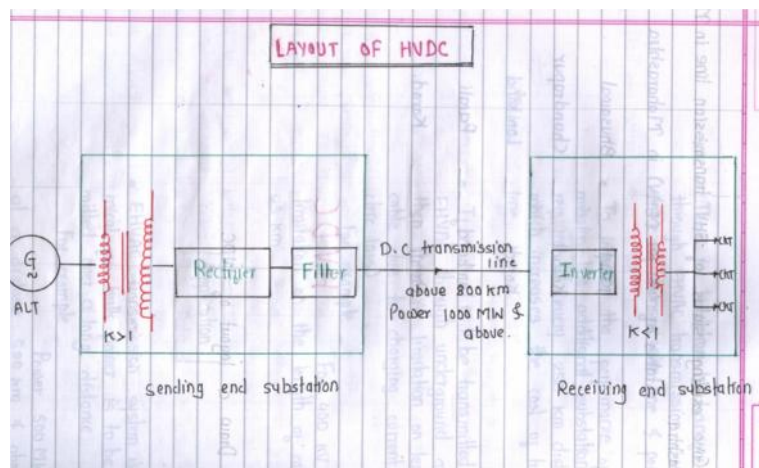
$$\% \eta_T = 97.04 \% \text{----- (1Mark)}$$

b) i) Draw a block diagram for HVDC transmission starting from generator. (4 Marks)

ii) State any four advantages and disadvantages of HVDC transmission.

(Advantages-2 Marks & Disadvantages-2 Marks)

i) Draw a block diagram for HVDC transmission starting from generator.



or equivalent diagram

ii) State any four advantages and disadvantages of HVDC transmission.

Advantages of HVDC Transmission System :- (Any Four Expected) ----- (2 Marks)

- 1) The basic D.C transmission line requires only 2 Conductor. (+ ve & - Ve) and if ground is used as a return path, then only one conductor is sufficient.
- 2) If ground is used as return path, then only 2 conductors are sufficient for double circuit.



- 3) As number of conductor required are less, so load on tower is less. This make Tower design simple and lighter.
- 4) No intermediate substation is required like HVAC transmission line.
- 5) Due to above advantages, Cost of transmission line per KM is less.
- 6) Skin effect is absent.
- 7) No proximity effect.
- 8) Less radio interference.
- 9) No Ferranti effect.
- 10) Low corona loss.
- 11) Copper loss is less.
- 12) As effect of L & C is absent and value of DC resistance of conductor is less, so voltage drop in transmission line is less.
- 13) Voltage regulation is better than HVAC transmission line.
- 14) There is no need of reactive power compensation.
- 15) Voltage control easy for long distance HVDC transmission line.
- 16) HVDC line has more stability than HVAC.
- 17) There is no limit for transmission of power.

Disadvantages of HVDC transmission Line :- (Any Four Expected) ----- (2 Marks)

- 1) It is difficult to step up and step down DC voltage like AC voltage.
- 2) Cost of DC substation is more than AC substation, due to additional equipment required like rectifier, inverter etc.
- 3) Maintenance cost of DC substation is more due to additional equipment.
- 4) Losses in DC substation are more due to additional equipment.
- 5) Special cooling arrangements are necessary for converter, so it increases cost of substation.
- 6) Converter has little over load capacity.
- 7) Reliable DC circuit breakers are not available like AC circuit breakers.
- 8) If ground is used as the return path, then it leads corrosion of underground metallic structure of buildings, pipes, etc. Also causes disturbance in underground communication cable.

c) i) Explain three requirements of good distribution system.

(4 Marks)

ii) Draw a diagram showing interconnected distribution system.

(4 Marks)

i) Explain three requirements of good distribution system.

Following are the different Requirements of good distribution system :- (Any Three)

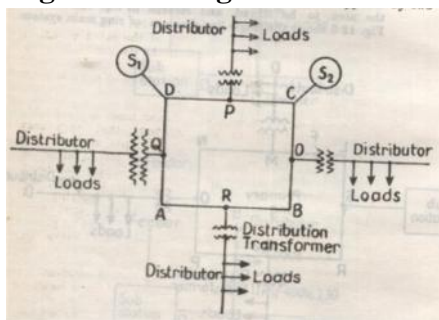
- a) **Design layout:** - It should be simple in design.
- b) **Initial Cost:** - It should be less and also time required for completion of work should be less.
- c) **Maintenance:** - It should be easy, less costly and time required for maintenance should be less.



- d) **Reliability:** - It should have high reliability to maintain supply.
e) **Voltage fluctuation:** - It should be less and should be within permissible limit.
f) **Availability of power:** - Power must be available to all consumers on demand that they may require from time to time.
g) **Stability:** - Fault on nearest distribution system should not affect stability of existing distribution system.

ii) Draw a diagram showing interconnected distribution system.

(4 Marks)



or equivalent diagram

Q.5 Attempt any Four:-----16 Marks

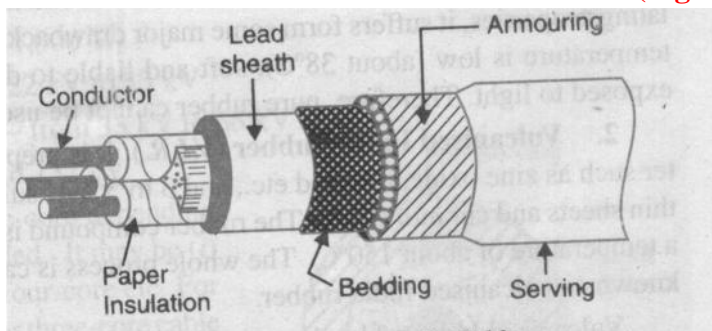
a) State any four differences between AC distribution and DC distribution system.

Compare of AC Distribution & DC distribution System :- (Any Four Point- 1 Marks each point)

S.No	A.C Distribution System	D.C Distribution System
1	It require Four conductor	It require Two / Three conductor
2	More complicated system	It is simple system
3	Losses are more	Losses are less
4	Effect of L & C Present	Effect of L & C Zero (absent)
5	Voltage regulation is poor	Voltage regulation is better
6	Presence of skin effect	No skin effect
7	Efficiency is less	Efficiency is more
8	Effective resistance of conductor is more	Effective resistance of conductor is less

b) Draw a diagram of underground cable showing different parts.

(Figure- 2 Mark & list of part - 2 Mark)

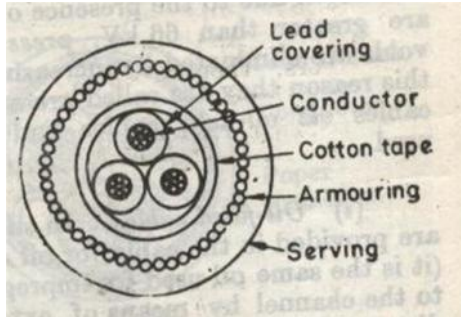


or equivalent diagram consider in which all parts are mentioned



c) Explain construction of SL type Cable.

(Explanation-2 Marks & Figure-2 Marks)



or equivalent diagram

- Above figure shows the constructional details of a 3-core SL (Separate Lead) type cable.
- It is basically H-type cable but the screen round each core insulation is covered by its own lead sheath.
- There is no overall lead sheath but only armouring and serving are provided.
- The S.L type cables the separate sheaths minimize the possibility of core-to-core breakdown. And bending of cables becomes easy due to the elimination of overall lead sheath.
- The disadvantage of this cable is that the three lead sheaths of cable are much thinner than the single sheath of H-type cable.

d) Define substation. State different types of substation according to service requirements

(Defination-2 Marks & Types- 1/2 Marks each)

Sub-Station:-

Sub-station is link between generating station and consumer. **OR**

The assembly of apparatus used to change some characteristic of electric supply is called sub-station. & it is important part of power system.

Types Sub-station According to service requirements:- (Any Four type expected)

- i) **Transformer Sub-station:-** Those sub-station which change the voltage level of electric supply is called transformer sub-station.
- ii) **Switching sub-station:-** this sub-station does not change the voltage level.
- iii) **Power Factor correction sub-station:-** These sub-station which improve the power factor of the system.
- iv) **Frequency changer sub-station:-** These sub-station which change the supply frequency.
- vi) **Converting sub-station:-** These sub-station which change AC power into DC power or DC power into AC power
- vii) **Industrial Sub-station:-** These sub-station which supply power to individual industrial concerns.
- viii) **Traction substation:** These sub-station which supply power to electric railway.



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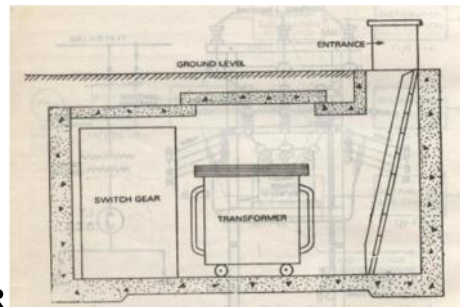
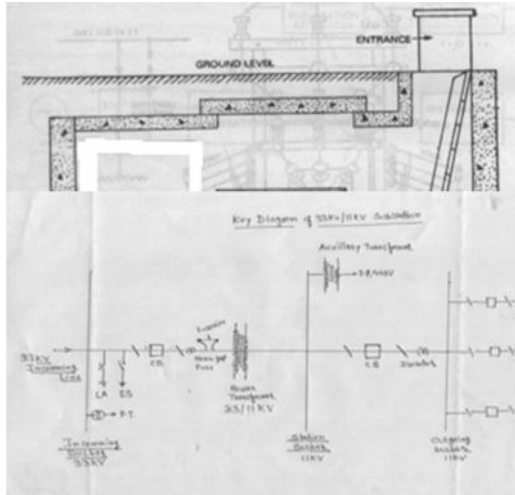
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e) Write construction of underground sub-station. Draw diagram of underground substation.

(Explanation-2 Marks & Figure- 2 Marks)



OR

or Equivalent fig.

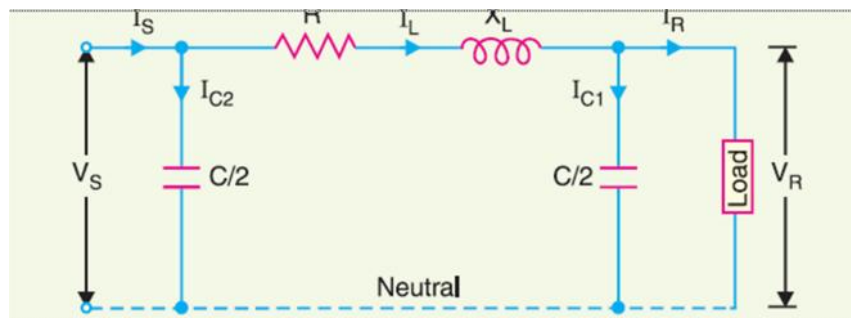
In thickly populated cities, availability of land is less as well as the prices of land are very high. This has led to the development of underground substation. The construction of underground sub-station consist of :

- The location of the station is under ground.
- There is reasonable distance between two equipment
- There is provision for emergency lighting and protection against fire.
- There is good ventilation.
- There is provision for remote indication of excessive rise in temperature so that H.V supply can be disconnected.
- The transformers, switches and fuses are air cooled to avoid bringing oil into the premises.

Q.6 Attempt any Four: -----16 Marks

a) Draw a nominal pi network. Draw its phase diagram.(Figure-2 Marks & Vector-2 Marks)

Nominal π (pi) Network: - ----- (2Marks)





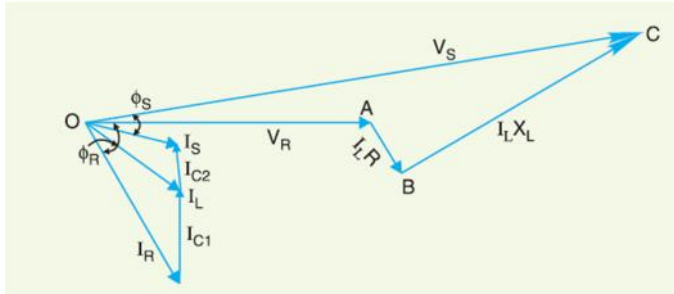
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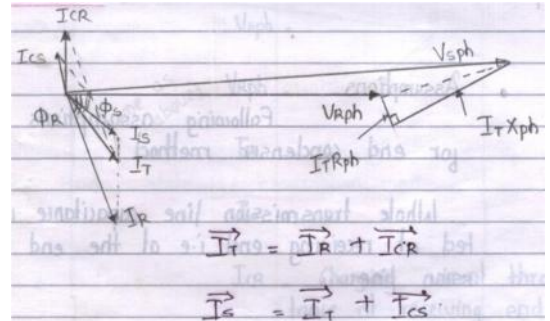
Model Answer

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Vector diagram of f network for: ----- (2Marks)



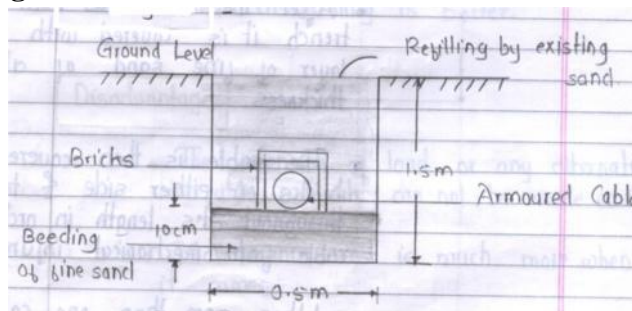
or



or equivalent vector diagram

b) Explain Direct laying method for cable laying. (Explanation-2 Marks & Figure-2 Marks)

Direct Laying method:-



or Equivalent fig.

- For laying of a cable trench about 1.5m deep and 0.5m wide is made along the cable route.
- A layer of 10 cm thickness of soft soil is spread throughout the cable route in trench.
- The cable is laid on this soft soil (bed)
- A wall of bricks (concrete cover) is provided on either side or top of cable along the length of cable for better mechanical protection.
- Another layer of soft sand, about 10 cm thicknesses is spread throughout its cable length.
- Refill the remaining trench with the help of remaining soil up to ground level.
- While crossing roads (public-crossing) cable is laid through cement pipe or DWC pipe, instead of bricks for better mechanical protection.
- When more than 1 cable is to be laid in the same trench, then minimum 30 cm spacing is provided between 2 cables and gap is filled by sand.
- The spacing is kept between 2 cables to reduce the effect of mutual heating and also fault occurring on one cable does not damage the adjacent cable.
- Only armored cables are used in this method.



c) Explain construction of gas pressure cable. State its application.

(Explanation-2 Marks, Figure-1 Mark & Application-1 Mark)

Gas Pressure Cable:-



or Equivalent fig.

- The above figure shows the section of external pressure cable designed by Hockstadter, vogal and Bowden.
- The construction of cable is similar to ordinary solid type except that it is of triangular shape and thickness of lead sheath is 75% that of solid cable.
- The triangular section reduces the weight and gives low thermal resistance.
- The main reason for triangular shape is that the lead sheath acts as a pressure membrane.
- The sheath is protected by a thin metal tape.
- The cable is laid in a gas-tight steel pipe; the pipe is filled with dry nitrogen gas at 12 to 15 atmospheres.
- The gas pressure produces radial compression and closes the voids that may have formed between the layers of paper insulation.
- Such cable can carry more load current and operate at higher voltages than normal cable.

Application:- For high voltage transmission

d) Explain the four advantages and four disadvantages of underground substation

(Advantages- 2 Marks & Disadvantages-2 Marks)

Advantages of underground Substation:- (Any Four Expected)

- i) Space required for underground substation is less.
- ii) Chances of leakage current is less
- iii) Maintenance cost is less.
- iv) Switching operation is safer even in rainy season.
- vii) No effect of atmospheric condition.
- viii) Such substation is useful where cost of land is high and availability space is less.
- ix) Such substation is useful where high rainfall and snow fall occurs.

Disadvantages of underground Substation:- (Any Four Expected)

- i) Construction work required is more.
- ii) Time required for completion of installation work of substation is more.
- iii) There is no-easy access for incoming & outgoing lines.



- iv) There is less distance between two equipments which will be increases possibility of fault & reduces safety.
- v) Natural cooling is not available to equipments.
- vi) No natural light is available due to underground installation so there is need of illumination even during day time, so it increases energy consumption & cost.
- vii) Replacement & maintenance of faulty equipment can be difficult due to underground installation.
- x) In case of accident there is more risk & danger to other equipment & operator etc than outdoor substation.
- xi) Extension of substation is not easily possible whenever needed

e) State any eight major equipments in substation. State function of each equipment

(Any Eight expected function of equipment Expected -1/2 Marks each)

- i) Busbar:** - Busbar receives power from incoming circuit & delivers it to outgoing circuit.
- ii) Power Transformer:-** Its function is to step down the incoming voltage to outgoing voltage without change in frequency.
- iii) Auxiliary Transformer:** - Its function is to step down the input voltage (11 KV) to distribution voltage (3-ph, 4wire, 440V) to give supply to control room, area lighting, staff quarters etc,
- iv) Lighting Arrester:** - It is provided for protection of substation, transformer against lightning stroke
- v) Earth switch:** - It is used for safety purpose. It is closed during maintenance to discharge capacitor.
- vi) Isolator:** - Its function is to isolate the circuit whenever required. e.g at the time of maintenance.
- vii) Circuit Breaker:** - It is protective device. It open or break the circuit whenever there is fault & protect the equipment.
- viii) Horn Gap Fuse:** - It is provided to primary side of transformer for protection against over current.
- ix) Instrumental Transformer (CT & PT):-** C.T & P.T are used for measurement of electrical quantities also C.T. is used for protection purpose.
- x) Control Room:** - It is construction near switchyard in which control panel is installed from which various circuits are controlled by operator.
- xi) Control Panel:** - Control panel consists of different types of relays to detect different types of faults.
- xii) PLCC (Power Line carrier communication):-** It is used for direct communication between substations to generating station also between two major substations. For this purpose same transmission line carries communication signal.
- xiii) Series Reactor:** - To limit the short circuit current
- xiv) Shunt Reactor:** - It supplies lagging KVAR to control voltage of transmission line.



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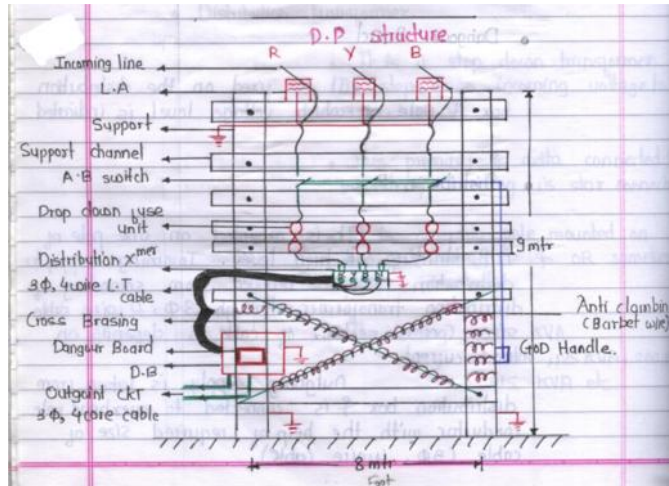
Model Answer

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- xv) **Series Capacitor:** - It supplies leading KVAR
xvi) **Shunt Capacitor:** - For power factor improvement.

f) Draw a typical layout diagram of 11 KV distribution substations.

(4 Marks)



END

Page No: 21 to 22 Question Paper & Summary of Marking Scheme



Question Paper & Summary of Marking Scheme

Q.1 A) Attempt any six:

- a) Draw a block diagram of power system. **(2 Marks)**
- b) Compare overhead system and underground distribution system on any four points **(2 Marks)**
- c) State different voltage levels used in transmission of power in India. **(2 Marks)**
- d) State any four properties of conductor. **(Any four points expected- 1/2 marks each point)**
- e) State different types of line insulators. **(Write any four 1/2 Marks each)**
- f) Define: i) Transmission efficiency ii) voltage regulation in transmission line
(Each Definition – 1 Marks)
- g) Explain why transposition of line is done. **(Figure – 1 Marks & Reason- 1 Marks)**
- h) Classify transmission Line. State voltage and length of each line **(2 Marks)**

Q.1 B) Attempt any Two:

- a) Explain how a lightning arrester protects substation equipments.
(Explanation-3Marks & Figure-1 Marks)
- b) Explain corona effect. State different factors which affects corona
(Explanation-2 Marks & Factors – 2 Marks)
- c) Explain : i) Skin effect ii) Ferranti effect **(Each Effect- 2 Marks)**

Q.2 Attempt any Four:

- a) Explain proximity effect in power system. **(Explanation-3 Marks& Figure-1 Marks)(For explanation any three points consider out of following)**
- b) State any four advantages of EHVAC transmission. **(Each advantages-1 Mark)**
- c) State difference between feeder and distributor on any points.
(Any Four points expected- 1 Marks each point)
- d) Draw a diagram showing primary distribution system and secondary distribution system. **(4 Marks)**
- e) Explain ring distribution system. State any two advantages of ring distribution system.
(Explanation-2 Marks, Figure- 1 Marks & Advantages-1 Marks)
- f) Draw phasor diagram of a 11KV, 20 km line having leading power factor. **(4 Marks)**

Q.3 Attempt any two:-

- a) Given Data : $V_3 = 20KV$ **(Give stepwise Marks as mention below)**
- b) i) Explain Sag in transmission. **(Explanation-2 Mark & Figure-2 Mark)**



ii) State different factors on which spacing between conductors depends

(Any Four points-1 mark to each point)

c) Explain effect of poor power factor on efficiency and voltage regulation of transmission line.

(Explanation of each effect Efficiency & regulation – 4 Marks)

Q.4 Attempt any two:-

a) Given Data:-

(Give stepwise Marks as mention below)

b) i) Draw a block diagram for HVDC transmission starting from generator. (4 Marks)

ii) State any four advantages and disadvantages of HVDC transmission.

(Advantages-2 Marks & Disadvantages-2 Marks)

c) i) Explain three requirements of good distribution system.

(4 Marks)

ii) Draw a diagram showing interconnected distribution system.

(4 Marks)

Q.5 Attempt any Four: -----16 Marks

a) State any four differences between AC distribution and DC distribution system.

b) Draw a diagram of underground cable showing different parts.

(Figure- 2 Mark & list of part - 2 Mark)

c) Explain construction of SL type Cable.

(Explanation-2 Marks & Figure-2 Marks)

d) Define substation. State different types of substation according to service requirements

(Definition-2 Marks & Types- 1/2 Marks each)

e) Write construction of underground sub-station. Draw diagram of underground substation.

(Explanation-2 Marks & Figure- 2 Marks)

Q.6 Attempt any Four: -----16 Marks

a) Draw a nominal pi network. Draw its phase diagram.(Figure-2 Marks & Vector-2 Marks)

b) Explain Direct laying method for cable laying. (Explanation-2 Marks & Figure-2 Marks)

c) Explain construction of gas pressure cable. State its application.

(Explanation-2 Marks, Figure-1 Mark & Application-1 Mark)

d) Explain the four advantages and four disadvantages of underground substation

(Advantages- 2 Marks & Disadvantages-2 Marks)

e) State any eight major equipments in substation. State function of each equipment

(Any Eight expected function of equipment Expected -1/2 Marks each)

f) Draw a typical layout diagram of 11 KV distribution substations.

(4 Marks)