UNIT I
STRUCTURE OF POWER SYSTEM

PART-A
(2 MARK QUESTIONS WITH ANSWERS)

1. Mention the location of the HVDC transmission.

The locations of the HVDC transmission are Chandigarh, Delhi, Patiala and Faridabad.

2. What is primary transmission?

The electric power at generating station is stepped up to 132kV (to reduce the transmission loss) and transmitted by three phase, three wire overhead system to the outskirts of the city. This forms the primary transmission.

3. What is secondary transmission?

The primary transmission line continues via transmission towers till the receiving stations. At the receiving stations, the voltage level is reduced to 22kV or 33kV using the step down transformer. There can be more than one receiving stations. Then at reduced voltage level of 22kV or 33kV, the power is transmitted to various substations using overhead three phase three wire system. This is secondary transmission

4. Write the advantages of A.C transmission.

The advantages of A.C transmission are:

- It can be generate power at very high voltages.
- The maintenance of A.C. substation is easy and cheaper.
- A.C. voltage can be stepped up or stepped down with the help of transformer.
- Construction is simple.
- Fault can be detected very easily.
- There is no converter device required.

5. Write the disadvantages of A.C transmission.

The disadvantages of A.C transmission are:

- More copper is required than D.C.
- Construction is complicated than D.C.
- Presence of skin effect to increase the effective resistance of the line.
- In A.C system due to the presence of capacitance there is continuous loss of power due to charging current even when the line is open.

6. Mention the limitations of high transmission voltage.

The limitations of high transmission voltage are:

- The cost of insulating the conductor is very high.
- Cost of transformer, switchgear and other terminal apparatus are very high.

7. List the various systems of power transmission in D.C. system.

The various systems of power transmission in D.C. system are:

- D.C. two wire system
- D.C. two wire with midpoint earthed.
- D.C. three wire.

Single phase A.C. system

- Single phase two wire
- Single phase two wire with midpoint earthed
- Single phase three wire.

Two phase A.C. system

- Two phase four wire
- Two phase three wire

Three phase A.C. system

- Three phase three wire(Transmission system)
- Three phase four wire(Distribution system)

7. What is a feeder?

Feeder is defined as lines, which connect the distribution station and distributor.

9. What is a distributor?

Distributor is defined as a common bus bar, which connect the service main and feeder.

10. How distribution systems are classified?

Distribution systems are classified by,

- Nature of current
- Type of construction
- Scheme of connection
- D.C distribution.

11. What is a service main?

Service main is defined as a small cable or conductor which connects the distributor to the domestic terminal.

12. Distinguish between overhead system and underground system.

S.No	Overhead system	Underground system
1	Construction cost is less.	Construction cost is high.
2	To occupy the more spaces in metropolitan area.	To enhance the city beauty
3	It is operated above 66KV.	It is limits up to 66KV.
4	Fault can be easily detected and rectified.	Fault cannot be easily detected.

13. List the components of a power system.

The components of a power system are:

- Generating station
- Step up transformer
- Step down transformer
- Transmission line
- Switching station
- Primary distribution line
- Secondary distribution line
- Feeder
- Distributor and Consumer

14. What is a distribution substation?

Distribution substation is a primary distribution system that delivers power to various substations.

15. Give the types of loading in distribution system.

The types of loading in distribution system are:

- Uniform loading
- Concentrated loading
- Combination of uniform loading and
- Concentrated loading.

16. What is meant by Electrical power system?

The flow of electrical power from the generating station to the consumer is called as an electrical power system

17. Define one line diagram.

One line diagram is defined as the way in which all electrical apparatus represented by single line in symbolic form.

17. Which system is adopted for transmission of electric power?

A.C system is suitable for transmission of electric power due to the technical difficulties of D.C system. There is possibility of saving the copper conductor.

19. Mention the equipment's that supply reactive power in HVDC converter stations?

Ac filters, static shunt capacitors, synchronous condenser, static var compensators.

20. What is the interconnected system?

When the feeder ring is energized by two or more than two generating stations or substations is called as inter-connected system.

PART-B
(13 MARK QUESTIONS)

1. Discuss various types of HVDC links. **(7)**
2. List out the main components of a HVDC system. **(7)**
3. Draw and explain the structure of modern power systems with typical voltage levels **(13)**
4. Explain the effect of high voltage on volume of copper and on efficiency. **(13)**
5. Explain why the transmission lines are 3 phase 3-wire circuits while distribution lines are 3 phase 4-wire circuits. **(13)**
6. Draw the model power system with single line representation. Show its essential constituent sections. **(6)**
7. What are the AC transmission and distribution level voltages we have in India? **(4)**
8. What are the different kinds of DC links? Draw relevant diagrams **(6)**
9. Explain why EHV transmission is preferred? What are the problems involved in EHV AC transmission? **(7)**
10. With neat schematic, explain the principle of HVDC system operation. **(7)**
11. Explain about FACTS with neat diagram **(13)**
12. Explain TCSC and SVS systems **(13)**
13. Explain with neat diagram about STATCOM and UPFC **(13)**
14. Compare EHVAC and HVDC transmission **(7)**

15. Explain the applications of HVDC transmission system **(7)**
16. Write short notes on distributed and concentrated loads? **(7)**
17. What are distributors? Explain its types in detail **(7)**

UNIT-II
TRANSMISSION LINE PARAMETERS

PART-A
(2 MARK QUESTIONS WITH ANSWERS)

1. What are the line parameters in transmission line?

- Resistance
- Inductance
- Capacitance

2. What are the factors to be considered while designing the transmission line?

- Type and size of a conductors
- Line regulation and control of voltage
- Efficiency of transmission
- Corona loss
- Power flow capability

3. What are the types of aluminium conductor?

- AAC- All Aluminium Conductor
- AAAC - All Aluminium Alloy Conductor
- ACSR - Aluminium Conductor with Steel Reinforcement
- ACAR - Aluminium Conductor with Alloy Reinforcement

4. What are the advantages of ACSR conductor?

- They have low corona loss
- Skin effect is to reduced extent
- Due to high mechanical strength the line span can be increased. This is minimizing cost of erection and maintenance.

5. Define inductance?

The flux linkage per ampere is called the inductance.

$L = \Psi / I$

6. What is mean by skin effect?

When a conductor is carrying steady direct current this current is uniformly distributed **over** the whole cross section of the conductor. An

alternating current flowing through does not distribute uniformly rather it has the tendency to concentrate near the surface of the conductor. This is known as skin effect.

7. What are the advantages of aluminium conductor?

- They have low cost
- Less resistance and corona loss
- Less weight

8. What are the steps for reducing telephone interference?

- The harmonics at the source can be reduced with the use of a harmonic filters, DC harmonic filters and smoothening reactors.
- Use greater spacing between power and telephone lines.
- The parallel run between telephone line and power line is avoided.
- If the telephone circuit is ground return then replace it with metallic return.

9. What are factors influencing the telephone interference?

- Because of harmonics in power circuit their frequency range and magnitudes.
- Electromagnetic coupling between power and telephone conductor.
- Due to unbalance in power circuits and in telephone circuits.
- Type of return telephone circuit i.e. either metallic or ground return.
- Screening effect.

10. What is mean by telephone interference?

The distortion effect and potential rise effect are disturbance which is produced in the telephone communication because of power lines is called telephone interference.

11. Write down the comparison between single circuit and double circuit.

Sl.No	Single circuit	Double circuit
1.	This type of arrangement is less Dangerous during repair work	This type of arrangement is Comparatively dangerous
2.	From continuity of supply point of view, the circuit is less reliable	With reference to continuity of supply, the circuit is much reliable

12. Write down the depending factors of electrostatic effects.

The electrostatic effect mainly depends on what is the distance

between power and communication circuits and length of the route over which they are parallel.

13. What is mean by proximity effect?

The current distribution may be non-uniform because of another effect known as proximity effect. Consider two wire line as shown in fig, let each of the conductor is assumed to be divided into three sections having equal cross sectional area. Three parallel loops are formed by the pairs xx', yy' and zz'. The flux linking loop xx' is least and it increases for the remaining loops. Thus the inductance of inner loop is less. Thus the current density is highest at inner edges of conductor.

14. Write down the depending factors for skin effect.

- Nature of the material
- Diameter of the wire
- Frequency of supply
- Shape of wire

15. What are the advantages of bundled conductor?

- low radio interference and corona loss
- reduced voltage gradient at conductor surface
- increase in capacitance
- low reactance due to increase in self GMD
- increase in surge impedance loading

16. What is mean by standard conductor?

The standard conductor usually has a central wire which is surrounded by the layers of wires. This layer consists of 6, 12, 17, wires successively. Thus the total strands are 7, 13, 19.This type of conductor is called stranded conductor.

17. What is mean by bundled conductor?

The conductors of any one bundle are in parallel and charge per bundle is assumed to divide equally between the conductors of bundle. The composite or stranded conductors touch each other while the bundled conductors are away from each other. This type of conductor is called bundled conductor.

18. What is mean by resistance?

It is defined as the opposition offered by the transmission lin conductors to the flow of current.

19. What is mean by symmetrical spacing?

Consider three conductors A, B and C. if the three conductors are placed symmetrically at the corners of an equilateral triangle of sides. Then it is called symmetrical spacing.

20. What is mean by unsymmetrical spacing?

When three phase line conductors are not equidistance from each other the conductor spacing is said to be unsymmetrical spacing.

21. What is transposition of conductors?

The transposition is defined as interchanging of position of the line conductors at regular intervals along the line so that each conductor occupies the original position of every other conductor over at equal distance. Such an exchange of positions is known as transposition

PART-B
(13 MARK QUESTIONS)

1. From the fundamentals derive an expression for inductance of a single phase transmission system. **(7)**
2. Write short notes on corona discharges **(7)**
3. Derive an expression for capacitances of a single phase transmission system and discuss the effect of earth on capacitance with suitable equation. **(13)**
4. Derive an expression for inductance of a single-phase overhead line. **(7)**
5. A conductor is composed of seven identical copper strands each having a radius r. Find the self-GMD of the conductor**.** Derive an expression for the capacitance between conductors of a Single phase overhead line. **(7)**
6. Find the capacitance between the conductors of a single-phase 10 km long line. The diameter of each conductor is 1.213cm. The spacing between conductors is 1.25m. Also find the capacitance of each conductor neutral. **(7)**
8. Derive the expression for inductance of a two wire 1Φ transmission line **(7)**
9. Derive the expression for capacitance of a 1Φ transmission line **(7)**
10. What are the advantages of bundled conductors? **(7)**
11. Derive the expression for capacitance of a double circuit line for hexagonal spacing. **(7)**
12. Why is the concept of self GMD is not applicable for capacitance? **(4)**
13. Explain clearly the skin effect and the proximity effects when

referred to overhead lines. **(7)**

14. Write a short note on the inductive interference between power and communication lines. **(7)**

15. Derive the expression for the capacitance per phase of the 3 Φ double circuit line flat vertical spacing with transposition. **(7)**

16. A 3 Φ overhead transmission line has its conductors arranged at the corners of an equilateral triangle of 2m side. Calculate the capacitance of each line conductor per km. Given the diameter of each conductor is 1.25cm. **(7)**

17. Find the capacitance per km per phase of a 3Φ line arrangement in a horizontal plane spaced 8 meters apart. The height of all conductors above the earth is 13 meters. The diameter of each conductor is 2.6 cm. the line is completely transposed and takes the effect of ground into account. **(7)**

18. Discuss the concept of GMR and GMD in the calculation of transmission line inductance. **(7)**

UNIT III
MODELLING AND PERFORMANCE OF TRANSMISSION LINES

PART-A
(2 MARK QUESTIONS WITH ANSWERS)

1. Write down the classification of overhead transmission line

- Short transmission line
- Medium transmission line
- Long transmission line

2. What is mean by Short transmission line?

If the transmission line length is about 50 km and the line voltage is low i.e. is 20kv or less than that the line is treated as short transmission line.

3. What is mean by medium transmission line?

When the transmission line length is about 50 to 150 km and the line voltage is 20kv to 100kv than that the line is treated as short transmission line.

4. What is mean by long transmission line?

When the transmission line length is about 150 km and the line

voltage is Above 100kv than **that** the line is treated as short transmission line.

5. What are the types of medium transmission line?

- End condenser method
- Nominal T method
- Nominal π method

6. Define voltage regulation.

The difference in voltage at the receiving end of the transmission line at the no load and **full** load is termed as voltage regulation expressed in terms of percentage of receiving end voltage

% voltage regulation = $(V_{noload} - V_{full\ load} / V_{full\ load})$ X100

7. Define transmission efficiency.

The ratio of power obtained at the receiving end to the power at sending end is called transmission efficiency of the line.

8. What is mean by Surge impedance?

In the power system network the characteristic impedance is sometimes referred as surge impedance. It is defined as square root of Z/Y.

Where,

Z = series impedance of line

Y = Shunt admittance of line.

9. What is mean by Surge impedance loading?

The surge impedance loading of a line is the power delivered by a line to a purely resistive load equal to its surge impedance. The line is assumed to have no resistance.

10. What is mean by Ferranti effect?

At no load condition in transmission line the voltage at receiving and is more than that sending end because of the effect of the line capacitance. This is called Ferranti effect.

11. Write down the line compensation using in transmission line.

- Series compensation
- Shunt compensation

12. What are the advantages of series compensation?

- Increase in power transmission capacity of line
- Improvements in system stability

- Improved voltage regulation
- Load division between parallel circuits
- Damping effect

13. What are the disadvantages of series compensation?

- Reduce the reactance of line and increase the fault current level
- It gives high torsional stresses
- It will increasing the hunting
- The series capacitor may cause faculty operation of distance relays of the line protection if the degree of compensation and location of capacitor is not proper.

14. Write down the various factors on which transmission line capability.

- Thermal limits of conductor
- Transient and steady state stability
- Transmission line capability depends on over voltage at the capacitor terminals of series compensated line.

15. Write down the effect of shunt compensation.

- It reduces the line current losses owing to generation of reactive power.
- It reduces the transmission line current to a value less than the current in the load
- It improves the power factor of the transmitted power
- It reduces the voltage drop uniformly along the length of the line

16. Write down the advantages of shunt compensation.

- The kw of alternators, transformers and lines are increased. The line current is reduced
- The losses in power transformer and cables are reduced which saves the energy
- It prevents overloading of transformers and switchgears
- Improved voltage is obtained at the receiving end

17. Write down the disadvantages of shunt compensation.

The only disadvantage with shunt capacitor is that the response to voltage dips is not as rapid as with series capacitor since the switching of the bank is initiated by change in voltage.

18. Write down the comparison between series and shunt capacitors.

- The rise in voltage due to a shunt capacitor is uniformly distributed

along the length of the transmission whereas in case of series capacitors the rise in voltage in sudden where the capacitor is installed.
- For the same rise in voltage the reactive power capacity of a shunt capacitor is greater than that of a series capacitor
- The power factor is improved because of a shunt capacitor while the power factor is little effected by series capacitor
- The series capacitors are found to be more effective for improving the system stability

19. What is mean by corona effect?

It can be noticed that near the overhead lines there exists a hissing noise and sometimes a faint violet glow. The effect due to which such phenomenon exists surrounding the overhead lines is called corona effect.

20. What is mean by corona power loss?

The ions produced in the air due to corona are moving. The energy required to keep them moving is derived from the supply system. This additional power required which is dissipated in the form of heat, sound and light in case of corona, is called corona loss.

21. What are the factors affecting corona and corona loss?
- Electrical factors
- Line voltages
- Size of the conductor
- Surface conditions
- Spacing between conductors

22. What are the advantages of corona?
- Due to corona the air surrounding the conductor is ionized and becomes conducting. This increasing the virtual diameter of the corona
- Corona reduces the effect produced by the surges and conductor is saved from possibilities of lightning

23. What are the advantages of corona loss?
- The corona power loss is the biggest disadvantage which reduce the transmission efficiency
- The third harmonic components produced due to corona makes the current non- sinusoidal. This increases the corona loss
- The ozone gas formed due to corona chemically reacts with the conductor and can cause corrosion

24.Write down the methods to reducing corona effect

- Increasing the conductor size
- Increasing the conductor spacing
- Using hollow and bundled conductors

25. Define radio interference.

The corona discharge produces the radiations which may introduce noise signals in the communication lines, carrier signal, radio and television receivers, navigation signals etc. Such noise signals which adversely affect the wireless signals, produced by corona is called radio interference.

26. How is corona loss related with the diameter of the conductor?

Corona loss related with the diameter of the conductor by the following Way,

Corona loss=r/d

Where,

d - Diameter of the conductor.

Hence lower the diameter of the conductor, higher is the loss.

27. What is local corona?

The corona does not start simultaneously on the whole surface, but it takes place at different points of the conductor which are pointed is known as local corona.

PART-B

(13 MARK QUESTIONS)

1. Determine the efficiency and regulation of a 3phase, 100Km, 50 Hz transmission line delivering 20 MW at a power factor of 0.8 lagging and 66 kV to a balanced load. The conductors are of copper, each having resistance Ω / Km, 1.5 cm outside dia, spaced equilaterally 2 meter's between centers. Use nominal T method. **(13)**

2.A three phase 5 km long transmission line, having resistance of 0.5 Ω / km and inductance of 1.76mH/km is delivering power at 0.8 pf lagging. The receiving end voltage is 32kV. If the supply end voltage is 33 kV, 50 Hz, find line current, regulation and efficiency of the transmission line. **(13)**

3. Derive the expressions for sending end voltage in nominal T method and end Condenser method. **(13)**

4. What is an equivalent circuit of long line? Derive expression for parameters of this circuit in terms of line parameters. **(13)**

5. Define regulation of a transmission line and derive the approximate expression for the regulation of a short transmission line. **(8)**

6. What is corona loss? How do you determine this loss? **(8)**

7. A 220kV, 3Φ transmission line has an impedance per phase of (40+j200)Ω and an admittance of (0+j0.0015) mho. Determine the sending end voltage and sending end current when the receiving end current is 200 A at 0.95 pf lagging. Use nominal method. **(13)**

8. Determine the efficiency and regulation of a three phase 200 km, 50Hz transmission line delivering 100MW at a pf of 0.8 lagging and 33kV to a balanced load. The conductors are of copper, each having resistance 0.1 Ω/km, and 1.5cm outside dia, spaced equilaterally 2m between centres. 9. Neglect leakage reactance and use nominal T and π methods. **(13)**

10. Explain the Ferranti effect with a phasor diagram and its causes **(7)**

11. A 50Hz transmission line 300 km long total series impedance of 40+j25 Ω and total shunt admittance of 10-3 mho. The 220 Kv with 0.8 lagging power factor. Find the sending end voltage, current, power and power factor using nominal pi method. **(13)**

12. Explain the classification of lines based on their length of transmission**.** **(7)**

13. What are ABCD constants? **(8)**

UNIT IV
INSULATORS AND CABLES

PART-A
(2 MARK QUESTIONS WITH ANSWERS)

1. What are the properties of insulators?

- High mechanical strength.
- High electrical resistance
- High relative permittivity
- High ratio of puncture strength
- The insulator material should be non-porous

2. What are the types of insulators?

- Pin type insulators
- Suspension insulators
- Strain insulators
- Shackle insulators
- Stay insulators

3. What are the advantages of suspension type insulator?

- Suspension type insulators are cheaper than pin type insulators
- Each unit or disc of suspension type insulator is designed for low

voltage
- If anyone disc is damaged the hole string does not affected
- Greater flexibility the line

4. Define string efficiency?

The ratio of voltage across the whole string to the product of number of discs and the voltage across the disc nearest to the conductor is known as string efficiency.

5. What are the methods of improving string efficiency?
- By using longer cross arms
- By grading the insulators
- By using a guard ring

6. What is mean by insulators?

The insulators provide necessary insulation between line conductors and supports and thus prevent any leakage current from conductors to earth.

7. What are the materials using in insulators?
- Porcelain
- Glass
- Synthetic resin

7. What is mean by annealing?

The glass also can be used instead of porcelain. The glass is made tough by heat treatment which is called annealing.

9. What are the advantages of glass insulators
- As transparent cracks bubbles and defects in the insulator can be easily detected by inspection
- The dielectric strength is very high
- Cheaper than the porcelain
- The resistivity is very high

10. What are the disadvantages of glass insulators?
- Chances of moisture condensation on the surface are higher so leakage current is high
- Less stronger than the porcelain
- High tension system
- Cannot be moulded in irregular shape.

11. What are the advantages of synthetic resin?

- High tensile strength
- The weight is low
- Cost is low

12. What is mean by self or mutual capacitance?

The porcelain portion which is an insulator is in between the two metal fittings. Thus it forms a capacitor. This is called self or mutual capacitance.

13. What is mean by shunt capacitance?

In transmission line towers in addition to the self-capacitance there will be capacitance between each metal fittings and the earth. i.e. tower the air act as an insulating medium such a capacitance is called shunt capacitance.

14. What are the advantages of suspension insulators?

- The voltage distribution is not uniform
- The charging currents through various mutual capacitors are varied
- Voltage across bottom insulator is high
- Electrical stress is high

15. What is mean by guard ring?

The transmission line tower a large metal ring surrounding the line unit and connected to the metal part of the bottom of the line unit is used. Such a ring is called guard ring.

16. What are the requirements of the cables?

- The size of the conductor used must be such that it should carry the specified load without overheating and keeping the voltage drop well within the permissible limits
- At the voltage level for which cables are designed the insulation thickness must be proper so as to provide high degree of safety and the reliability
- The materials used in the manufacturing of the cables must be such that there is complete chemical and physical stability throughout.

17. Write down the various parts of cables.

- Core
- Insulation
- Metallic sheath
- Bedding

- Armouring
- Serving

17. What are the types of cables?

- Low tension cable
- High tension cable
- belted cable
- super tension cable
- extra tension cable

19. What are the advantages of separate lead sheath cables?

- Due to individual lead sheath core to core fault possibility gets minimized
- The electrical stress are radial in nature
- Bedding of cable is easy
- Increases the current carrying capacity

20. What are the types of super tension cable?

- Oil filled cables
- Gas pressure cables

21. What are the advantages of oil filled cables?

- Thickness of insulation is less
- The thermal resistance is less
- The possibility of voids is completely eliminated
- Reduced earth fault

22. What are the disadvantages of oil filled cables?

- The initial cost is very high
- The long length is not possible
- The laying of cable is difficult
- Maintenance of cable is difficult

23. What are the advantages of gas pressure cables?

- Maintenance cost is small
- The nitrogen in the steel tube helps in quenching any fire or flame
- No reservoirs or tanks required
- The power factor is improved

24. What is mean by grading of cables?

The process of obtaining uniform distribution of stress in the insulation of cables is called grading of cables.

25. What is mean by capacitance grading?

The grading done by using the layers of dielectrics having different permittivity between the core and the sheath is called capacitance grading

26. What are the types of suspension type insulator?

- Cemented cap type
- Hewlett or inter linking type

27. What are the methods used to secure insulator to the bolt?

- The porcelain insulator has cement threads which are lined with a soft material like lead.
- The pin is screwed into such cement screw
- Solid lead screw is casted on the head of the pin and is screwed directly into the porcelain

27. What are the properties of insulating materials?

- It should be flexible
- To avoid electrical breakdown
- It should be non-inflammable
- It should have high temperature
- To prevent leakage current

29. What are the main insulating materials used?

- Poly vinyl chloride (PVC)
- Paper
- Cross linked polythene
- Vulcanized India rubber

30. What are disadvantages of gas pressure cable?

The only disadvantage of this cable is very high initial cost

PART-B
(13 MARK QUESTIONS)

1. Discuss any two methods to increase the value of string efficiency, with suitable sketches. **(13)**

2. Explain any two methods of grading of cables with necessary diagrams. **(13)**

3. What are different methods to improve string efficiency of an insulator? **(8)**

4. In a 3-unit insulator, the joint to tower capacitance is 20% of the

capacitance of each unit. By how much should the capacitance of the lowest unit be increased to get a string efficiency of 90%. The remaining two units are left unchanged. **(8)**

5. Derive the expression for insulator resistance, capacitance and electric stress in a single core cable. Where is the stress maximum and minimum? **(8)**

6. A single core 66kv cable working on 3-phase system has a conductor diameter of 2cm and sheath of inside diameter 5.3cm. If two inner sheaths are introduced in such a way that the stress varies between the same maximum and minimum in the three layers find: position of inner sheaths voltage on the linear sheaths maximum and minimum stress **(8)**

7. Draw the schematic diagram of a pin type insulator and explain its function. **(8)**

8. A 3 phase overhead transmission line is being supported by three disc insulators. The potential across top unit (i.e. near the tower) and the middle unit are 8kV and 11kV respectively. Calculate, the ratio of capacitance between pin and earth to the self-capacitance of each unit, Line Voltage, String Efficiency **(8)**

9, Describe with the neat sketch, the construction of a 3 core belted type cable**.** **(8)**

10. A conductor of 1cm diameter passes centrally through porcelain cylinder of internal diameter 2 cms and external diameter 7cms. The cylinder is surrounded by a tightly fitting metal sheath. The permittivity of porcelain is 5 and the peak voltage gradient in air must not exceed 34kV/cm. Determine the maximum safe working voltage. **(8)**

11. What are the various properties of insulators? Also briefly explain about suspension type insulators. **(8)**

12. Calculate the most economical diameter of a single core cable to be used on 132kV, 3 phase system. Find also the overall diameter of the insulation, if the peak permissible stress does not exceed 60kV/cm. also derive the formula used here. **(8)**

13. Briefly explain about various types of cables used in underground system. **(8)**

14. A string of 4 insulator units has a self-capacitance equal to 4 times the pin to earth capacitance. Calculate, Voltage distribution as a % of total voltage String efficiency **(8)**

15. Give any six properties of a good insulator. **(4)**

16. With a neat diagram, explain the strain and stay insulators. **(4)**

17. A cable is graded with three dielectrics of permittivity 4, 3 and 2. The maximum permissible potential gradient for all dielectrics is same and equal to 30 kV/cm. The core diameter is 1.5cm and sheath diameter is 5.5cm. **(8)**

18. Explain the constructional features of one LT and HT cable **(7)**

19. Compare and contrast overhead lines and underground cables. **(7)**

UNIT V
MECHANICAL DESIGN OF LINES AND GROUNDING

PART-A
(2 MARK QUESTIONS WITH ANSWERS)

1. What is substation?

Substation is the assembly of apparatus used to change some characteristics of electric supply.

2. Give the conditions of laying out a substation.

The conditions for laying out a substation are:

- It should be located at a proper site.
- It should provide safe and reliable arrangement.
- It should be easily operated and maintained.
- It should involve minimum capital cost.

3. Mention the classification of substation according to service.

According to service, substations are classified as,

- Transformer substations
- Switching substations
- Power factor correction substations
- Frequency changer substations
- Converting substations
- Industrial substations

4. List the classification of transformer substations.

Transformer substations are classified as,

- Step-up substation
- Primary grid substation
- Secondary substation
- Distribution substation

5. Define bus bar.

Busbar is defined as a conductor to which a number of circuits are connected

6. Give the materials mainly used in busbar?

The materials that are mainly used in bus bar are:

- Copper
- Aluminium

7. What are the factors to be considered for busbar design?

The factors to be considered for busbar design are:

- Material
- Cross section of conductors
- Temperature rise
- Distance between phase conductors
- Enclosure design

8. Which tests are necessary on station busbars?

The tests conducted on station busbars are:

- Temperature rise test
- Rated short time current test
- Rated momentary current test
- High voltage test

9. What is neutral grounding (or) neutral earthing?

The neutral point of star connected three phase winding of power transformers, generators, motors, earthing transformers are connected to low resistance ground. Such a connection is called neutral grounding (or) neutral earthing.

10. State the advantages of neutral grounding.

The advantages of neutral grounding are:

- Arcing grounds are reduced or eliminated
- The life of insulation is long
- Reduced maintenance, repairs and breakdowns
- Stable neutral point
- Improved service reliability
- Greater safety

11. Define earth resistance.

Earth resistance is defined as the resistance of the earthing electrode to the real earth and is expressed in ohms.

Earth resistance ER = V/I
Where,
V – Voltage between the electrode and the voltage spike
I – Injected current

12. What are the devices that are used for transferring D.C. power at the substation by using converting machinery?

The devices that are used for transferring D.C. Power at the substation by using converting machinery is:

- Mercury arc rectifier
- Rotary converters and
- Motor generator set

13. What is an interconnector?

The interconnector or inter connected network is a common development of simple ring system to reduce the power loss and voltage drop.

14. What is an interconnected system?

Interconnected system is a system in which the feeder ring is energized by two or more than two generating stations or substations.

15. Write the methods of earthing.

The methods of earthing are:

- Pipe earthing
- Plate earthing

Classify the connection schemes.

Classification of connection schemes are:

- Radial system
- Ring main system
- Interconnected system

16. List the disadvantages of D.C. Three wire distribution system.

Disadvantages of D.C. three wire distribution systems are:

- Three wires are required
- A balancer is required and as such the cost is increased
- The safety is partially reduced

17. Write the advantages of radial system.

The advantages of radial system are

- The initial cost is low
- Useful when the generation is at low voltage.

- Preferred when the station is located at the centre of the load.

17. Which factors affect sag in the transmission line?

- Weight of the conductor per unit length
- Span length
- Conductor tension
- Surrounding temperature

19. Define sag of a line?

The differences in level between the points of supports and the lowest point of the conductor are called as sag.

20. What are the types of bus bars used in substation?

- Single
- Single with sectionalized
- Double
- Main and transfer
- Double bus bars with bypass isolator

PART-B

(13 MARK QUESTIONS)

1. Explain the following: Neutral grounding Resistance grounding. **(13)**
2. Write short notes on AIS. **(13)**
3. Write short notes on GIS. **(13)**
4. Explain various methods of grounding. **(13)**
5. An overhead line has a span of 336 m. The line is supported, at water crossing from two towers whose heights are 33.6 m and 29 m above water level. The weight of conductor is 8.33 N/m and tension in the conductor is not to exceed 3.34 × 104 N. Find (i) Clearance between the lowest point on the conductor and water (ii) horizontal distance of this point from the lower support. **(13)**
6. Derive expressions for sag and tension in a power conductor strung between to supports at equal heights taking into account the wind and ice loading also**.** **(13)**
7. An overhead line has a span of 300m. The conductor diameter is 1.953 cm and the conductor weight is 0.844 kg/m. Calculate the vertical sag when a wind pressure is 736 N/sq.m of projected area acts on conductor. The breaking strength of conductor is 77990 N and the conductor should not exceed half the breaking strength**.** **(8)**
8. A transmission line conductor at a river crossing is supported from two towers at a height of 50 and 80 m above water level. The horizontal distance between the towers is 300 m. if the tension in the conductor is

2000 kg find the clearance between the conductor and water at a point midway between the towers. Weight of conductor/m = 0.844 kg. Derive the formula used. **(13)**

9. Derive the expressions for sag and conductor length under bad weather conditions. Assume Shape of overhead line is a parabola. **(13)**

10. Explain the design principles of substation grounding system and Grounding grids **(13)**

11. With the neat layout explain the design of modern substation with all protecting devices. **(13)**