TRANSMISSION LINE PARAMETERS
PART A

1. Write the transmission and distribution voltage levels in India. **APRIL/MAY 2015** (R8) **(or)** Mention the transmission voltages that followed in tamilnadu. **(May 2017)**

   The voltage levels in use in TNEB are 400KV, 230 KV, 110 KV, 66 KV,33 KV, 22 KV and 11 KV. In order to evacuate bulk power from one region to another region, there is a more scope for enhancing transmission capability to 765 KV level and setting up of 800 KV High Voltage DC system.

2. Write the various factors affecting the corona loss. **NOV/DEC 2011 (R8)**

   Corona loss depends upon numerous factors like system frequency, system voltage, air density; surface and size of conductor etc. .. When potential difference increase the electric field increases and therefore powerloss due to corona increases.

3. Differentiate between bundled conductors and stranded conductors. **NOV/DEC 2007**

Stranded conductors	Bundled conductors
Stranded conductors are composed of two or more elements of strands electrically in parallel with alternate layers spiralled in opposite direction to prevent unwinding.	A bundled conductor is a conductor made up of two or more sub-conductors and is used as single phase conductor. Bundled conductors are separated from each other by 30 cm or more and conductors of each phase are connected by connecting wires at particular length.
It is used for voltages less than 230 kV.	It is used for voltages above 230 kV.

4. Define ACSR.

   ACSR is aluminium conductor with steel reinforcement. This conductor is low tensile strength of aluminium conductors is made up by providing central strands of high tensile strength galavanised steel.such conductor is known as ACSR. Therefore this conductor reduces the corona losses and used in long transmission lines.

5. Explain the advantages of ACSR conductors when used for overhead lines.

   - Cheaper and lighter than copper.
   - Low density and low conductivity, which increases diameter of conductor.
   - Increases flexibility.

6. State the skin effect in transmission line .mention its effect on the resistance of the line. **(May 2017)** What is skin effect? **(Dec 2016)**

   Skin effect is the tendency for alternating current (AC) to flow mostly neat the outer surface of a conductor which causes non-uniform distribution of current. Thus the current

density is largest near the surface of the conductor and decreases with greater depth inside the conductor .the effect becomes more and more apparent as the frequency increases

Due to reduction in effective area of cross section offered to the follow of the current through the conductor, the resistance of the conductor increases.

7. State the different types of overheads conductors. **(May 2017)**
   - Hard drawn copper conductor
   - Steel cored copper conductor
   - Cadmium copper conductor.
   - Copper welded conductor.
   - All aluminium conductors.
   - Aluminium conductor with steel reinforcement
   - All Aluminium alloy conductor
   - ACAR conductor
   - Phosphor bronze conductor
   - Alumoweld conductor
   - Galvanized steel conductor
8. What are the advantages of bundled conductors ?**(Dec 2016)**
   - Increases the capacitance.
   - Increases the power capability of the line.
   - Reduces the voltage surface gradient.
   - Reduces corona loss.
   - Reduces radio interference.
9. What is transposition? Why are the transmission line transposed? **(Dec 2017)**
   Define transposition? **(May 2016)**
   Transposition is the periodic swapping of position of the conductors of a transmission lines, so that each conductor occupies the original position of every other conductor over a equal distance so as to achieve balance in the three phases
10. What is corona? **(May 2016)**
    When the potential difference is increased, a potential gradient is set up. If the potential gradient is above 30 kV/cm, the conductor gets ionized. The phenomenon of faint violet glow, hissing noise and production of ozone gas is known as corona.

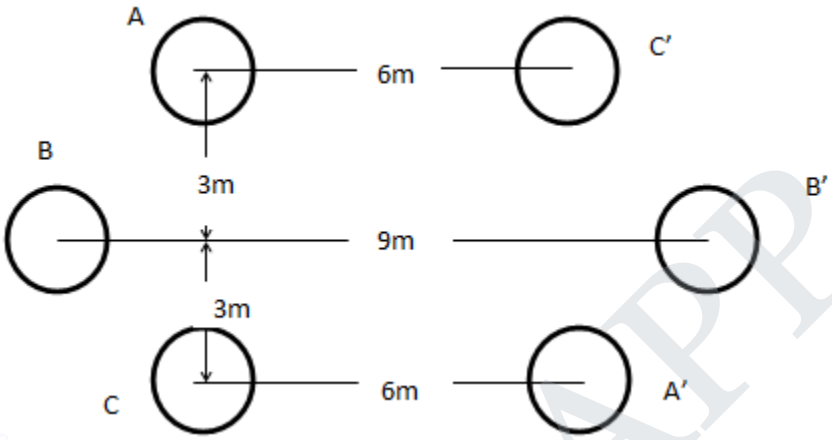
11. Define proximity effect on conductor? **(May 2015)**
    The alternating magnetic flux in a conductor caused by the current flowing in a neighboring conductor gives rise to circulating currents which cause non-uniformity of current and an apparent increase in the resistance of the conductor. This phenomenon is known as proximity effect.

12. Define the term critical disruptive voltage?**(Dec 2011, Dec 2013)**
    The potential difference between conductors, at which the electric field intensity at the surface of the conductor exceeds the critical value and occurs corona is known as critical disruptive voltage.
13. What are the factors affects the corona?
    The factors affecting the corona are;
    - Atmosphere.
    - Conductor size
    - Spacing between the conductors.
    - Line voltage.
14. Define visual critical voltage ?**(Dec 2009, May 2013)**
    Minimum phase to neutral voltage at which corna glow appears and visible all along the conductors is called visual critical voltage.
15. What are the factors depend upon the skin effect?
    The skin effect depends upon the following factors;
    - Nature of material.
    - Resistivity.
    - Frequency.
    - Conductor size.

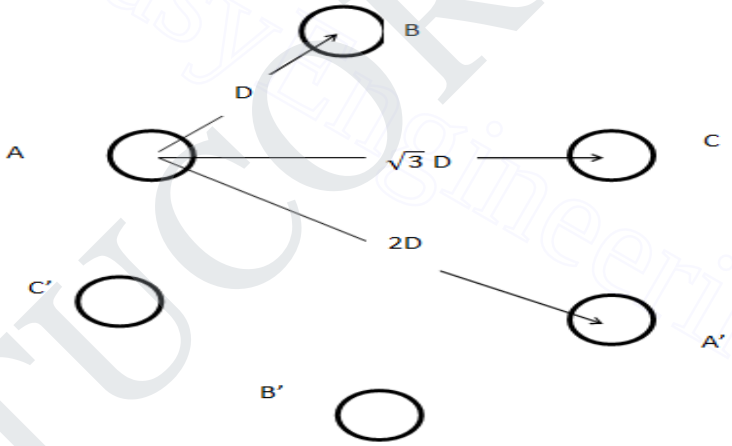
PART B

1. Draw and explain the structure of electric power system indicating the voltage level in each transmission levels. **MAY/JUNE 2011,12,13,14,16, NOV/DEC 2013, 2007**
2. Explain the following with respect to corona (i) corona (ii) effects of corona (iii) disruptive critical voltage (iv) visual critical voltage (v) corona power loss (vi) interference with neighboring communication circuits (vii) advantages, disadvantages and methods to reduce the effect of corona. **APRIL/MAY 2015 (R13, R8), NOV/DEC 2012, 13,16, MAY/JUNE 2013**
3. Derive the capacitance of a single phase and three-phase overhead line for symmetrical spacing. **MAY/JUNE 2013, 14 (R8)**
4. Deduce an expression for capacitance of three phase transmission line with unsymmetrical spacing. (Transposed conductors) **NOV/DEC 2012, 13,14,15, MAY/JUNE 2016**
5. Starting from fundamental derivation of flux linkages with conductor per phase **(derivation for loop inductance of a single phase system),** Derive the expression for the inductance per phase for a 3-phase overhead transmission system when conductors are symmetrically placed. **APRIL/MAY 2015 (R8), DEC -2015, 13.**
6. Derive an expression for the inductance per phase for a 3-phase overhead transmission system with unsymmetrical spacing. **MAY-13, NOV/DEC 2016**
7. Derive an expression for the inductance per phase for a 3-phase overhead transmission system with unsymmetrical spacing with transposed conductors.

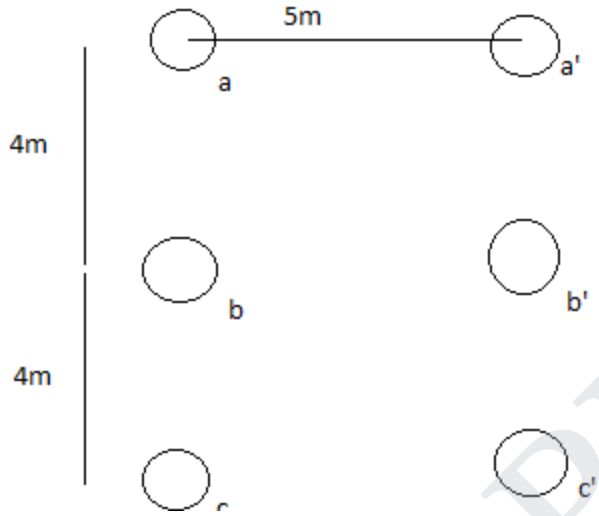
8. A three phase circuit line consists of 7/4.5 mm hard drawn copper conductors. The arrangement of the conductors shown in Fig. The line is completely transposed. Calculate inductive reactance per phase per km of the system. **APRIL/MAY 2015 (R13), NOV/DEC 2011,13 (R8), MAY/JUNE 2016**



9. If the double circuit 3-phase line in Fig. has conductors of diameter 2.5 cm and distance of separation (D) is 2m in the hexagonal spacing arrangement, calculate the phase-to-neutral capacitance in µF per 100km of the line. **APRIL/MAY 2015 (R8)**



10. A 3-phase 80km long transmission line has its conductor of 1.0 cm diameter spaced at the corners of the equatorial triangle of 100 cm side. Find the inductance per phase of the system. **APRIL/MAY 2015 (R8)**
11. Estimate the corona loss for a three-phase, 110Kv, 50Hz, 150Km long transmission line consisting of three conductors each of 10 mm diameter and spaced 2.5m apart in a equatorial triangle formation. The temperature of air is $30^0 C$and the atmospheric pressure is 750mm of mercury. Assume the irregularity factor as 0.85. Ionization of air may be assumed to take place at a maximum voltage gradient of 30Kv/cm. **MAY/JUNE 2014 (R8)**
12. Determine the capacitance/ phase of the double circuit line as shown in the fig. the diameter is 2.1793cm.



UNIT II
MODELLING AND PERFORMANCE OF TRANSMISSION LINES
PART A

1. **How are transmission lines classified ?[Nov 2017]**

Based on the line length and voltage, the overhead transmission lines are classified as

- Short transmission lines (length > 80km , voltage >20kV)
- Medium transmission line (length <80km and > 200km, voltage<20kV and >100kV)
- Long transmission line(length <200km , voltage <100kV)

2. **How are transmission lines classified ?[Nov 2017]**

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3. **What is Ferranti effect? [Nov 2017] [May 2017][May 2015]**

Define Ferranti effect? [May 2016]

In long transmission lines, receiving end voltage is greater than sending end voltage during light load or no-load operation. Under no load or light, the capacitance associated with the line generate more reactive power than the reactive power which is absorbed, hence $V_R > V_S$. This effect is known as Ferranti effect.

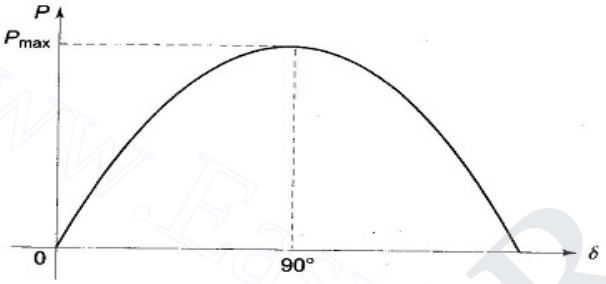
4. Write down the significance of SIL on transmission line. [May 2017]
Mention the significance of surge impedance loading. [May 2016]

- The surge impedance loading of a line is defined as the power delivered by a line to a pure resistive load equal to its surge impedance.
- SIL is also called as natural power of the line
- The permissible loading of a transmission line can be expressed as a fraction of its SIL and provides a comparison of load carrying capabilities of lines

5. State the condition for maximum power delivered and draw the power angle diagram.

[Nov 2016]

The maximum power delivered when power angle ∂=90 degree



6. Mention the various methods of voltage control transmission lines. [Nov 2016] NOV/DEC 2011 (R8)

Voltage control of transmission lines can achieved following methods

- Use of series capacitors
- Use of shunt capacitors
- Use of static VAR sources
- Use of shunt reactors
- Tap changing transformer

7. Define transmission efficiency. [Nov 2015]

The transmission line efficiency is defined as the ratio of power at the receiving end to the power at sending end.

% transmission efficiency = $(P_R) / (P_S) *100$

Where P_S – Sending end voltage

P_R – Receiving End Voltage

8. Write the formula for finding surge impedance of transmission line. [Nov 2015]

$Z_c = \sqrt{Z/Y} = \sqrt{L/C}$ is pure resistance.

$P_R = |V_{RL}|^2/Z_c$

Where V_{RL} = Line voltage at the receiving end.

Z_c = Surge impedance = $\sqrt{L/C}$.
P_R = Surge impedance loading.

9. What is the importance of voltage control.[May2015]

The voltage variation from generation station to consumer end are undesirable and suppliers are required to maintain the voltage at prescribed limit so that voltage control are important in transmission lines

10. Define voltage regulation in connection with transmission line. MAY/JUNE 2014, NOV/DEC 2013, 2012.

Regulation of a transmission line is defined as the change in voltage at the receiving end,from no load to full load, the sending end voltage remaining the same.
Mathematically it can be expressed as,
% Regulation = $(V_S - V_R) / V_R * 100$
Where V_S – Sending end voltage
V_R – Receiving End Voltage

11. How the capacitance effects are taken into account in a long transmission line?

Long transmission lines have length > 250km and operate at voltage higher than 100 kV the effects of capacitance cannot be neglected. Therefore in order to obtain reasonable accuracy in long transmission line calculations, the capacitance effects must be taken into account.

12. Define attenuation constant. NOV/DEC 2011

The real part of the propagation constant is α. It determines the change in magnitude per unit length of the line of the wave is termed as attenuation constant. It is expressed in nepers per unit length

13. Define propagation constant. NOV/DEC 2011

The magnitude and the phase of a travelling wave is governed by the complex quantity γ. In other wards γ governs the propagation of component wave.
Propagation constant $\gamma = \sqrt{ZY} = \alpha + j\beta$
Where α = Attenuation Constant
β = Phase Constant.

14. What is the use of power circle diagram?

The use of power circle diagram is to determine the maximum power that can be transmitted over the line both at the receiving and the sending end.

15. What are the main objectives of compensation?

The main objectives of compensation are

- To improve the system stability.
- To produce substantially flat voltage profile.
- To meet economically way for reactive power requirement.
- To increase power transfer capability.

16. What are the devices used for compensation of transmission lines?

The devices used for compensation of transmission lines are

- Shunt reactor.
- Shunt capacitor.
- Static VAR system.
- Synchronous condensers.
- Series capacitors

.

17. What is shunt compensation?

Shunt reactors are used to compensate for the undesirable voltage effects associated with line capacitance. The amount of reactor compensation required to maintain the receiving end voltage at the specified value.

PART B

1. A balanced three phase load of 30Mw is supplied at 132kV, 50 Hz and 0.85 p.f. lagging by means of transmission line. The series impedance of a single conductor is (20+j52) Ω and the total phase neutral admittance is 315 x $10^{-6} Siemen$. Using nominal T method, Determine (i) A, B, C and D constants of the line (ii) sending end voltage (iii) regulation of the line. **APRIL/MAY 2015 (R13)**
2. Explain the real and reactive power flow in lines. Also explain the methods of voltage control. **APRIL/MAY 2015 (R13), NOV/DEC 2011, 2015,16**
3. (i) Explain the classification of transmission lines with their characteristics. (6m) **NOV/DEC 2014 (R8)**
   (ii) Define the following:
   (1) Surge impedance
   (2) Attenuation constant
   (3) Voltage regulation
   (4) Transmission efficiency
   (5) Concept of surge impedance loading. **NOV/DEC 2012,13 (R8)**
4. Perform the analysis of long transmission line using RIGOROUS method. **NOV/DEC 2012 (R8)**
5. What is power circle diagram? Explain the method of drawing sending end and receiving end power circle diagram **MAY/JUNE 2014 (R8), APRIL/MAY 2015 (R8)**
6. Draw the nominal T circuit of a medium length transmission line and derive expressions for sending end voltage and current. Also draw the respective phasor diagram. **NOV/DEC 2015**
7. Draw the nominal π and end condenser circuit of a medium length transmission line and derive expressions for sending end voltage and current. Also draw the respective phasor diagram. **MAY/JUNE 2013**

8. A 3-phase, 50Hz power transmission line has line resistance of 30 Ω and inductive resistance of 70 Ω per phase. The capacitive susceptance is 4 x 10^{-4} mho per phase. If the load at receiving end is 50 MW at 0.8 pf lagging with 132kV line voltage, calculate (i) sending end voltage and current (ii) regulation and (iii) efficiency (iv) p.f. of the line for this load. Use nominal π method. **APRIL/MAY 2015 (R8), NOV/DEC 2016, MAY/JUNE 2012**
9. A 50Hz, three-phase transmission line is 250Km long. It has a total series impedance of (40+j100) ohms and a shunt admittance of 914 x 10^{-6} ohms. It delivers 50MW at 220KV with a power factor of 0.9 lag. Find the :
   (i) Sending end voltage and current
   (ii) Sending end power factor
   (iii) Voltage regulation
   (iii) Transmission efficiency by nominal-T method. **MAY/JUNE 2014 ,16**
10. The constants of three phase line are A=0.91 and B= 140 ohms/ phase. The line delivers 60 MVA at 132kV and 0.8 pf lagging. Draw power circle diagrams and find **(a)** sending eng voltage and power angle **(b)** the max power which the line can deliver with the above values of sending and receiving end voltages **(c)** sending end power and pf **(d)** line losses **MAY/JUNE 2016**
11. A balanced 3 phase load of 30MW is supplied at 132 kV, 50 Hz and 0.85 P.F lagging by means of transmission line. The series impedance of a single conductor is (20+j52) ohms and the total phase-neutral admittance is 315 x 10^{-6} mho. Using nominal –T method , determine:
   (i) The A, B, C and D constants of the line.
   (ii) Sending end voltage.
   (iii) Regulation of the line. **NOV/DEC 2011 (R8)**
12. A three phase, 50Hz transmission line, 40km long delivers 36 MW at 0.8 power factor lagging at 60KV (phase). The line constants per conductor are R = 2.5 Ω, L = 0.1 H, C = 0.25 μF. Shunt leakage may be neglected. Determine the voltage, current, power factor, active power and reactive voltamperes at the sending end. Also determine the efficiency and regulation of the line using nominal π mehod. **NOV/DEC 2013(R8)**
13. A 15km long 3 phase overhead line delivers 5MW at 11 kv at 0.8 lagging p.f. line loss is 12% of power delivered. Line inductance is 1.1 mH/km/phase. Find the sending end voltage and regulation. **DEC-2012**

UNIT III

UNIT III MECHANICAL DESIGN OF LINES

PART A

1. What are the desirable properties of insulators? [Nov 2017]

The properties of an insulator are;

- It should be mechanically strong to bear the conductor load.

- It should have high dielectric strength.
- High ratio of puncture strength to flash over voltage.
- It should be non-porous.

It should not affected by the changes in the temperature.

2. Specify the different types of insulator? [may 2017]

The different types of insulators used for overhead lines are;

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

3. What are the methods of improving string efficiency in line insulators? [nov 2016]

The methods for improving string efficiency are;

- By reducing the value of K
- By grading of insulators.
- By using guard ring or static shielding.

4. What are the tests performed on the insulators? [May 2016]

The following tests are performed on insulators:

1. Mechanical tests
2. Electrical insulation tests
3. Environmental tests
4. Temporary cycle tests
5. Corona and radio interference tests

5. Define string efficiency. [nov 2015]

String efficiency is defined as the ratio of total voltage across the string to the product of number of units and the voltage across the unit adjacent to the line conductor. Mathematically it can be expressed as,

$$\text{String efficiency} = \frac{\text{Voltage across the string}}{(\text{Number of insulators}) \times (\text{Voltage across the unit nearest to the line conductor})}$$

6. What is the purpose of insulator? [may2015]

Insulators are the elements which provide necessary insulation between line conductors and supports and thus prevent any leakage current from conductors to earth.

7. What is meant by tower spotting? [nov 2015]

The art of locating structures of towers in a right way and selecting their type and height so as to meet all the necessary electrical requirements is called tower spotting. The sag template is used for tower spotting.

8. What is meant by sag template? [nov 2015]

For normal spans and for standard towers, the sag and the nature of the conductor curve are calculated under expected load conditions and plotted on a thin stiff plastic sheet. Such a graph is called sag template.

9. What are the materials mainly used in bus bars? [may2015]

The bus bars are either rigid type or strain type.

- For rigid type bus bars, copper or aluminium bars are used. Such bars are used for low and medium voltage levels.
- For strain type bus bars mainly stranded aluminium (ACSR) conductors are used which are supported by strain insulators. The strain type bus bars are used for high voltage levels.

PART B

1. What are various properties of insulators? Also briefly explain various types of insulators (suspension type and pin type are important). Draw the schematic diagram. Compare their merits and demerits. **APRIL/MAY 2015 (R13), MAY/JUNE 2012, 14 (R8), NOV/DEC 2014,2016**
2. Define string efficiency of suspension insulator string. List the methods to improve it. **APRIL/MAY 2015, NOV/DEC 2012, 15,16, MAY/JUNE 2013, 16**
3. What is sag-template? Explain how this is useful for location of towers and stringing of power conductors? Explain the factors affecting sag. **NOV/DEC 2013 (R8), NOV/DEC 2014 (R8)**
4. Deduce an approximate expression for sag in overhead lines when supports are approximated by a parabola. How can the effect of wind and ice loading be taken into account? **NOV/DEC 2013 (R8), NOV/DEC 2015**
5. Derive an expression for sag of a line supported between two supports of the different height. **NOV/DEC 2012 (R8)**
6. Explain in detail about the types of towers.
7. A transmission line has a span of 275 m between level supports. The conductor has effective diameter of 1.96 cm and weights 0.865 kg/m. Its ultimate strength is 8060 kg. If the conductor has ice coating of radial thickness 1.27 cm and is subjected to a wind pressure of 39kg/m^2 of projected area, calculate the maximum sag. Assume that the safety factor is 2 and ice weighs 910 kg/m^3 **NOV/DEC 2014 (R8), MAY/JUNE 2016**
8. An overhead line has a span of 150m between level supports. The conductor has a cross sectional area of 2 cm^2. The ultimate strength is 5000 kg/cm^2 and safety factor is 5. The

specific gravity of the material is 8.9 gm/cc. The wind pressure is 1.5 kg/m. calculate the height of the conductor above the ground level at which it should be supported if a minimum clearance of 7 m is to be left between the ground and the conductor. **APRIL/MAY 2015 (R8)**

9. A transmission line conductor at a river crossing is supported from two towers at a height of 50 and 80 meters above water level. The horizontal distance between the towers is 300 meters. 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 per meter = 0.844 kg. Derive the formula used. **NOV/DEC 2011,16, APRIL/MAY 2015 (R8)**

UNIT IV

UNDER GROUND CABLES

PART A

1. **Mention any four materials used for underground cables. [Nov 2016]**

   Various insulating materials used in cable construction are Rubber, Paper & PVC.

2. **Define grading of cables. (Dec 2004,Dec 2010, Dec 2012)**

   The process of achieving uniform electrostatic stress in the dielectric of the cables is called grading of cables.

3. **What is the main purpose of armouring ? (may2015)**

   It provides protection to the cable from mechanical injury. It consists of layers of galvanized steel wires.

4. **Give the relation for insulation resistance of a cable.(Dec 2003,2006,2009, May 2013)**

   Insulation resistance of a single core cable is given by,

$$R_{ins} = \frac{\rho}{2\pi l} * \ln(R/r) \quad \Omega$$

   r =diameter of core
   R =diameter of sheath
   l =length of cable

5. **What is dielectric stress?(May 2014)**

   The insulation of a cable is subjected to electrostatic force under operating conditions is known as dielectric stress.

6. **Classify the cables used for three phase service. [may 2016]**

   - Low tension (L.T) cables used up to 6.6 KV
   - Medium and high tension (H.T) cables up to 66 KV

   The H.T. cables are further classified as :

- Belted cables up to 11 KV
- Screened cables for 22 and 33 KV
- Pressure cables from 33 KV to 66 KV also called extra high tension cables
- Super tension (S.T.) cables for 132 KV to 275 KV which are further classified as
- Oil filled cables
- Gas pressure cables

7. **What is belted cables?[Nov 2017]**
   These types of cables used for the voltage levels up to 11kV. Here the cores are insulated from each other by use of impregnated paper and grouped together with paper belt.

PART B

1. Define Grading of cables. Discuss the capacitance grading and intersheath grading of underground cables. **MAY/JUNE 2013,14,16 (R8), NOV/DEC 2012**
2. Derive an expression for capacitance of a single core and three core cables. **NOV/DEC 2013, 14 (R8)**
3. Describe the general construction of an underground cable with a neat sketch. And also explain the types of underground cables. **APRIL/MAY 2015 (R8), NOV/DEC 2011, 12, 13 (R8)**
4. **(i)** Explain any four insulating materials used in manufacturing of cables. **NOV/DEC 2015**
   (ii) A string of eight suspension insulators is to be graded to obtain uniform distribution of voltage across the string. If the capacitance of the top unit is 10 times the capacitance to ground of each unit, determine the capacitance of the remaining seven units. **NOV/DEC 2015**
5. In a 3 unit insulator, the joint to tower capacitance is 20% of the capacitance of earth 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. **APRIL/MAY 2015 (R13)**
6. Each line of a 3-phase system is suspended by a string of three identical insulators of self-capacitance C farad. The shunt capacitance of connecting metal work of each insulator is 0.2 C to earth and 0.1 C to line. Calculate the string efficiency of the system if a guard ring increases the capacitance to the line of metal work of the lowest insulator to 0.3 C. **NOV/DEC 2014 (R8), APRIL/MAY 2015 (R8)**
7. An insulating string for 66KV lines has 4discs. The shunt capacitance between each joint and metal work is 10% of the capacitance of each disc. Find the voltage across the different disc and string efficiency. **NOV/DEC 2013 (R8)**
8. A 3 phase overhead transmission line is being supported by three disc insulators. The potential across top unit and middle unit are 9 kV and 11 kV respectively. Calculate (i) the ratio of capacitance between pin and earth to the self-capacitance of each unit. (ii) The line voltage and (iii) string efficiency. **NOV/DEC 2011 (R8)**

9. A three unit insulator string is fitted with a guard ring. The capacitance of the link pins to metal work and guard ring can be assumed to be a 15% and 5 % of the capacitance of each unit. Determine voltage distribution at each unit and string efficiency. **MAY/JUNE 2013,16**
10. A string of five insulator units has mutual capacitance equal to 10 times the pin to earth capacitance. Find voltage distribution across various units as the percentage of the total voltage across the string and string efficiency. **NOV/DEC 2016**
11. A 2km long 3 core cable has capacitance of 0.5mF/km between two conductors bunched with sheath and the third conductor. The capacitance between the conductors is also measured when bunched together and the sheath and found to be 0.75mF/km. Determine. (i) Capacitance between phases. (ii) Capacitance between the conductor and the sheath (iii) Effective per phase Capacitance (iv) Capacitance between two conductors connecting a third conductor to be sheath. (v) Charging current if the supply voltage is 11kV, 50Hz. **NOV/DEC 2016**
12. An insulator string consists of three units, insulator nearest to the line having a safe working voltage of 20kV. The ratio of self to shunt capacitance is 6:1. Find the line voltage and string efficiency. **MAY/JUNE 2012**

UNIT V

DISTRIBUTION SYSTEMS

PART A

1. List out the advantages of high voltage A.C. transmission. **MAY/JUNE 2016, NOV/DEC 2011 (OR)** Why is electrical power preferable to be transmitted at high voltage? **(May 2015)**
    - The volume of copper required is less at high voltage level
    - The efficiency is higher
    - Line drop becomes less
    - The power handling capacity of line increases
    - The total line cost per MW per km decreases
2. Define the terms feeders and Distributors. **APRIL/MAY 2015, NOV/DEC 2012, 16, NOV/DEC 2011,12, (May 2015)**
    - The feeders are the conductors which are of large current carrying capacity. The feeders connect the substation to the area where power is to be finally distributed to the consumers
    - Distributors are the conductors used to transfer power from distribution centre to the consumers
3. What are the objectives of FACTS? **(Dec 2017) MAY-2010**
    - The power transfer capability of transmission system is to be increased
    - The power flow is to kept over the designated routes.

4. What is ring main system?**(May 2017)**
   In this system the feeders covers the whole area of the supply in the ring fashion and finally terminates at the substations from where it is started .the feeders is in closed loop form and looks like a ring hence the name given to the system is ring main distribution system.
5. What is interconnected system?**(Dec 2017)**
   When a ring main system is supplied by two or more than two generating stations then it is called interconnected system.
6. State the application of HVDC transmission. **(Dec 2016)**
   - Long distance bulk power transmission, for connecting two different areas for exchange of power.
   - Power transmission through underground or submarine cables.
   - Connect D.C. transmission with A.C. distribution systems.
   - Control and stabilization of power flow in A.C. ties in an integrated power system.
7. What is meant by STATCOM? **(May 2007 ,May 2008)**
   STATCOM is a static synchronous generator operated as a shunt-connected static VAR compensator (SVC) whose capacitive or inductive output current can be controlled independently of the A.C. system voltage.
8. List out various devices used in FACTS. **(May 2006 Dec 2008)**
   - Static VAR compensators (SVC).
   - Thyristor controlled series compensator.
   - Thyristor switched series capacitors and reactors (TCSC).
   - Static Condensers (STATCOM).
   - Unified power flow control (UPFC).
9. Give any three HVDC lines in India.**(May 2004, Dec 2008)**
   - Rihand – Delhi HVDC transmission system.
   - Talcher – kolar HVDC transmission system.
   - Chandrapur – Padghe HVDC transmission system.
10. What is service mains?**(May 2005,Dec 2011)**
    Electrical power service is provided to a consumer from the distribution feeder through/at the service main.
11. Explain the term regional grid?(**Dec 2007)**
    The interconnected transmission system of a state or a region is called the grid of state or region. State grids are interconnected with the help of tie lines and form the regional grid.
12. Mention the types of HVDC links .**(Dec 2005, May 2013**)
    - Monopolar HVDC
    - Bipolor HVDC
    - Homopolor HVDC
    - Back to back HVDC coupling

- Multi terminal HVDC

13. Why transmission lines are 3 phase 3 wire while the distribution lines are 3 phase 4 wire circuit?**(Dec 2013)**
    - The transmission is at very high voltage level and such a balanced 3 phase system does not required neutral conductor.
    - For distribution it is necessary to supply single phase loads long with the three phase loads. For single phase distribution a neutral conductor is must.
14. **What are the major equipments of substation? [nov 2017]**

The various substation equipments are;

- Transformers.
- Circuit breakers.
- Isolators.
- Load break switch.
- Instrument transformers.
- Current transformers.
- Potential or Voltage transformers
- Busbars
- Protective relays
- Lightning arresters or surge arresters.
- Earthing switch.
- Shunt capacitors.
- Earthing
- Station battery and charging equipment.

15. **Enlist any two factors that affect the sag in transmission line. [may 2017] (or)**
What are the factors that affect the sag in transmission line? [nov 2016]

The two important atmospheric factors affecting the sag in transmission line are,

- Ice coating on the conductor which increases the weight of conductor.
- Wind pressure due to which the conductor gets subjected to the additional forces

Apart from these two factors the span, weight of conductors and the tension in the conductor also affect the value of sag.

16. **Write down the types of grounding. [may 2017]**

The types of grounding are

- Solid or effective grounding
- Resistance grounding
- Reactance grounding
- Resonant grounding

17. **What is the need of earthing ? [nov 2016]**
    - To ensure that live parts should not assume a potential which is dangerously different from that of surroundings.
    - To allow sufficient current to flow safely for proper operation of protective devices like circuit breakers, etc.

- To limit overvoltage's between neutral and ground and between line and ground.
- To suppress dangerous potential gradients.

18. **Define sag. [may 2016]**
    - When a conductor is suspended between two points then it takes the shape of parabola or catenary and sags down.
    - The difference in levels between the point of support and the lowest point on the conductor
19. **What is meant by string chart? [may 2016]**
    Give the significance of string chart? [nov 2017]
    - The tension at the time of erection of a transmission line is given by a cubic equation hence it is time consuming to solve such equation.
    - Instead of solving such a equation the graph of tension in kg against the temperature in ^{0}C and the graph of sag in meters against the temperature in ^{0}C is obtained.
    - Such graphs are called stringing chart.
20. **What is substation?**
    Substations are the point in the power network where transmission lines and distribution feeders are connected together through circuit breakers or switches namely busbars and transformers.
21. **How will you select an ideal location for a distribution substation?**
    Distribution substations are connected between primary distribution and secondary distribution. The primary distribution voltages such as 11kV or 6.6kV are to be stepped down to the supply voltage. These substations transfer power to the consumers through distributors and service mains.
22. **What is the role of circuit breaker in power system?**

    When a fault occurs in the bus bar the relay sense the fault and gives command signal to the circuit breaker. The circuit breakers disconnect and isolate the faulty section thereby protecting the equipments.

23. **Write down the difference between disconnector switch and isolator.**

    Whenever maintenance or repair work is to be carried out on equipment in a substation, it is disconnected from the supply by the isolators. It is operated under no load. Isolators are interlocked with circuit breakers and earthing switches. To open isolators, circuit breakers are to be opened first.

24. **What are the classifications of substation according to the service? [may2015]**
    According to service, the substations are classified as:
    - Transformer substations

    These are further classified as

    - Transmission or primary substation

- Sub transmission or secondary substation
- Step down or distribution substation

- Industrial substations
- Switching substations
- Synchronous substations
- Frequency change substations
- Converting substations

PART B

1. Discuss in detail about substation layout GIS and AIS. **MAY/JUNE 2012**
2. write short notes on :
   (i) Sub mains
   (ii) Stepped and tapered mains
   (iii) Grounding grids **APRIL/MAY 2015 (R13), NOV/DEC 2012 (R8)**
3. Explain the following:
   (i) Neutral grounding
   (ii) Resistance grounding
   (iii) Resonant grounding
   (iv)Reactance earthing. **APRIL/MAY 2015, MAY/JUNE 2013, 16, NOV/DEC 2015,16**
4. Discuss in detail the advantages and disadvantages and application of HVDC transmission. **APRIL/MAY 2015 (R13), NOV/DEC 2016**
5. Explain with a neat layout the modern EHV system. What is the highest voltage level available in India for EHV transmission? Also discuss the advantages of EHVAC. **NOV/DEC 2012,13, APRIL/MAY 2015 (R13)**
6. Discuss in detail the problem associated with EHV AC transmission. State how these problems are being solved. Also explain the effect of high voltage on volume of copper and on efficiency. **NOV/DEC 2013, 14, 16, MAY/JUNE 2012**
7. What are the various types of HVDC links? Explain them in detail. **NOV/DEC 2011,12,16, MAY/JUNE 2008,10,13, 16**
8. List out the adjectives of FACTS. What are the basic types of FACTS controllers? And explain about FACTS controllers. **NOV/DEC 2012,13, 14 (R8), MAY/JUNE 2010,12,16**
9. Discuss the various FACTS devices. **DEC 09, MAY-12, MAY/JUNE 2012**
10. Explain the following system of distribution: **APRIL/MAY 2015 (R13), 11**, **NOV/DEC 2010,12,13**
    (i) Radial system
    (ii) Ring main distribution system/ Ring main distributor
    (iii) Interconnected system
    (iv) Design consideration in distribution system.

(v) Stepped (or) tapered distributor
(vi) DC distributor fed at one end
(vii) DC distributor fed at both ends.

(Question no. 9 covers also the explanation of types of AC and DC distributors)

11. **(i)** Derive suitable expressions, draw current loading diagram and voltage drop diagram for uniformly loaded distributor of length 'l' fed at one end. How is power loss in the whole distributor computed? **NOV/DEC 2015,16**

    (ii) A uniform two wire DC distributor 250m long is loaded with 0.4 A/m and is fed at one end. If the maximum permissible voltage drop is not to exceed 10V, find the cross sectional area of the distributor conductor. Take $\rho = 1.78*10^{-8}$ Ωm. **NOV/DEC 2015**

12. **(i)** Consider a distributor loaded with uniform loading of i ampere/m run and are fed from two end feeding points at different voltages. Find the point of minimum potential occurrence in the distributor. **NOV/DEC 2015**

    (ii) A 800m long, two wire DC distributor fed from both ends, is loaded uniformly at the rate of 1.2A/m run. If the resistance of the distributor is 0.1 Ω/km (go and return) and feed points are maintained at 245V and 240V respectively. Calculate the min voltage, its point of occurrence and current supplied from two feeding points. **NOV/DEC 2015**

13. A two wire dc ring main distributor ABCDEA is fed at point A with 230V supply. The resistance of go and return conductors of each section AB,BC,CD,DE,AE are 0.1 ohm. The main supplies the loads of 10A at B, 20A at C, 10A at D, 30A at E. find the voltage at each load point. **MAY/JUNE 2016**