Unit-4 INSULATORS AND CABLES

**Session 1- Introduction: Role of insulators in power systems**

**Quiz**

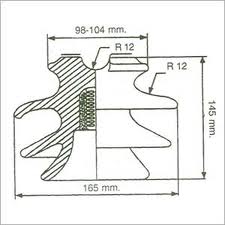
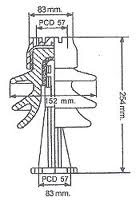
1. What is the role of insulators?
2. What are the types of insulators?
3. What is voltage regulation?
4. Define transmission efficiency

Ref: <http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html>

Presentation

Giving detailed explanation of insulators on a transmission line

Insulators are used in electrical equipment to support and separate electrical [conductors](http://en.wikipedia.org/wiki/Electrical_conductor) without allowing current through themselves. An insulating material used in bulk to wrap electrical cables or other equipment is called *insulation*. The term *insulator* is also used more specifically to refer to insulating supports used to attach electric power [distribution](http://en.wikipedia.org/wiki/Electric_power_distribution) or [transmission](http://en.wikipedia.org/wiki/Electric_power_transmission) lines to [utility poles](http://en.wikipedia.org/wiki/Utility_pole) and [transmission towers](http://en.wikipedia.org/wiki/Transmission_tower).



Board activity

Drawing the different conductor configuration for performance analysis

Ref; <http://www.cvel.clemson.edu/Emc/calculators/TL_Calculator/index.html>

**session 2- types of insulators**

**Quiz**

1. Write the expression for voltage distribution in insulator string.
2. What are the types of insulators?
3. What are the parameters affecting inductance?
4. Classify the transmission line arrangements

Ref: <http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html>

Presentation

Detailed description on types of insulators

Draw and explain the types of insulators

Types of insulator:

1.pin type insulator

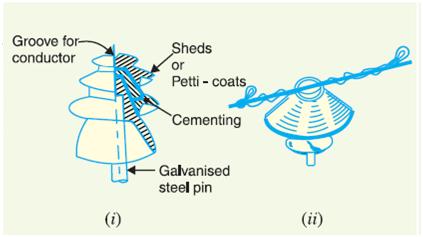
2.suspension type insulator

3.shackle type insulator

4.strain insulators

Board activity

Drawing the different types of insulators.



Ref: http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html

Session 3- Effect of uniform voltage distribution along the string

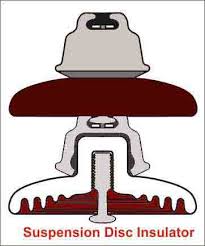
Quiz

1. What is voltage distribution?
2. List the components of flux linkages in a conductor

Ref: <http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html>

Presentation

Give detailed explanation about voltage distribution on insulators



Board activity

Deriving the expression

V2 = (1+m) V1  
V3 = (1+3m+m2) V1  
V4 = (1+6m+5m2+m3) V1  
Vph = V1+V2+V3+V4

Ref: <http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html>

**Session 4- Tutorial on voltage distribution**

**Quiz**

1. What is voltage distribution?
2. Effects of voltage distribution
3. Ways to reduce voltage drop.

Ref: <http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html>

Presentation

Giving detailed explanation on calculation of voltage distribution

Voltage distribution

Vph = V1+V2+V3+V4

Where v1,v2,v3 are the voltages across the conductors

Board activity

Solving a problem

Ref: <http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html>

**Session 5- Tutorial on improvement of string efficiency**

**Quiz**

1. What is string efficiency?
2. Factors affecting string efficiency

Ref: <http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html>

Presentation

Discuss detailed explanation about string efficiency

STRING EFFICIENCY:

string efficiency refers to the efiiciency of the string which is an assembly of two or more number of insulation disc used between the tower and conductor .   
it is given by the formula ,   
  
 string efficiency = voltage across the string / number of disc in the string \* voltage   
across the disc nearest the string

Board activity

Problems are solved on board by the students

Ref: <http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html>

**Session 6- Underground cables - constructional features of LT cable**

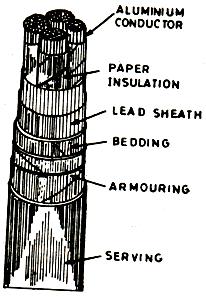
**Quiz**

1. What are underground cables?
2. What are the types of underground cable?

Ref: <http://www.technoend.com/what-is-transposition-of-electrical-transmission-line/>

Presentation

##### GENERAL CONSTRUCTION OF A CABLE



Board activity

Draw the diagram of the underground cable.Ref: <http://www.skm-eleksys.com/2011/03/transmission-line-parameters-resistance.html>

**session 7- Underground cables - constructional features of HT cables**

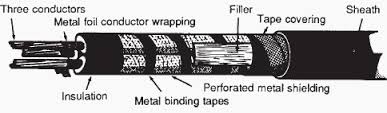
**Quiz**

1. What are the parts in the underground cable?
2. Define cable.

Ref: <http://www.electrical4u.com/abcd-parameters-of-transmission-line/>Presentation

Presentation

Discuss about constructional features of underground cable



Board activity

Diagram are drawn by the student

Ref: <https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&ved=0CDoQFjAD&url=http%3A%2F%2Fwww.ee.lamar.edu%2Fgleb%2Fpower%2FLecture%252009%2520-%2520Transmission%2520lines.ppt&ei=Bu8yUt6tD8SPrgeGyYBA&usg=AFQjCNEio_CEVpfccS3Bd6rFmVfTO94DMQ>

**Session 8- Insulation resistance**

**Quiz**

1. What is insulation resistance?
2. Factors affecting sending end voltage
3. ABCD constants

Ref: <http://www.researchgate.net/post/What_is_the_real_interpretation_of_ABCD_parameters_for_transmission_line>

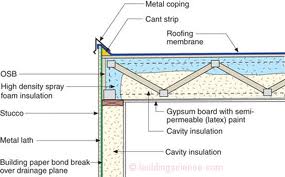
Presentation

Insulation resistance of a small length d*x* due to leakage current

where, *R*i is the resistance of the insulation

*R* is the radius of the cable

*r* is the radius of the core



Board activity

Deriving expression for insulation resistance

Ref: [www.egr.unlv.edu/~eebag/TRANSMISSION%20LINES.pdf](http://www.egr.unlv.edu/~eebag/TRANSMISSION%20LINES.pdf)

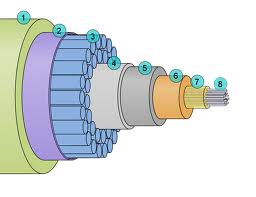
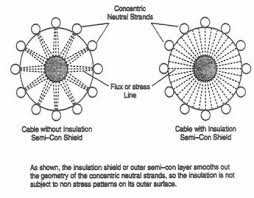
**Session 9- Capacitance of an underground cable**

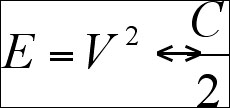
**Quiz**

1. What are the components of reactive power?
2. Effects of non optimized reactive power flow
3. Definition for reactive power

Ref: <http://electrical-engineering-portal.com/the-need-for-reactive-power-compensation> Presentation

Giving detailed explanation on capacitance on underground cable



Board activity

Deriving expression for capacitance on cables

Ref: <http://www.alstom.com/grid/products-and-services/high-voltage-power-products/power-compensation/>

**Session 10- Dielectric stress and grading**

**Quiz**

1. What is grading?
2. Factors affecting grading

Ref: <http://electricalquestionsguide.blogspot.in/2011/12/rotor-angle-stability-synchronous.html>

Presentation

Giving detailed explanation on grading of cables

GRADING:

It has been observed that the voltage gradient is maximum at the surface of the conductor and minimum at the inner surface of the sheath (i.e., the stress decreases from conductor surface to sheath). This causes breakdown in the insulation. For avoiding this breakdown, it is advisable to have more uniform stress distribution throughout the dielectric. The process of achieving uniform distribution in dielectric stress is called the grading of cables. There are two methods to achieve it, they are:

1. The application of layers of different dielectric materials called “Capacitance grading”.
2. Providing metallic intersheath between successive layers of the same dielectric materials and maintaining appropriate potential level at the intersheath is called “Intersheath grading”.

TYPES OF GRADING:

There are two methods of grading viz.

* 1. capacitance grading and
  2. intersheath grading.

Board activity

Deriving expression for power angle equation

Ref: <http://www.slideshare.net/Shahabkhan/definition-classification-of-power-system-stability>

**Session 11- Tan δ and power loss**

**Quiz**

1. What is surge impedance?
2. Factors affecting amount of loading
3. Significance of SIL

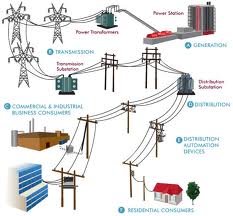
Ref: <http://electricalquestionsguide.blogspot.in/2012/05/surge-impedance-loading-sil.html>

PRESENTATION

Giving detailed explanation on surge impedance loading

The surge impedance loading (SIL) of a transmission line is the power (MW) loading of a transmission line when the line is lossless.

A transmission line produces reactive power (MVAr) due to their natural capacitance. The amount of MVAr produced is dependent on the transmission line's capacitive reactance (Xc) and the voltage (kV) at which the line is energized.



Board activity

Deriving expression for surge impedance loading

Ref: <http://www.transtutors.com/homework-help/electrical-engineering/power-system/surge-impedance-loading.aspx>

**Session 12- Thermal characteristics**

**Quiz**

1. What is rotor angle stability?
2. Factors affecting angle stability
3. Importance of rotor angle stability

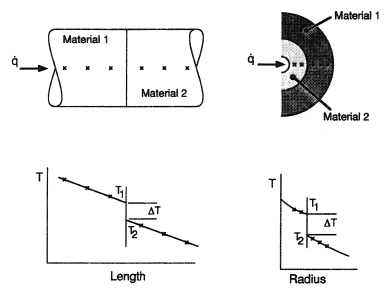
Ref: <http://electricalquestionsguide.blogspot.in/2012/05/surge-impedance-loading-sil.html>

Presentation

Giving detailed explanation on thermal charecteristics

Cables should not be operated at high temperatures because of the following reasons:

1. At high temperatures, expansion of oil may cause the sheath to burst.
2. The viscosity of the oil may decrease at a higher temperature.
3. Dielectric losses increase with increased temperature, so it may cause breakdown of insulation.



Board activity

Expression for thermal charecteristics was derived by the students