Simple introductory questions for High Voltage Engineering

1. What is an insulator?

It's a non-ohmic component which prevents current flow between two points with different electrical potential. When the voltage applied is higher than the breakdown voltage, the insulator will act as a conductor.

2. What is a conductor?

It is a material which allows the free flow of electrical current. Some examples of conductors are cupper or aluminum.

3. A metallic sphere contains a charge Q. What is the electric field inside it – explain.

Inside a metallic charged sphere there is no electrical field since all the charges are concentrated in the surface.

4. What does uniform field mean?

When the field magnitude is equal in size and direction regardless of the measured location.

5. A uniform field extends between two equipotential surfaces with a distance 10 cm. The electric potential between theses surfaces is 100 V. What is the electric field strength in the middle?

$$E = \frac{V}{d} \rightarrow E = \frac{100V}{0.1m} \rightarrow E = 1000\frac{V}{m}$$

6. How is electric potential defined?

"Electric potential is the amount of work needed to move a unit of positive charge from a reference point to a specific point inside a field without producing an acceleration."

-Wikipedia.

7. What does Gauss' law give a relation between? What can we use it for?

"Gauss' law relates the distribution of electrical charge to the resulting electric field."

-Wikipedia

It can be used for calculating the resulting electrical field of gaussian surfaces such as spheres.

8. Two metallic spheres are located in the vicinity of each other but far from other objects. One of them possesses a charge Q. Draw the electric field lines between spheres.
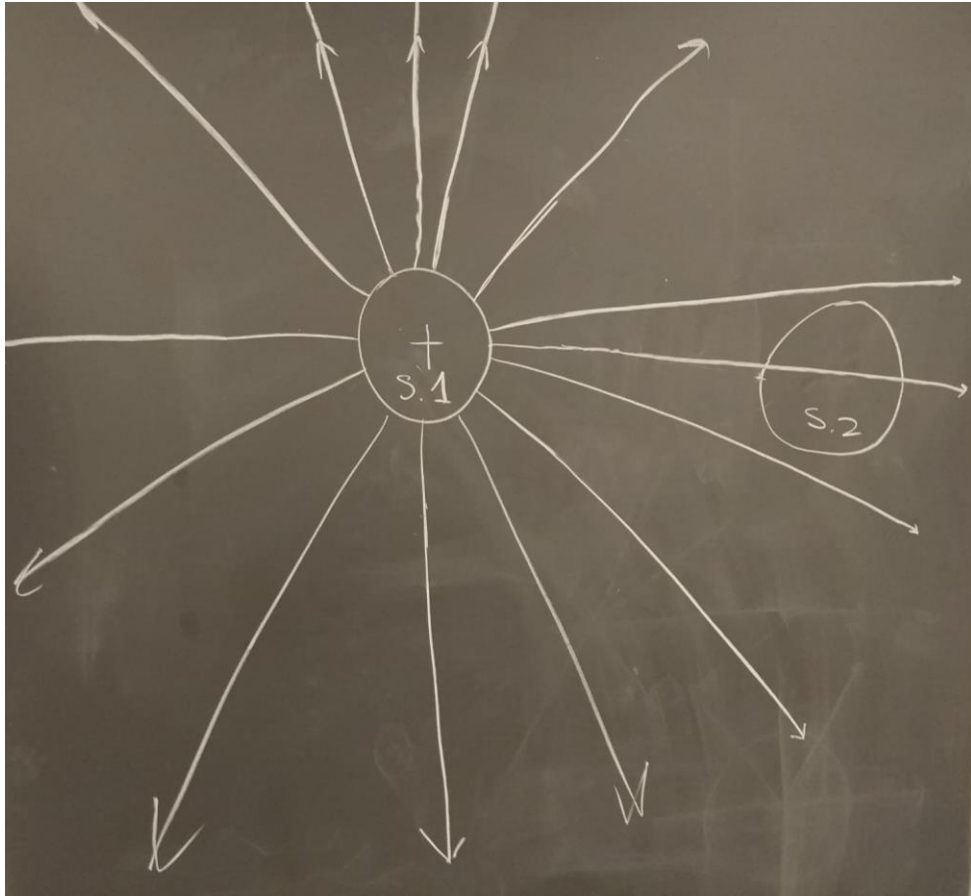

Figure 1. Electric field produced by sphere 1.

As it can be seen in Figure 1, the non-charged sphere does not produce any electrical field and the only the field lines in the drawing come out of the positive charged sphere.

9. What does permittivity mean?

"Permittivity describes the amount of charge needed to generate one unit of electric flux in a particular medium."

-Wikipedia

10. Explain the concept of relative permittivity. What is causing this?

It describes the relation of the permittivity of a medium related to the vacuum permittivity. The difference in the medium causes a relative permittivity to appear.

11. What is a capacitor and how is the concept capacitance defined? What does it mean?

A capacitor is a passive element that stores electrical energy in the form of electric field. Capacitance is the relationship between the capacitor's current and voltage in the following way:

$$C = \frac{\int I_c dt}{V_c}$$

12. What is an electric spark? What is causing it?

A spark is a current flow through an insulator when the breakdown voltage is surpassed.

13. Calculate the losses in a 10 nF capacitor energized with 100 V 50 Hz AC

The losses in passive elements are related to their internal resistance which is not given in the problem.

14. Does electric current have any influence with regard to electrical insulation?

The electrical insulation must be rated to the temperature that the conductor is going to achieve, and temperature is related with the power loss that depends quadratically on the current flow.

15. What is a transformer? How does it work? Draw its equivalent scheme.

A transformer is an electromagnetic machine that converts voltage and current, maintaining the same power (in ideal transformers). An input current flow is fed through a coil that generates a magnetic field, this magnetic field interacts with a secondary coil following the next relationship:

$$\frac{V_{out}}{V_{in}} = \frac{N_{out}}{N_{in}}$$

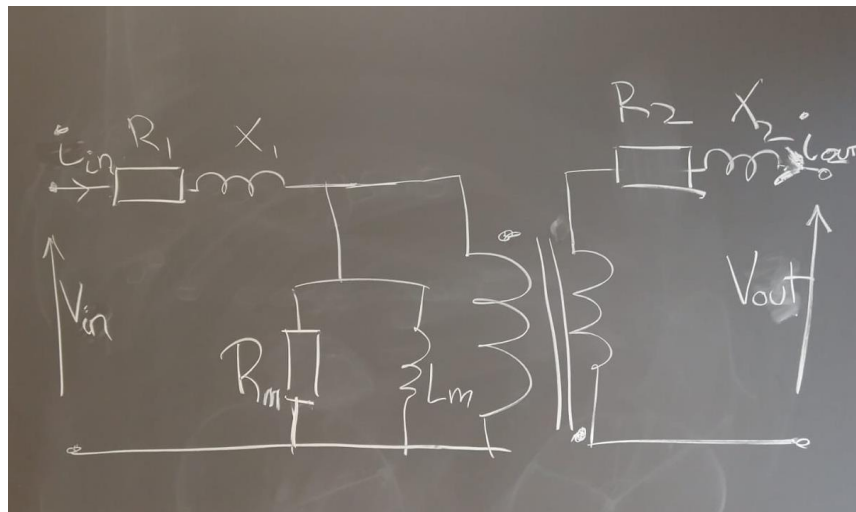Where N is the number of turns in the input and output coils.

Figure 2. Transformer diagram.

16. A three-phase system consists of three parallel plates each energized with one of the phase voltages. The voltage is 420 kV and 1 m is between plates. Calculate the maximum electric field strength Emax.

Supposing that 420kV is the line voltage, maximum electric field is given by the following equation:

$$E = \frac{V}{d} \rightarrow E = \frac{420kV}{1m} \rightarrow E = 420kV/m$$

17. We have two metallic rods with a hemispherical capping. One is 1 cm in diameter; the other one is 2 cm in diameter. They are energized with the same voltage. Which of them possesses the highest electric field?

The smallest capping produces a higher electrical field because the distance is smaller.

18. Is electricity dangerous? Why? How would you protect yourself from electric shock?

Yes, electricity is dangerous because the flow of current through a human body is harmful and can led to death. Using the ground stick will assure that the components are safe to touch. Also wearing isolating boots can prevent the current flow through a body. Finally it is important to stand far away from the voltage source and in an isolated environment.

19. Explain the concepts "time-domain" and "frequency-domain".

Time domain is used to represent the variation of amplitude as a function of time while frequency domain is used to understand the behavior of a function with respect to its frequency.

20. In real life engineering how do we assure things are made properly so they can be used in a proven way without having to do excessive research every time we want to build new things?

Data collection, modelling and simulation.