Name:

Neptun code:

**I. Are the statements below true or false?**

Write a **T** or an **F** in the placeholder! (Good answer 1 point, bad answer -1 point, no answer 0 point)

1. qThe electric field is conservative, so it can be described by a potential. **True**
2. qStatic magnetic field is rotation free. **False**
3. qIt is possible to induce electric field with static magnetic field. **True**
4. qThe normal component of the E field is continuous on the interface of different dielectric materials **False**
5. qThe capacitance of a metal sphere is proportional with its surface area **True**

**II. Solve the problems!** (Prepare the solutions on separate sheets, then fold them into the problem sheet!)

1. The coaxial cable is a cylindrical capacitor essentially. Dielectric material is located between the electrodes. Find the capacitance (c=?) of a one meter long piece of such cable. Data: R1=1mm, R2=4mm, relative permittivity εr=2. Find the maximum safe voltage (Umax=?) one can apply to the capacitor, if the breakdown electric field of the dielectric material is Ecritical=108 V/m. (ε0=8.86 10-12 As/Vm)

R1

R2

er

s

N1

N2

2. A toroid transformer contains the primary and the secondary coils with the number of turns N1 and N2 respectively. Data: circumference l=0.5m, cross sectional area of the coil A=10cm2, N1=102, N2=103, current in the primary coil is I=10A, relative permeability of the iron μr=103. Find the mutual inductance (M=?) of the coils. The current is decreased at uniform pace all the way to zero in τ=10 seconds. Find the induced voltage (U2=?) in the secondary coil as the function of time. (μ0=4π 10-7Vs/Am)

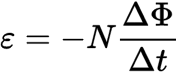
**III.** Reply briefly the questions below (3-5 lines / question, 6 points / question)

1. What symmetry classes of charge distribution are suitable for calculating the electric field by means of Gauss Law? Explain.

* A charge distribution with spherical symmetry
  + System only varies with the distance from the origin, not in direction
* A charge distribution with cylindrical symmetry
  + system only varies with distance from the axis, not direction
* A charge distribution with planar symmetry
  + system only varies with distance from a plane

1. Find the amount of energy stored in a capacitor with the capacitance C at the voltage U. How much is the energy density in the dielectric material of the capacitor?
   1. The energy density of all dielectric capacitor devices is proportional to the voltage squared
2. Describe the Faraday induction Law (Formula, meanings of letters, physical dimensions)

**describes how a changing magnetic flux induces an electric field**. Faraday's law is of special significance because it describes a coupling of the E-field and B-field and recognizes that this coupling requires a time variation of the flux. Only when ΦB changes is there an induced E-field



induced voltage=- number of loops \* change in magnetic flux/ change in time

Name:

Neptun code:

**I. Are the statements below true or false?**

Write a **T** or an **F** in the placeholder! (Good answer 1 point, bad answer -1 point, no answer 0 point)

1. qThe speed of light in a medium is proportional to its index of refraction
2. qWhen a ray of light enters water from air, the refraction angle is greater than the incident angle.
3. qElectromagnetic waves cannot exist in perfect vacuum.
4. qThe pointing vector is perpendicular to the direction of propagation.
5. qMaterials with high magnetic permeability has a smaller skin depth.

**II. Solve the problems!** (Prepare the solutions on separate sheets, then fold them into the problem sheet!)

3. An object is placed in front of an optical system, consisting of two convex lens. The focal length of the first lens is f1 = 1 m. The distance between the object and the first lens is 2 m, while the distance between the lenses is 3 m. Determine the focal length of the second lens, if the image is formed 3 m behind it!

O1=2m, F1=1m, D=3m I2=3m

1. Find image of first lens

1/F1=1/O1+1/I1

1/I1=1/F1-1/O1

1/I1=1/1-1/2=1/2 I1=2m

2. Find object distance of second lens

O2=D-I1=3-2=1m

1/F2=1/O2+1/I2=1/1+1/3=3/3+1/3=4/3

F2=3/4m=0,75m

3. A thin layer is deposited to a glass substrate. Their refractive indices are nl = 1.3 and ng = 1.6, respectively. Determine the thickness of the layer if at normal incidence, it enhances reflection at 433 nm, and decreases it when the wavelength of light is 520 nm. Are there other possible layer thicknesses that satisfy the above condition? At which wavelength does it enhance reflection if the incidence angle is 60°?

**III.** Reply briefly the questions below (3-5 lines / question, 6 points / question)

4. What is the Pointing vector? How can it be calculated? (Definition, formula, meaning of letters.)

Pointing vector is the directional energy flux or power flow of an electromagnetic field.



S (pointing vector), E (electric field vector), H (magnetizing field)

If electromagnetic energy is not given or lost:



u (energy density of the electromagnetic field)

5. What is total internal reflection?

Total internal reflection is the optical phenomenon in which (for example) the surface of the water in a fish tank, viewed from below the water level, reflects the underwater scene like a mirror with no loss of brightness