

系所組別： 物理學系

考試科目： 電磁學

考試日期： 0307，節次： 2

※ 考生請注意：本試題 可 不可 使用計算機

答案卷請依題目卷題號次序書寫，並清楚書寫其題號

1. Write down the equation and explain its physical meaning for the following questions: (each one is 4 points)
 - a). Faraday's Law of Induction
 - b). Ampere-Maxwell Law for magnetic field
 - c). How to produce a uniform electric field and a uniform magnetic field in a free space region.

2. a). Derive the equation $U(E) = \frac{1}{2} \epsilon_0 E^2$, based on the capacitor charging process.
E is electric field; U is electric field energy density. (6 points)
b). Derive the equation $U(B) = \frac{1}{2\mu_0} B^2$, based on R (resistor) L (inductor) circuit as shown in figure 1. B is the magnetic field inside the solenoid inductor; U(B) is magnetic field energy density inside the solenoid inductor. (6 points)

3. Magnetic material can be classified into three different types, please explain its physical mechanisms (or reasons). (Each one is 4 points)
 - a). Diamagnetism
 - b). Paramagnetism
 - c). Ferromagnetism

4. A ferromagnetic material magnetized by an external magnetic field B, can be described by a hysteresis curve, as shown in figure 2.
 - a). Explain the physical reasons for this curve. (4 points)
 - b). The physical meaning of point a, b, c, d. (8 points)

5. (Each one is 4 points)
 - a). Write down the differential equation of q (t) for a RLC circuit as showed in figure 4.
 - b). Find the solution of q (t). (t is time, in second)
 - c). Find the solution of I (t). (current)
 - d). Explain the solutions from energy point of view.
The initial total charges of capacitor is Q when the capacitor begins the discharge at time t=0.

(背面仍有題目,請繼續作答)

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6. As shown in figure 3, an isolated spherical solid metal ball (radius R , without charge in initial) has two spherical holes (each one with radius r). Point charge q_1 and q_2 is placed and fixed at the center of each hole. Please find (put a line under each answer) (Each one is 4 points for a, b, c and d)
- Total charges at outer metal surface
 - Total charges inside the metal (surface charges are not considered)
 - Total charges at hole surface q_1 ; d). Total charges at hole surface q_2 .
 - If a point charge q_3 is placed at long distance L far from the center of metal, find the force between q_3 and the system.(5 points)

7. A parallel-plate capacitor, made up of two plates (surface area is 0.4 m^2 for each plate), separated by a distance 2 mm , and filled with a uniform dielectric material (relative dielectric constant $\epsilon_r = 4$). The potential is 800 V before the dielectric material is filled. Please find (put a line under each answer, answer must be with numerical number and physical units) (Each one is 3 points)
- Electric field E inside the dielectric
 - Electric dipole moment P inside the dielectric
 - Surface charge density σ_m of metal plate
 - Surface charge density σ_d of dielectric surface
 - Electric displacement D inside the dielectric

Some useful information:

Permittivity constant $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / (\text{N m}^2)$; C: coulomb; N: Newton; m: meter

Electric dipole $P = (\epsilon_r - 1) E$; Displacement $D = \epsilon_0 E + P$

