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THE OPEN UNIVERSITY OF SRI LANKA

B.SC. DEGREE PROGRAMME

FINAL EXAMINATION -2010/2011

PHU 2142/ PHE 4142 ADVNCED ELECTROMAGNETISM

DURATION: TWO AND A HALF (2 $^1/_2$) HOURS

Date: 11th July 2011 **Time: 1.30 pm to 4.00 pm**

Answer **Four (4)** questions only

(1) (i) An electric field in space is given by

$$E = 2x^2z\,i + xy^2z\,j + 3yz^2\,k$$

Find the followings at the point (1,1,1)

(a) $\nabla \cdot E$

(b) $\nabla(\nabla \cdot E)$

(c) $\nabla X E$

(d) $\nabla^2 E$

(ii) The temperature (T) in a room at a given moment is represented by the scalar field as

$$T = 2xz^4 - x^2y$$

(iii) Find the temperature variation in the room (∇ T).

(iv) How does the ground temperature of the room (x-z plan) change ?

(2)(i) Write down the Gauss's theorem in the integration form.

(ii) Selecting a suitable volume, find the electric field intensity on the surface of a charged conducting plate of surface charge density σ.

(ii) A spherical charged solid conductor is surrounded by a concentric, uncharged spherical conducting shell of internal radius a and external radius b . This shell is cut into two equal parts. Find the force action on the one part of the divided shell.

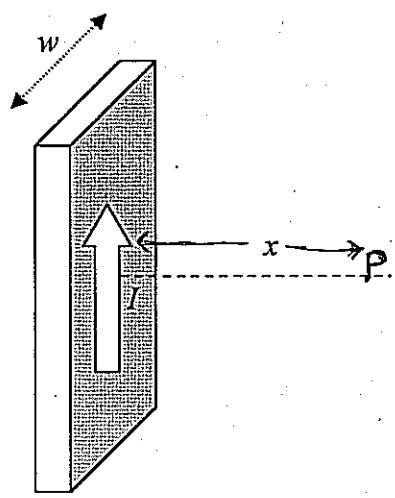
(3) (i) What do you mean by the method of images in electrostatics ?

(ii) Write down two important consequences of the Uniqueness theorem used in the method of Images.

(iii) A point charge; Q is located out side an earthed conducting sphere of radius a at a distance c from the center of the sphere. Derive a charge (quantity and location) to replace the earthed sphere without disturbing the potential on and outside the sphere. If $Q = 5$ C, $a =$ 3 cm and $c = 10$ cm, considering any two points on the plane where the sphere was, verify the image charge you found.

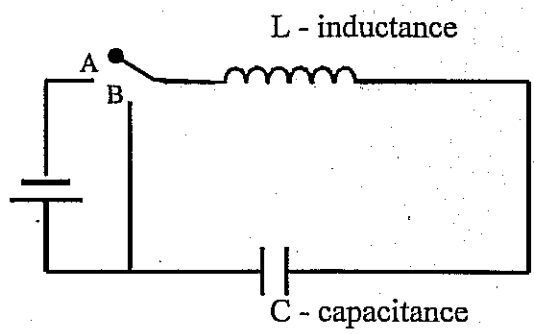
(4) (i) Write down the Biot- Savart law in mathematical form describing the variables.

(ii) A flat , thin , infinitely long sheet of width w carries a uniform current I as shown in the figure.



Determine the magnetic field at the point p which is on the perpendicular plane going through the middle line of the sheet .

(5) The following figure shows an idealized *LC* circuit.



At the beginning, the switch is at position *A* until the capacitor is fully charged to $Q_0 = C/\varepsilon_0$ Now the switch is put to position B at time t = 0 where ε_0 is the permittivity relevant to the capacitor (neglecting any energy losses in the circuit , heir u).

(i) Write down the total energy of the circuit at time t.

(ii)What are the contribution of energy of condenser and inductor at time t, if the current in the circuit is I and the charge in the capacitor is Q ?

(iii) Find I and Q using Q_0 , L and C differentiating the total energy equation.

(iv) What is the maximum value of the current in this circuit , if L = 10 mH, C = 25 μC and the capacitor is initially charged to 18 V ?

(6) (i) What are the values for current density j, charge density ρ in free space?

(ii)Write down the Maxwell's equations in free space.

(iii) Using the above equations, derive the wave equation for magnetic field ; ***B***.