UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	ELECTROMAGNETISM
COURSE CODE	:	BWC 21103
PROGRAMME	:	2 BWC
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS IN SECTION A 2. ANSWER **ONE (1)** QUESTION ONLY IN SECTION B

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

SECTION A

Q1 (a) Find the force on 0.3 mC at (1, 2, 3) m due to a second charge of 0.1 mC at (2, 0, 5), in the free space.

(5 marks)

(b) A point charge of 6 μC is located at the origin, a uniform line charge density of 180 nC/m^2 lies along x - axis and uniform sheet of charge equal to 25 nC/m^2 lies in the $z = 0$ plane. Analyze;

(i) $\bar{\mathbf{D}}$ at A (0, 0, 5)

(ii) $\bar{\mathbf{D}}$ at B (1, 2, 5)

(iii) Total electric flux leaving the closed surface of a sphere of 5 m radius, centered at the origin.

(15 marks)

(c) Determine the electric field, $\bar{\mathbf{E}}$ at (0, 3, 4) m in Cartesian co-ordinates due to a point charge Q = 0.5 μC at the origin.

(5 Marks)

Q2 (a) Consider differential surface area dS as shown in the **Figure Q2 (a)** below. The direction normal to the surface dS is $\hat{a}_r$, considering spherical coordinate system. The radius of the sphere is r = a. The direction of $\overline{D}$ is along $\hat{a}_r$ which is normal to dS at any point P.

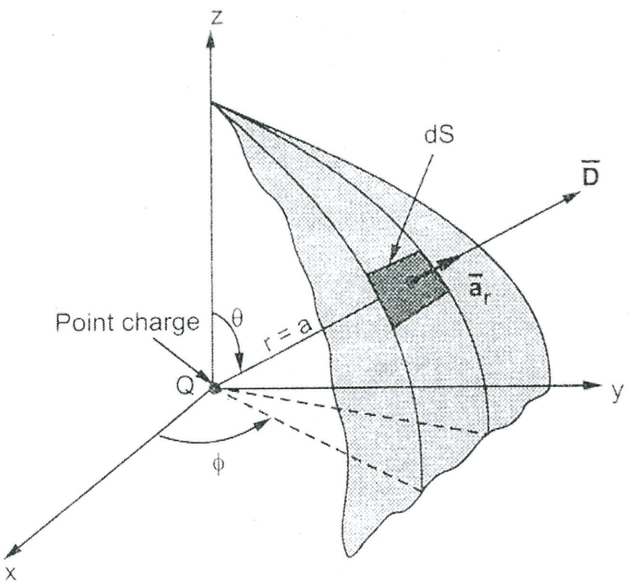

Figure Q2 (a)

(i) Calculate $\vec{D}$ due to point charge Q.

(ii) Convince the Gauss Law where Q coulomb of flux crosses the surface if Q coulombs of charges are enclosed by that surface.

(10 marks)

(b) A particular vector field $\vec{F} = r^2 \cos^2 \emptyset\, \widehat{a_r} + z \sin \emptyset\, \widehat{a_\emptyset}$ is in the cylindrical coordinates system. Analyse the flux, $\oint_S \vec{F} \cdot d\vec{S}$, emanating due to this field from the closed surface of the cylinder $0 \leq z \leq 1$, $r = 4$.

(15 marks)

Q3 (a) Consider the two points P_1 and P_2 along with the $I_1 d\overline{L}_1$ current element at P_1 shown in **Figure Q3(a)**.

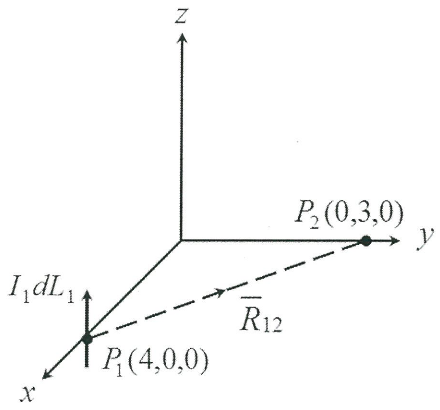

Figure Q3 (a)

Calculate the incremental field strength, $d\overline{H}_2$ at P_2 (0, 3, 0) due to the current element of $2\pi\overrightarrow{a_z}\ (\mu Am)$ at P_1 (4, 0, 0).

(10 marks)

(c) Given the Stoke's theorem:

$$\oint_L \vec{H} \cdot d\vec{L} = \int_S (\nabla \times \vec{H}) \cdot d\vec{S}$$

Evaluate the left hand side of the Stoke's theorem for the field $\vec{H} = 6xy\widehat{a_x} - 3y^2\widehat{a_y}(A/m)$ and the rectangular path around the region, $2 \le x \le 5$, $-1 \le y \le 1$, $z = 0$. Assume that the positive direction of $d\vec{S}$ be $\widehat{a_z}$.

(10 marks)

(d) Given the magnetic field, $\vec{H} = [3x\cos\beta + 6y\sin\alpha]\widehat{a_z}$. Determine the current density, $\vec{J}$ if fields are invariant with time.

(5 marks)

SECTION B

Q4 (a) Sketch the graph showing the plane electromagnetic wave propagating in the + x direction.

(5 marks)

(b) Consider the 9375 MHz uniform plane wave is propagating in polystyrene where $\mu_r = 1$ and $\varepsilon_r = 2.56$. If the amplitude of the electric field intensity is 20 V/m and the material is assumed to be lossless, σ = 0, determine the velocity of the propagation and the amplitude of the magnetic field intensity.

(10 marks)

(c) In free space (z ≤ 0), a plane wave with:

$$\overrightarrow{H_\iota} = 10\cos(10^8 t - \beta z)\,\widehat{a_x}(mA/m)$$

is incident normally on a lossless medium ($\varepsilon = 2\varepsilon_0, \mu = 8\mu_0$) in region z ≥ 0. Distinguish the reflected wave $\overrightarrow{H_r}$, $\overrightarrow{E_r}$ and the transmitted wave $\overrightarrow{H_t}$, $\overrightarrow{E_t}$.

(10 marks)

Q5 (a) Can light phenomena be better explained by a transverse wave model or by a longitudinal wave model? Explain your answer.

(2 marks)

(b) Define the LCD then briefly explain how does it change colours?

(8 marks)

(c) Given:

$$\vec{E}_y(x,t) = E_0\cos(kx - \omega t)\,\hat{x} \text{ with } \omega = kc.$$

(i) Verify that the equation above satisfy the one dimensional wave equations

$$\frac{\partial^2 E_y(x,t)}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2 E_y(x,t)}{\partial t^2}$$

(10 marks)

(ii) Create the corresponding magnetic field, $\vec{B}$.

(5 marks)

- END OF QUESTION –

FINAL EXAMINATION

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LIST OF EQUATIONS

Electric	Magnetic
$\mathbf{F} = \frac{Q_1 Q_2}{4\pi\, \varepsilon_0^2}\mathbf{a}_r$	$d\mathbf{B} = \frac{\mu_0 I d\mathbf{l} \times \mathbf{a}_r}{4\pi R^2}$
$\int \mathbf{D}.d\mathbf{S} = Q_{enc}$	$\int \mathbf{H}.d\mathbf{l} = I_{enc}$
$\mathbf{F} = Q\mathbf{E}$	$\mathbf{F} = Q\mathbf{u} \times \mathbf{B}$
dQ	$Q\mathbf{u} = Id\mathbf{l}$
$E = \frac{V}{l}$ (V/m)	$H = \frac{I}{l}$ (V/m)
$\mathbf{D} = \frac{\Psi}{S}$ (C/m^2)	$\mathbf{B} = \frac{\Psi}{S}$ (Wb/m^2)
$\mathbf{D} = \varepsilon\mathbf{E}$	$\mathbf{B} = \mu\mathbf{H}$
$\mathbf{E} = -\nabla V$	$\mathbf{H} = \nabla V_m$ $(\mathbf{H} = 0)$
$V = \int \frac{\rho_L\, dl}{4\pi\, \varepsilon\, r}$	$\mathbf{A} = \int \frac{\mu\, I\, d\mathbf{l}}{4\pi\, R}$
$\Psi = \int \mathbf{D}.d\mathbf{S}$	$\Psi = \int \mathbf{B}.d\mathbf{S}$
$\Psi = Q = CV$	$\Psi = LI$
$I = C\frac{dV}{dt}$	$V = L\frac{dI}{dt}$
$w_E = -\frac{\rho_v}{\varepsilon}\mathbf{D}.\mathbf{E}$	$w_m = \frac{1}{2}\mathbf{B}.\mathbf{H}$
$\nabla^2 V = -\frac{\rho_v}{\varepsilon}$	$\nabla^2 \mathbf{A} = -\mu\mathbf{J}$