	امتحان دور مايو 2023	جامعة دمياط Damietta University
الشعبة: رياضيات التاريخ:2023/6/17 زمن الامتحان:3 ساعه	الفرقة: الثالثه علوم معتمد كود المقرر:312 ر الدرجة الكلية: 105	الكلية : كلية العلوم القسم: الرياضيات اسم المقرر :الكتروديناميكا

Answer the following questions:

Question One: **[20marks]** prove that the Maxwell's equations in free space have the following form:

$$(1)\ div\vec{E} = 4\pi\rho \quad (2)\ div\vec{H} = 0 \quad (3)\ Curl\vec{E} = -\frac{1}{c}\frac{\partial\vec{H}}{\partial t} \quad (4) Curl\vec{H} = \frac{4\pi}{c}\vec{J} + \frac{1}{c}\frac{\partial\vec{E}}{\partial t}$$

Question Two: **[23 marks] (a) [13 marks] Show that the equations of the potentials** $\vec{A}$ *and* $\vec{\phi}$ **in free space are:**

$$\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\vec{A} = -\frac{4\pi}{c}\vec{j} \qquad and \left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\vec{\phi} = -4\pi\rho$$

(b) [10 marks] By using the Maxwell's equations in free space Show that the Law of conservation of charge is: $div\vec{J} + \frac{\partial\rho}{\partial t} = 0$ where $\vec{J}$ is the current and ρ is the density.

Question Three: **[20 marks]** prove that the Maxwell's equations in the medium have the following form:

$$(1)\ div\vec{D} = 4\pi\rho \quad (2)\ div\vec{B} = 0 \quad (3)\ Curl\vec{E} = -\frac{1}{c}\frac{\partial\vec{B}}{\partial t} \quad (4) Curl\vec{H} = \frac{4\pi}{c}J + \frac{1}{c}\frac{\partial\vec{D}}{\partial t}$$

where $\vec{D} = \vec{E} + 4\pi\rho$ *and* $\vec{B} = \vec{H} + 4\pi M$

Question Four: **[20 marks]** **show that the wave equation in the vacuum is:**

$$\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)A = 0 \qquad and \left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\phi = 0$$

And show that $\vec{E}$ *and* $\vec{H}$ satisfy the same relation **in the vacuum.**

Question five: **[22 marks] (a) [11 marks] prove the Law of conservation of the energy of the electromagnetic field in a medium.**

(b) [11 marks] Solve the plane waves equations

$$\frac{\partial^2 A}{\partial t^2} - c^2\frac{\partial^2 A}{\partial x^2} = 0 \qquad and \qquad \frac{\partial^2\phi}{\partial t^2} - c^2\frac{\partial^2\phi}{\partial x^2} = 0$$

With Best Wishes Dr. R. F. Yassen &Head of Mathematics Department: Prof. Dr. A. K. Trabia

جامعة دمياط Damietta University	امتحان دور مايو 2023	
الكلية : كلية العلوم القسم: الرياضيات اسم المقرر :إليكتروديناميكا	الفرقة: الثالثه علوم معتمد كود المقرر :312 ر الدرجة الكلية: 105	الشعبة: رياضيات التاريخ:2023/6/17 زمن الامتحان:3 ساعه

Answer the following questions:

Question One: [20marks]

prove that the Maxwell's equations in free space have the following form:

(1) $div\vec{E} = 4\pi\rho$ (2) $div\vec{H} = 0$

(3) $Curl\vec{E} = -\frac{1}{c}\frac{\partial \vec{H}}{\partial t}$ (4) $Curl\vec{H} = \frac{4\pi}{c}\vec{J} + \frac{1}{c}\frac{\partial \vec{E}}{\partial t}$

Question Two: [23 marks]

(a) [13 marks] Show that the equation of the potentials $\vec{A}$ and $\vec{\phi}$ in free space have the following form:

$$\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\vec{A} = -\frac{4\pi}{c}\vec{j} \quad and \quad \left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\vec{\phi} = -4\pi\rho$$

(b) [10 marks] by using the Maxwell's equations in free space Show that the Law of conservation of charge is: $div\vec{J} + \frac{\partial \rho}{\partial t} = 0$ where $\vec{J}$ is the current and ρ is the density.

Question Three: [20 marks]

prove that the Maxwell's equations in the medium have the following form:

(1) $div\vec{D} = 4\pi\rho$ (2) $div\vec{B} = 0$

(3) $Curl\vec{E} = -\frac{1}{c}\frac{\partial \vec{B}}{\partial t}$ (4) $Curl\vec{H} = \frac{4\pi}{c}J + \frac{1}{c}\frac{\partial \vec{D}}{\partial t}$

where $\vec{D} = \vec{E} + 4\pi\rho$ *and* $\vec{B} = \vec{H} + 4\pi M$

Question Four: [20 marks]

show that the wave equation in the vacuum is:

$$\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)A = 0 \quad and \quad \left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\phi = 0$$

And show that $\vec{E}$ *and* $\vec{H}$ satisfy the same relation **in the vacuum.**

Question five: [22 marks]

(a) [11 marks] prove the Law of conservation of the energy of the electromagnetic field in a medium.

(b) [11 marks] Solve the plane waves equations

$$\frac{\partial^2 A}{\partial t^2} - c^2 \frac{\partial^2 A}{\partial x^2} = 0 \qquad and \; \frac{\partial^2 \phi}{\partial t^2} - c^2 \frac{\partial^2 \phi}{\partial x^2} = 0$$

With Best Wishes

Dr. R. F. Yassen & ***Head of Mathematics Department:*** *Prof. Dr. A. K. Trabia*