EASTERN UNIVERSITY, SRI LANKA

EXTERNAL DEGREE SECOND EXAMINATION IN SCIENCE - 2002/2003

SECOND SEMESTER(October/November, 2007)

EXTMT 218 - FIELD THEORY

Answer all Questions **Time: Two hours**

Q1. (a) With the usual notations, prove that

$$\vec{E} = -\vec{\nabla}\phi.$$

Hence, show that

$$\phi = \frac{Q}{4\pi\varepsilon_o r}.$$

[40 marks]

(b) A potential distribution is given by the expression

$$\phi = \frac{20}{(x^2 + y^2 + z^2)}.$$

Determine the electric field intensity $\vec{E}$ in the general form and also the particular value at the point (5,3,0). [40 marks]

(c) What is meant by the following mathematical interpretation? Explain it.

$$\oint \vec{E}.\vec{dr} = 0.$$

[20 marks]

Q2. (a) State **Gauss law** of the electric field and write down its integral form for a continuous charge density. [20 marks]

(b) Obtain **Possion's equation** using part (a) and hence, find the relation i potential if it is a function of r, distance along the radial direction, only.

[45 mar

(c) A uniform volume charge distribution of -10^{-8} coulomb/m^3 occupies the regi between two co-axial conducting cylinders of radii 20 and 50 mm. If the elect field and potential are both zero on the inner cylinder, find the potential the outer cylinder. [Use the result obtained in part (b)] [35 mar

Q3. (a) Write down the integral and differential forms of **Ampere's law** of magne field. [20 mar

(b) Using Ampere's Law, prove that the following result:

(i) $\vec{\nabla} \times \vec{H} = \vec{J}$;

(ii) $\oint_c \vec{H}.\vec{ds} = I$;

where $\vec{H}$ and $\vec{J}$ are magnetic field strength and current density, respectivel

[50 mar

(c) Show that the magnetic field B due to an infinitely long conductor carryin steady current i through it, is,

$$B = \frac{\mu_o i}{2\pi a},$$

where a is the radius of the loop. [30 mar

Q4. (a) Write down the Kepler's law of planetary motion. [30 mar

(b) Consider a particle of small mass m moves around another particle of la mass M. The mass m is attracted by M and M to be at rest. If (r, θ) is t polar coordinate of m with respect to M and G is the gravitational consta prove that

$$\frac{d^2u}{d\theta^2} + u = \frac{GM}{l^2},$$

where $u = \frac{1}{r}$ and l is a constant. If the general solution of the different equation above is

$$u = c\cos(\theta + \theta_o) + \frac{GM}{l^2},$$

where c and θ_o are arbitrary constants, prove that

$$s = \frac{l^2}{GM} \text{ and } e = \frac{cl^2}{GM},$$

where s and e are the semi-latus rectum and eccentricity of the conic shape

$$r = \frac{s}{(1 + e\cos\theta)},$$

respectively. What can you say about the path of the mass m? [70 marks]