EASTERN UNIVERSITY, SRI LANKA

FIRST EXAMINATION IN SCIENCE 2005/06 (AUG-SEP. 2007)

FIRST SEMESTER

PH 101 – MECHANICS I

Time: 01 hour.
Answer ALL Questions.

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1. (a) Define "average velocity" and "instantaneous velocity" and give mathematical expression for both.
A particle located at position $x = 0$ at time $t = 0$, starts moving along the positive x – direction with a velocity v that varies as $v = kx^{\frac{1}{2}}$. How do the *displacement, velocity* and *acceleration* of the particle vary with time t. What is the average velocity of the particle over the first d distance of its path?

(b) A particle is moving in two dimensions and its position is given by the polar co-ordinates (r, θ). Show that the velocity $\vec{v}$ and the acceleration $\vec{a}$ of the particle are given by,

$$\vec{v} = \dot{r}\vec{e}_r + r\dot{\theta}\vec{e}_\theta$$

$$\vec{a} = (\ddot{r} - r\dot{\theta}^2)\vec{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\vec{e}_\theta.$$

Where, $\vec{e}_r$ and $\vec{e}_\theta$ are the unit vectors along and perpendicular to the radial direction respectively.
A particle moves in two dimensions $r = 2\theta$, where θ varies with time t as $\theta = t^2$. Show that the acceleration of the particle is $\vec{a} = 4(1 - 2t^4)\vec{e}_r + 20t^2\vec{e}_\theta$.

2. Explain briefly what you mean by *kinetic energy*, *power* and *work done by a force*. State "work-energy theorem".

A force $F(t)$ is acting on a particle moving with velocity $v(t)$. Show that the work done W by the force between the time interval t_1 and t_2 is,

$$W = \int_{t_1}^{t_2} (\vec{F}.\vec{v})dt.$$

A force given by $\vec{F} = (4\vec{i} + 8\vec{j} + 12t\vec{k})$, acts on a particle of mass $2kg$, where the force is in Newton and t is in sec. Assuming that when $t = 0$ the position vector and the velocity of the particle are zero, find

i. the velocity and the position vector of the particle when $t = 1$ sec;
ii. the work done by the force in the time interval $t = 0$ sec and $t = 1$ sec;
iii. the power of the force at any time t sec.
iv. Calculate the kinetic energy of the particle when $t = 1$ sec and verify the "Work-Energy" theorem.