EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCES - 2003/2004

SECOND SEMESTER

(JUNE/JULY 2005)

PH 204 MECHANICS II

Time: 01 hour.

Answer ALL Questions

---

01. Starting with radial and transverse components of the acceleration of a particle in plane polar coordinates r and θ show that the differential equation for the orbit of a particle in a central field of force is given by

$$\frac{d^2U}{d\theta^2}+U=-\frac{m}{L^2U^2}F\left(\frac{1}{U}\right)$$

where $F\left(\frac{1}{U}\right)$ and L are respectively the attractive force and the angular momentum of the particle and $U=\frac{1}{r}$.

A particle of mass m moves under the influence of a central attractive force $\frac{k}{r^2}$. Show that the total energy of the particle is given by

$$E=\frac{1}{2}m\dot{r}^2+\frac{L^2}{2mr^2}-\frac{k}{r}$$

Using the above equations show that the orbit of the particle is circle of radius $\frac{L^2}{mk}$ when $E=-\frac{mk^2}{2L^2}$.

02. (a) State Kepler's laws of planetary motion and show how they lead to Newton's law of universal gravitation by assuming the orbit of planets are circular.

(b) Considering the Earth to be a solid uniform sphere of radius $6.4\times10^3 km$.

i. Find the density it must have in order to account for observed acceleration due to gravity g as $10 m\sec^{-2}$ at its surface.

ii. Find the acceleration due to gravity $50km$ above Earth's surface.

(c) Show that, to escape from the atmosphere of a planet a necessary condition for a particle is that it has a velocity such that $V^2>\frac{2GM}{r}$ where M is the mass of the planet and r is the distance of the particle from the center of the planet.

Universal gravitational constant $G=6.67\times10^{-11}Nm^2kg^{-2}$.