Physical Geodesy Lab-3

Karam Mawas	2946939
Ehtesham Hasnain	2995236

1. **Superposition of Earth's and Moon's gravitational fields**

   (a) **Predefining**
   We define the coordinates of the Earth with respect to a geocentric reference system.

   $$X_E = 0\,km, Y_E = 0\,km, Z_E = 0\,km$$

   The coordinates of the Moon are also defined in the same system.

   $$X_M = r_M.\cos(k.10^{o})\,km, Y_M = r_M.\sin(k.10^{o})\,km, Z_M = 0\,km\,; k = 39$$

(b) **Visualization the vector field**

Computing of the vector field driven by both Earth and Moon, we have to distinguish between the two cases:

	$r \leq R$	$r \geq R$
a	$-\dfrac{4}{3}\pi G\rho r$	$-\dfrac{4}{3}\pi G\rho R^3\dfrac{1}{r^2}$

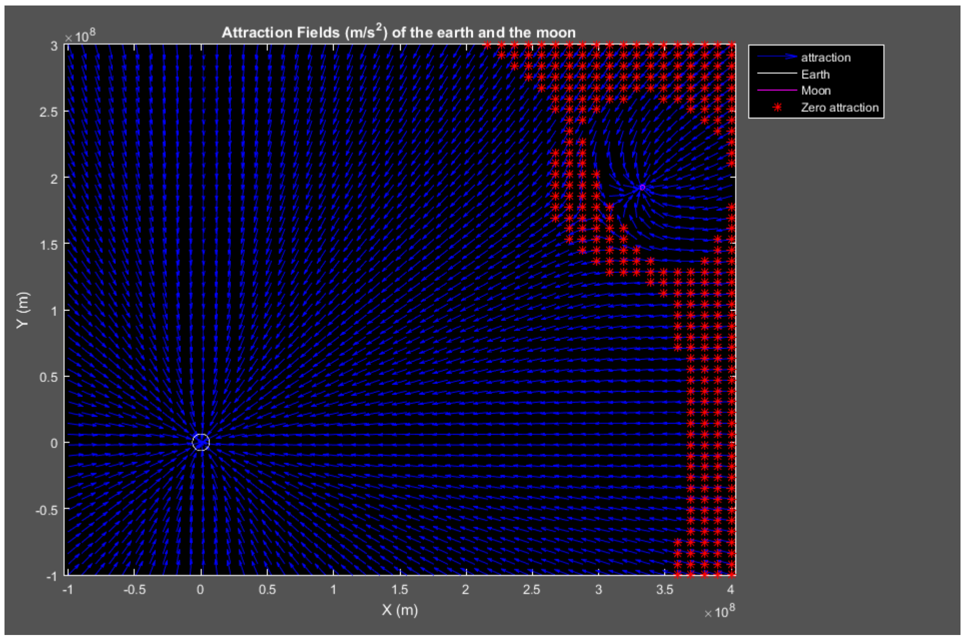

Figure-1 Vector Field

The figure shows the superimposed attraction of both Earth and Moon represented by the blue vectors. And the red dots represent the area of zero attraction by threshold 0.003. The size of the Earth and the Moon are shown to their scale. The vector fields are more for Earth than the Moon which is because of the difference of their masses.

(c) **Superimposed potential of both Earth and Moon**

	$r \leq R$	$r \geq R$
V	$-2\pi G\rho(R^2 - \frac{1}{3}r^2)$	$\frac{4}{3}\pi G\rho R^3 \frac{1}{r}$

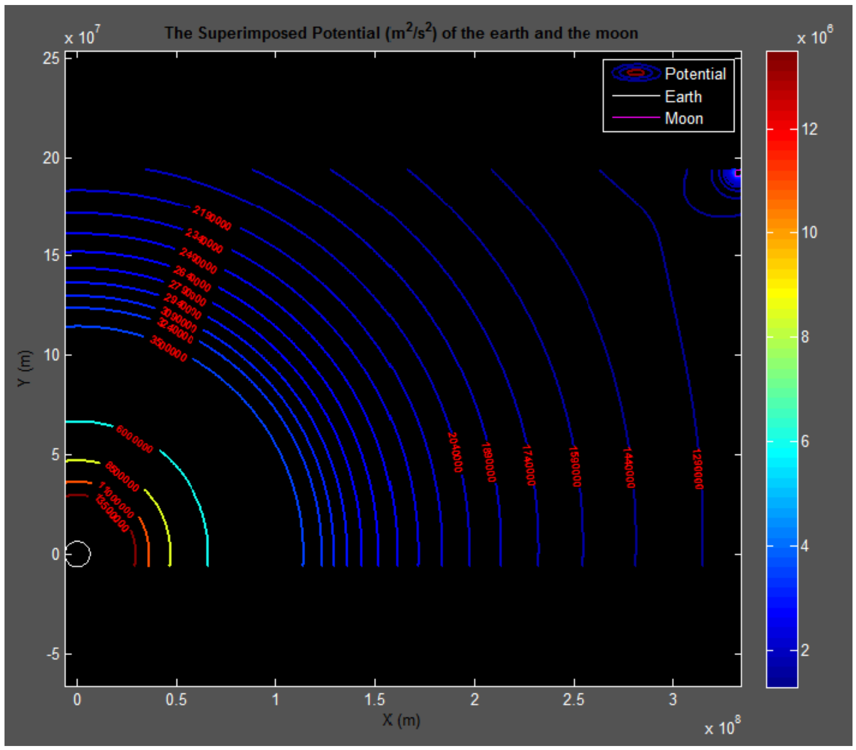

Figure-2 Potentail Field

The figure shows the potential field. It is higher around the Earth, and not around the Moon which is due to the fact that the former has higher mass. It can be deduced that the potential field would be greater if we are near the Earth and it decreases as the distance from it increases.

2. **Gravitational potential and attraction of spherical shells**

   (a) **The attraction and the potential of two shells**

	in	within	out
	$r \leq R_c$	$R_c \leq r \leq R_m$	$r \geq R_m$
V	$2\pi G\rho(R_m^2 - R_c^2)$	$2\pi G\rho(R_m^2 - \frac{1}{3}r^2) - \frac{4}{3}\pi G\rho R_c^3 \frac{1}{r}$	$\frac{4}{3}\pi G\rho(R_m^2 - R_c^2)\frac{1}{r}$
a	0	$-\frac{4}{3}\pi G\rho(r^3 - R_c^3)\frac{1}{r^2}$	$-\frac{4}{3}\pi G\rho(R_m^3 - R_c^3)\frac{1}{r^2}$

   (b) **Visualiztion of the potential of two shells**

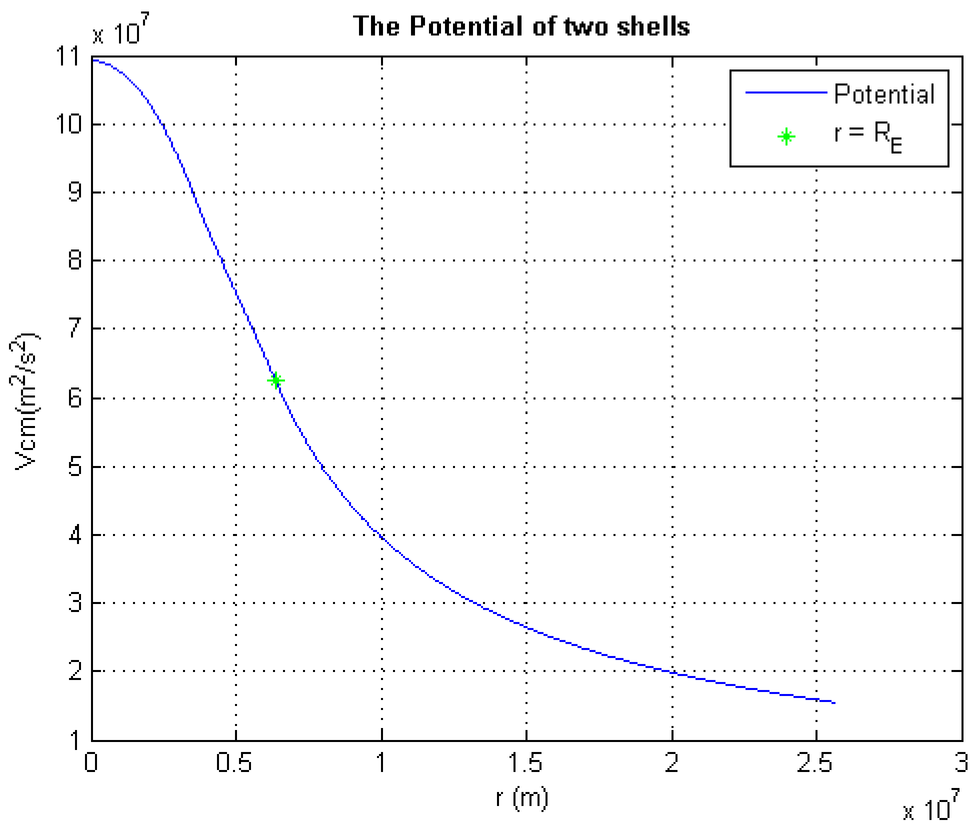

Figure-3 The potential of two shells

The figure is not accurate because we considered only two shells inspite of the fact that the Earth has a myriad of shells. The point on the figure is at the radius of the earth, but it is not on the function because it is a matter of interpolation of the points

(c) **Visualiztion of the attraction of two shells**

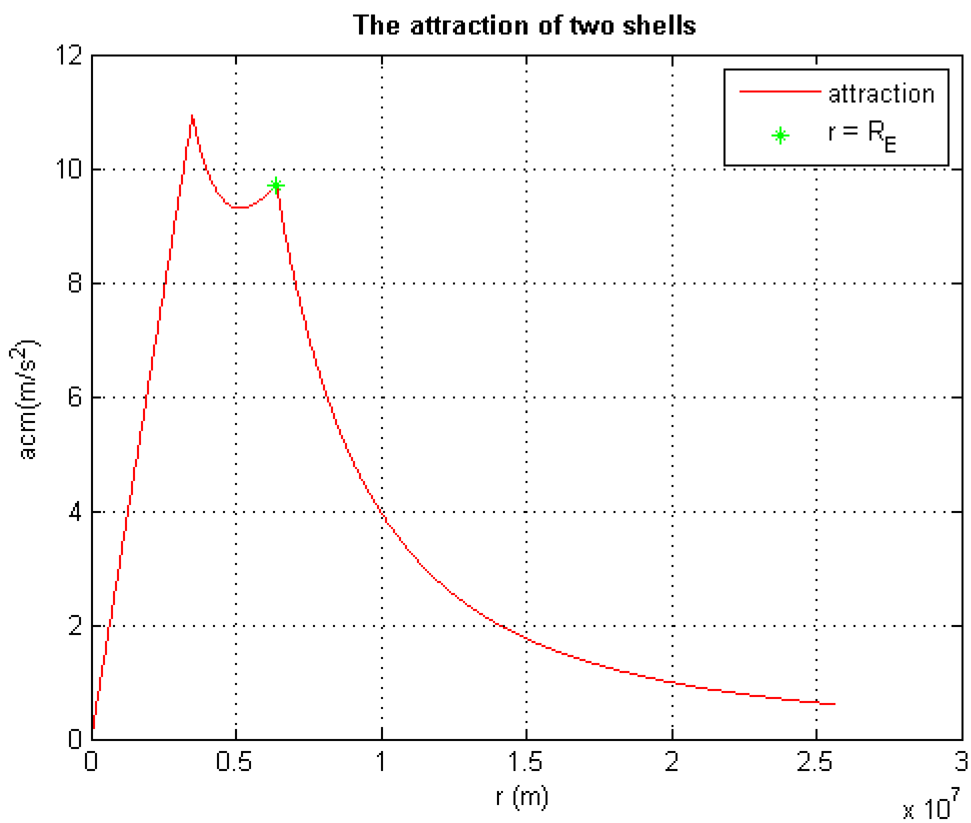

Figure-4 The attraction of two shells

The accuracy is same as fig-3 and here our distinguished point $r = R_E$ the attraction $a_E = 9.693291 m/s^2$ which is quite far from the accurate value $a = 9.808929 m/s^2$, because of the rarity of the shells we considered.

3. **PREM density model of the Earth**

   (a) **Visualiztion of the potential of PREM**

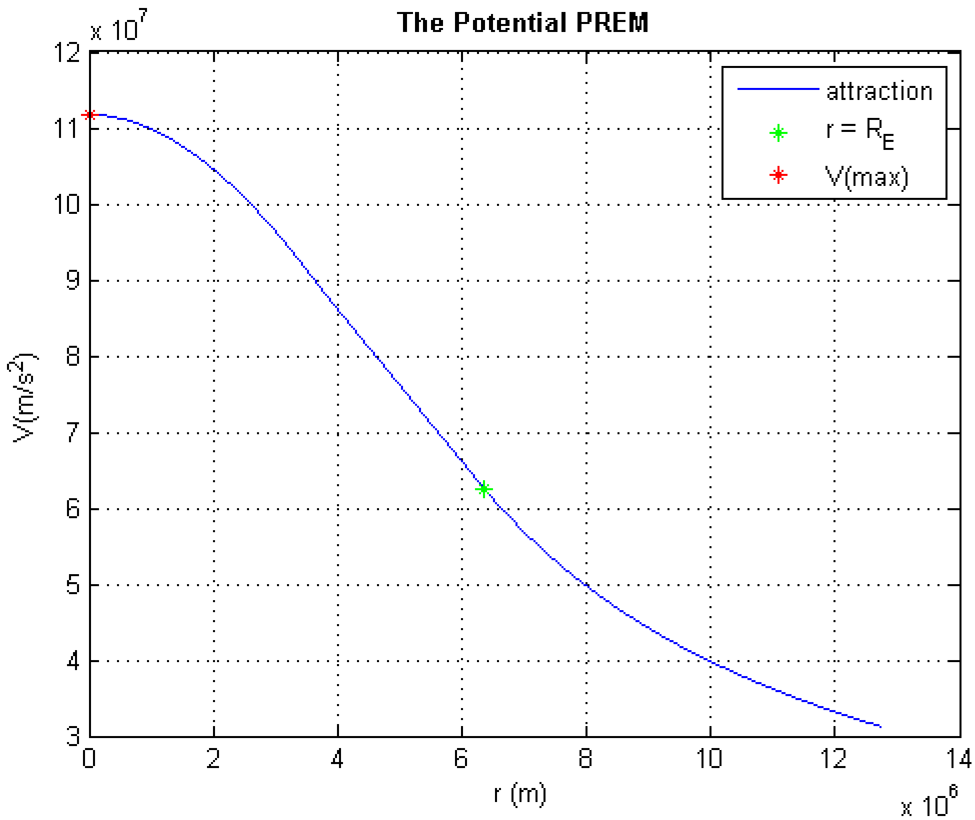

Figure-5 The attraction of two shells

Here we observe the differences from the Fig-3 and this is indeed more accurate because of taking into account a plenty of shells.

$$V_{R_E} = 6.256283165450073.10^7 \; (m^2/s^2)$$

$$V_{max} = 6.354770888324875.10^7 \; (m^2/s^2)$$

(b) **Visualiztion of the attraction of PREM**

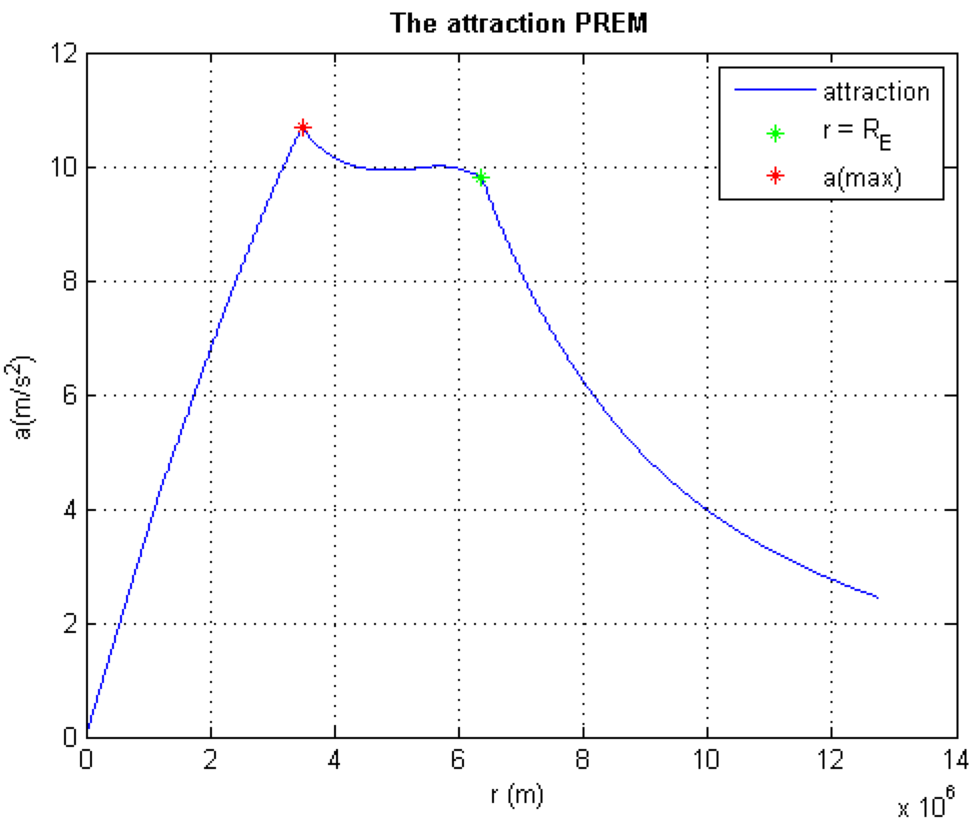

Figure-5 The attraction of two shells

Also in this figure we can observe the differences from the Fig-4.

$$a_{R_E} = 9.819084\,(m/s^2)$$
$$a_{max} = 9.865107\,(m/s^2)$$