Classical Mechanics, PHYB54
Problem Set 2

Professor Hanno Rein
TA Rejean Leblanc

Due: Monday, January 23th 2017, 4pm

Note: Assignments can be hand-written, but illegible answers will not be marked. Clearly indicate your final answers.

Problem 1.1

a) Use the series expansions of e^z to prove Euler's identity, $e^{i\pi} + 1 = 0$.
b) Use the series expansions of e^z to prove $e^{u+v} = e^u e^v$.
c) Using the previous results, write $\cos(u + v) + i\sin(u + v)$ in terms of $\cos(v)$, $\cos(u)$, $\sin(v)$, and $\sin(u)$.

Problem 1.2

a) The masses of the Earth and Moon are approximately $M_e = 6.0 \times 10^{24}$ kg and $M_m = 7.4 \times 10^{22}$ kg. The center to center distance is approximately 3.8×10^5 km. Where is the center of mass if we assume the center of the Earth is the origin of the coordinate system.
b) The Earth's distribution of mass is not symmetrical. One way to approximate this effect is to add a third body. Assume that along the direction of the Moon, we add a third body halfway with a mass which is a tenth of a percent of Earth's mass. What is the new center of mass of this system? Additionally, express this change in center of mass as a percentage (i.e. $\frac{\text{Two body system}}{\text{Three body system}}$). How significant is this correction?

Problem 1.3

A particle moves under the influence of a central force directed toward a fixed origin **O**. Explain why the particle's angular momentum about **O** is constant. Give in detail the argument that the particle's orbit must lie in a single plane containing **O**.