Computational Mission Analysis Lecture Notes

Lecture #1

This course has no final. It is designed for people who want to learn some orbit mechanics, some Physics, some history, and something that hasn't been satisfactorily described -- how to solve new problems and develop new concepts. The lecturer will assign some homework, some supplemental reading upon which to base a grade and a course project. The grade you get is not really important; in the long run, the Universe will test you.

The lecturer has little use for formal educational institutions, less for organized religion, and none for politics. The student is in danger of being instilled with a severe case of irreverence. Balancing this grave danger is the possibility of a lifetime of enhanced understanding of the Universe around you and the great work of Isaac Newton and many others.

The lecturer will give a personal account of how he learned orbit mechanics at a time when there were few courses in astrodynamics. This personal account will be accompanied by personal anecdotes from forty years in the Space Biz or as some have called it "The Rocket Racket." The most valuable thing the lecturer can teach is the importance of learning to teach yourself. If your desire for knowledge is great enough, you'll do that anyway.

The next most important thing is to learn to balance analytic and creative aspects of your own mental processes. It is the lecturer's opinion that this balance should be about 50/50. Most courses stress the ability to solve certain types of standard problems very quickly and are lucky to get 5% on the creative or artistic side. This is not one of those courses.

Course Question:
How is it possible to describe the Universe if that description is to be part of the Universe we hope to describe?

The student is asked to consider this question throughout the course, and to formulate a rational answer or a reasonable demonstration that the question has no answer. If you ask someone who has had the course already, you'll be cheating yourself.

Next Question:
Everyone knows that the intersection of a cone and a plane is either an ellipse, a parabola, or a pair of hyperbolae. Where, with respect to the cone are the foci of these conic sections? Can you think of a good use for this knowledge?

Next Question:
A man walks 100 km South(along a meridian) from somewhere on the Earth. He then walks East (along a circle of constant latitude) for 100 km. He then walks North (along a meridian) for 100 km and is exactly at the point on the Earth from which he started his trek. A bear comes along. What color is the bear?

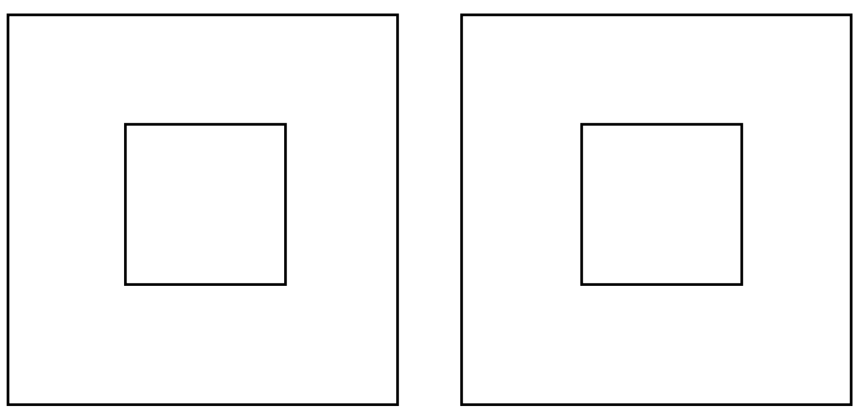
This is the easy part; most people know what color the bear is and where the person started out. The hard part is:

Is there another point on the Earth where the same walking strategy will return the walker to the same point from which he or she started? Are there any other points that will satisfy the walking requirements? If so, how many?

If you know the answers to any of the questions from other inputs, please state your sources and whether you figured them out yourself. You will get no credit for getting the right answer; you will get much credit for a lucid description of how you got the answer or for finding other solutions after you learned the key from some other sources. Be sure to reference the source and any other inputs you had that led you to the solution. If you've read the solution, just say so and I'll find another problem for you. Then you'll be in deep trouble. But you'll have a good chance for an A+.

Next Question:
Below is an engineering drawing (showing all embedded lines as dashed) showing the top and side views of the figure. Please draw the isometric (oblique) view of any figure(s) that satisfy these requirements (that is, no dashed lines in the top and side views). If you solve it, tell me how and whether you've seen the problem before. If so, where? If not, show me your thought processes. The center squares are supposed to be the same size. There are no visible dashed lines in the figures. The solution is a solid figure.

Top View Side View



Oblique View ?

Next Question: That's enough; I'll think of other goodies as I get to know yourgoodselves.

Some Good Books

Danby, J.M.A., "The Fundamentals of Celestial Mechanics," Willmann-Bell, Philadelphia, (2nd Edition has lots of good programs; there's a CD available.)

McCuskey,S.W.., "Introduction to Celestial Mechanics", Addison-Wesley , 1959.

Deutsch, Ralph, "Orbital Dynamics of Space Vehicles", Prentiss-Hall, 1963.

Moulton, F.R., "Celestial Mechanics", 2nd Revised Edition, The MacMillan Co., fifteenth printing 1962. (Original Copyright 1914).

Asimov, I., "Biographical Encyclopedia of Science and Technology", Avon Books, Copyright 1964,1972; First Avon printing, February 1976.

McCuskey,S.W., "Introduction to Advanced Dynamics", Addison-Wesley, c 1963.

Brouwer,D. and Clemence,G.M., "Methods of Celestial Mechanics", Academic Press, 1961. (Considered "the Bible" by many.)

Szebehely, V., "Theory of Orbits", Academic Press, 1967.
(This is "THE" book on the Restricted 3-Body Problem.)

Thomson,W.T. "Introduction to Space Dynamics", Dover Publications, c. 1970. (See especially Ch. 8 for optimal staging problem)

Lanczos, C., "Variational Principles of Analytical Dynamics," (I can't find this one but it's a classic.) It's probably a Prentice-Hall book but I'm not sure.

Lanczos, C. , "Applied Analysis" (3rd Printing 1964) Prentice-Hall, Englewood Cliffs, N.J. 1964, (1964; third printing).

Roy,A.E., "Orbital Motion", ??,?? (this is one of Johnny Kwok's favorites).

Battin, R. H., "An Introduction to the Mathematics and Methods of Astrodynamics," American Institute of Aeronautics and Astronautics, 1987. (This is much more extensive than Battin's early book called "Astronautical Guidance." I call this one "big Battin.")

Chauncey Uphoff , 2001 October