Homework problems set 3, FYTN08, vt19

The exercises for this week (due Friday 26 April, 10.15) are:

1 Exercise 4.21 p 108

2 Exercise 4.22 p 108

3 Exercises 8.3 page 199

4 Exercise 8.8 page 199

5 Exercise 8.19 page 201. For part 8.19c you can use methods similar to those in Chapter 11 for getting at the orbits. However, if you do so you have to be careful with the expansions, the actual expansion is in $x = \sqrt{M/L}$ and you have to keep terms up to one order higher than you would naively do. The solution given in the book first edition and the study book is actually wrong. An easier way is to use the geodesic equation for r and the fact that it is a circular orbit.

This exercise shows how to define the angular momentum of an isolated system (in the weak gravity approximation) similar to the way we defined the mass in Ch. 8. The physical effect it produces is called frame dragging. The solution method is essentially a generalization of what was done in Section 8.4.

6 Not required, but I at least find it interesting from the principle. Prove that the curve connecting two points with the shortest invariant distance satisfies the geodesic equation. This is the alternative generalization of a straight line in flat space as the shortest distance between two points.

Hint, use your Lagrangian mechanics minimization techniques to minimize

$$\int \sqrt{\left| g_{\alpha\beta} \frac{dx^\alpha}{d\lambda} \frac{dx^\beta}{d\lambda} \right|} \, d\lambda$$

This is essentially exercise 6.15 and the solution can be downloaded from the course homepage.

Something to think about

An accelerated charge radiates EM waves. We on Earth are not at rest, but are actually accelerated by its surface. Do the charges we have here then actually radiate EM waves?