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MICHIGAN STATE
U N I V E R S I T Y

PHY422/820: Classical Mechanics

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Midterm #2 Preparation

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Problem P10 – Stability of Circular Orbits

In class, we discussed the possible trajectories for an object with energy E that is moving in a central potential $V(r)$.

1. Under which condition(s) do we obtain a circular orbit?

2. Determine the equations of motion in polar coordinates for a general potential $V(r)$. What condition does the radial equation of motion have to satisfy for a circular orbit?

3. Now consider a circular trajectory with an added perturbation:

$$r(t) = R + \epsilon(t), \quad R = \text{const.} \tag{1}$$

Expand the equation of motion through linear order in ϵ to find an ODE for the perturbation. Which condition does $V(r)$ have to satisfy to ensure that the orbit will be stable? (**Note:** A special case is discussed in **P5**.)