PH 354: hw 2, problem 9

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At Lagrange point L1, the net gravitational force accounts for the centripetal force.
For a Earth-Moon system and the third body being the satellite (restricted 3 body problem),

$$-\frac{GM_{\oplus}m_s}{r^2} + \frac{GM_{moon}m_s}{(R-r)^2} - m_s\Omega^2 r = 0$$

$$\implies -\frac{GM_{\oplus}}{r^2} + \frac{GM_{moon}}{(R-r)^2} - \Omega^2 r = 0$$

This equation can be solved numerically to get the value of r (distance of L1 from Earth).
It comes out to be around 0.002 AU