Session 2 Newton-Raphson Kepler's Equation (Extra Exercise 1)

Exercise: Newton-Raphson Kepler's Equation. Implement a Newton-Raphson algorithm to compute the eccentric anomaly E for a given time Δt after periapsis.

Assume the central body is the Earth, an orbit with a 400-km-altitude perigee, a 6000-km-altitude apogee, and $\Delta t = 0.65$ hours.

1. Initialize problem: define constants and info provided in statement, etc.

2. Compute parameters describing the orbit: semi-major axis, eccentricity, mean motion.

3. Compute target value of Kepler's equation: $M(t) = M_t = n\left(t - t_{periapsis}\right) = E - e \cdot sin(E)$.

4. Provide initial guess for eccentric anomaly, E_0.

5. Compute value of function $f(E_k) = M_t - M(E_k)$ for $E = E_0$.

All of the above initializes the problem and constructs iteration 0.

6. Define loop to iterate on the value of E. We want $f(E) = 0$. You can do this with a while-loop: while $|f(E)|$ is larger than a certain tolerance.

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while abs(f)>tolerance
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7. Within the loop, we want to iterate on the value of E_k until convergence is achieved.

8. The new value of E_k is obtained as $E_{k+1} = E_k - \frac{f(E_k)}{f'(E_k)}$, so we need to know the current value of E_k, we need to evaluate $f(E_k) = M_t - M(E_k)$, and its derivative $f'(E_k) = \frac{df(E_k)}{dE} = -1 + e \cdot cos(E_k)$.

9. Loop is repeated until convergence is achieved.

10. Check the solution is reasonable.