Particle on a ring Solve for an energy eigenstate of a particle confined to a ring, with a potential energy $V(\phi) = V_0 \cos\phi$. Please use a shooting approach, keeping in mind that the Hamiltonian is given by

$$\hat{H} = -\frac{\hbar^2}{2mR^2}\frac{\partial^2}{\partial\phi^2} + V_0 \cos\phi \tag{1}$$

You will need the finite difference approximation for the second derivative:

$$\frac{\partial^2\psi}{\partial\phi^2} \approx \frac{1}{\Delta\phi^2}(\psi(\phi + \Delta\phi) + \psi(\phi - \Delta\phi) - 2\psi(\phi)) \tag{2}$$