1. (20 pts.) Evaluate the commutator $[\frac{d}{dx}, x^2]$
2. (40 pts.) Consider $\Omega = \begin{pmatrix} 2 & 1+i \\ 1-i & 3 \end{pmatrix}$.

2.1 (20 pts) Find the eigenvalues and normalized eigenfunctions.
2.2 (20 pts) Are the eigenfunctions orthogonal?
3. The simplest model for the potential experienced by an electron at the surface of a metal is a step:

\[ V(x) = \begin{cases} 
-V_0 & \text{for } x < 0 \quad \text{(inside the metal)} \\
0 & \text{for } x > 0 \quad \text{(outside the metal)} 
\end{cases} \]

For an electron that approaches the surface from the interior, with \( E (>0) \) in the positive x direction.

3.1 Write expressions for Hamiltonian and wavefunctions in each zone of the potential. Also write the corresponding expressions for wavenumber in each zone, \( i.e. k_1 \) and \( k_{II} \).
3.2 Use the boundary conditions to find the ratio of the coefficients in the wavefunction for Zone I, namely, $B_1/A_1$.

4.3 Calculate the probability (=transmission probability) that it will escape.