Problems:

1. (10 pts) Thornton and Rex, problem 6.15
2. (9 pts) Thornton and Rex, problem 6.23
3. (10 pts) (a) Thornton and Rex, problem 6.24; (b) Thornton and Rex, problem 6.25
4. (5 pts) Thornton and Rex, problem 6.57
5. (5 pts) Thornton and Rex, problem 6.43
6. (11 pts) A scanning tunnel microscope (STM) is an instrument to image surfaces with atomic resolution. A current tunnels from a sharp tip, through air, to a conducting sample.

   (a) (5 pts) Quantitatively argue that the tunneling current \( I_t \propto e^{-2kd} \), where \( k = \sqrt{2m\phi/\hbar} \) is the inverse decay length of the wavefunction in the gap between the tip and sample. Here, \( \phi \) is the potential barrier and \( d \) is the distance between the tip and the sample.

   (b) (2 pts) Estimate \( d \) and explain your reasoning.

   (c) (2 pts) Estimate \( \phi \) and explain your reasoning.

   (d) (2 pts) Estimate \( I_t \) and explain your reasoning.

Grading rubric:

- You are encouraged to show work and explain it in your own words. Partial credit will be assigned in proportion to the correct principle applications.

- Your work must be legible. Illegible (parts of) solutions will not be read, and points may be deducted.

- One point will be deducted for missing or incorrect units on (numerical) solutions.

- For plots one point will be deducted for missing axis and tick labels. Another point will be deducted for missing or incorrect units if applicable.

- “An Aggie does not lie, cheat or steal, or tolerate those who do.” If academic dishonesty is discovered, all associated individuals will receive a zero for this assignment.