1. Shankar, exercises 1.8.1, 2, 3, 4

2. Does the derivative operator in the third-order polynomial vector space have an inverse? Explain in terms of how this operator acts on particular elements of the space. Verify your answer using a property of its matrix form.

3. The angular momentum operator $J_3$ (or $J_z$) is the Hermitian operator that generates small rotations around the $z$-axis. By expanding $R$ from the second homework to first order in $\theta$, determine the matrix form of $J_3$ in the space of physical vectors. Then exponentiate it (keeping enough terms in the expansion to be convincing) and show that you reproduce $R$.

4. In the two-dimensional subspace made up of first-order polynomials, compute the $2 \times 2$ matrix $\exp(\Delta x [\partial_z])$, where $[\partial_z]$ is the matrix representation in this subspace and $\Delta x$ is a real parameter. (It’s much easier than you’d think.) Let it act on a generic vector in this space, and explain what happened. (You’ll probably need to expand your vector in the orthonormal basis from the first set, then unexpand it after acting with this operator.)