1. Consider a decay process wherein \( A \rightarrow B + C \). Again consider all masses known, i.e. \( m_A, m_B, m_C \). Determine the energies \( E_B \) and \( E_C \) in terms of the masses \( m_A, m_B, m_C \). Also determine the magnitude of the outgoing 3-momentum of each decay product \( |\vec{p}_B| \) and \( |\vec{p}_C| \) in terms of the masses \( m_A, m_B, m_C \).

2. Using the method I showed you in class for finding elements of \( F_{\mu \nu} \) by using the definition \( F_{\mu \nu} = \partial_\mu A_\nu - \partial_\nu A_\mu \), find the \( F_{23} \) and \( F_{22} \) components.

3. Beginning with the generator \( g_{R_{xy}} \) given in class for the 2D case, use the exponential map to and Taylor series to find the matrix transformation that this generates, that is find \( R_{xy} = e^{i g_{R_{xy}} \theta} \) as a 2D matrix.

4. The generators of SU(3) can be written as \( g_i = \frac{\lambda_i}{2} \) where:

\[
\begin{align*}
\lambda_1 &= \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \\
\lambda_2 &= \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \\
\lambda_3 &= \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}, \\
\lambda_4 &= \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{pmatrix}, \\
\lambda_5 &= \begin{pmatrix} 0 & 0 & -i \\ 0 & 0 & 0 \\ i & 0 & 0 \end{pmatrix}, \\
\lambda_6 &= \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}, \\
\lambda_7 &= \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & -i \\ 0 & i & 0 \end{pmatrix}, \\
\lambda_8 &= \frac{1}{\sqrt{3}} \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -2 \end{pmatrix}.
\end{align*}
\]

Verify that these generators satisfy the algebra \([g_i, g_j] = if^{ijk}g_k\) where

\[ f^{123} = 1, \quad f^{147} = f^{246} = f^{257} = f^{345} = f^{376} = \frac{1}{2}, \quad f^{458} = f^{678} = \frac{\sqrt{3}}{2} \]

and the \( f^{ijk} \) are totally antisymmetric in the three indices, i.e. \( f^{ijk} = -f^{jik} \). If a particular index combination doesn’t appear in this list (or from cyclic permutations) it is 0. You need not verify all 28 versions of this relationship. A couple of examples should suffice for you to understand how this works. In particular checking \([g_4, g_5]\) would be the most instructive case.

5. Verify the algebra of the Lorentz generators, i.e. that \([J_i, J_j] = i e^{ijk} J_k\), \([K_i, K_j] = -i e^{ijk} J_k\) and \([J_i, K_j] = i e^{ijk} K_k\). You should try at least one nontrivial case for each, i.e. no repeated indices.

6. Verify the algebra of the linear combinations \( J_{\pm i} \), i.e. that \([J_{\pm i}, J_{\pm j}] = i e^{ijk} J_{\pm k}\) and \([J_{+ i}, J_{- j}] = 0\). Again, you should try at least one nontrivial combination from each case.