**Problem 1.** – *Lorentz Transformation*
Consider two inertial frame $\Sigma, \Sigma'$ with parallel axes and relative speed $\overrightarrow{v} = v\overrightarrow{e}_x$. The transformation between $\Sigma$ and $\Sigma'$ is given by

$$\begin{pmatrix} x^{0'} \\ x^{1'} \end{pmatrix} = A(v) \begin{pmatrix} x^0 \\ x^1 \end{pmatrix}, \quad x^{2'} = x^2, \quad x^{3'} = x^3. \tag{1}$$

Find the matrix $A(v)$ by using the 2. postulate of relativity, the linearity of the transformation, and $A^{-1}(v) = A(-v)$.

**Problem 2.** – *Relativistic Momentum- and Position operator*
The contravariant four-vectors of position and momentum are : $x^\mu : \{ct, x, y, z\} = \{ct, \overrightarrow{r}\}$, $p^\mu : \left\{\frac{E}{c}, p_x, p_y, p_z\right\} = \left\{\frac{E}{c}, \overrightarrow{p}\right\}$. Find the form of the corresponding operators in position space and momentum space, that satisfy the commutation relation

$$[x^\mu, p^\upsilon] = -i\hbar g^{\mu\upsilon}$$

**Problem 3.** – *Klein-Gordon-Equation*
Show that the Klein-Gordon-Equation

$$-\hbar^2 \frac{\partial^2}{\partial t^2}\psi = \left(-\hbar^2 c^2 \Delta + m_0^2 c^4\right)\psi$$

remains invariant under Lorentz transformation.