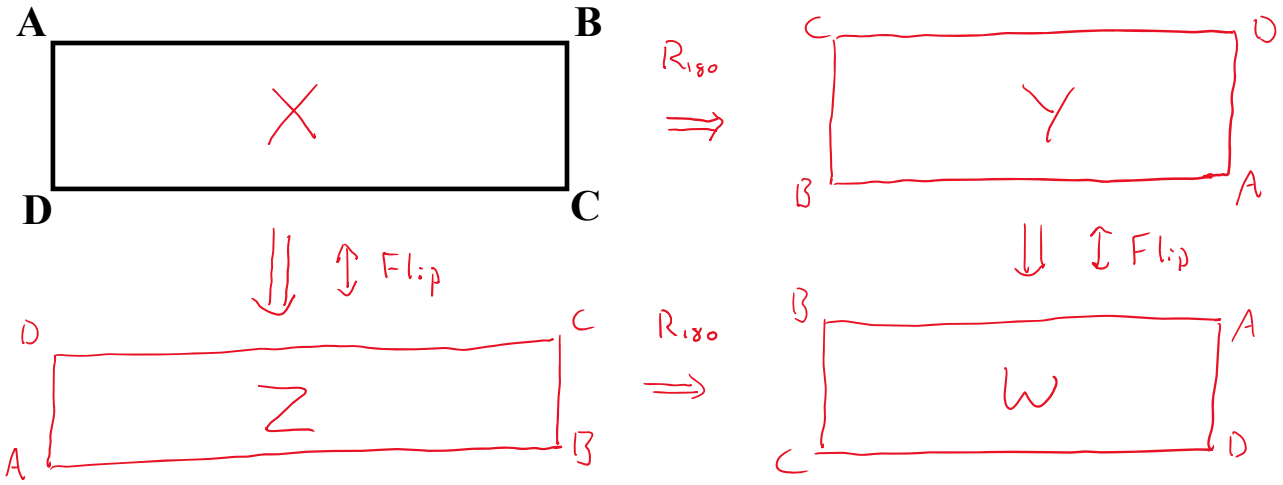
General Relativity HW 2 Quiz Name_____

You can try both problems below, but you will only receive credit for the most correct solution.

1. (*10pts*) Consider the set of transformations in **3D** on a rectangle which carries corners into corners based on the representation pictured. Draw and label the full set of configurations, select a set of basis vectors and construct the corresponding group transformations as matrices. You can use any dimension of representation you like, but make sure you allow for transformations in 3D. You should think about this one a bit before hammering away!



The simplest method is to assign: $X=\begin{pmatrix}1\\0\end{pmatrix}$, $Y=\begin{pmatrix}0\\1\end{pmatrix}$, $Z=\begin{pmatrix}-1\\0\end{pmatrix}$, $W=\begin{pmatrix}0\\-1\end{pmatrix}$

Then: $\{I, R_{180}, Flip, R_{180}Flip\} = \left\{\begin{pmatrix}1&0\\0&1\end{pmatrix}, \begin{pmatrix}0&1\\1&0\end{pmatrix}, \begin{pmatrix}-1&0\\0&-1\end{pmatrix}, \begin{pmatrix}0&-1\\-1&0\end{pmatrix}\right\}$

Or one can just supply the 3 generators: $\{I, R_{180}, Flip\} = \left\{\begin{pmatrix}1&0\\0&1\end{pmatrix}, \begin{pmatrix}0&1\\1&0\end{pmatrix}, \begin{pmatrix}-1&0\\0&-1\end{pmatrix}\right\}$

It can be done in 4D using: $X=\begin{pmatrix}1\\0\\0\\0\end{pmatrix}$, $Y=\begin{pmatrix}0\\1\\0\\0\end{pmatrix}$, $Z=\begin{pmatrix}0\\0\\1\\0\end{pmatrix}$, $W=\begin{pmatrix}0\\0\\0\\1\end{pmatrix}$

Then: $\{I, R_{180}, Flip, R_{180}Flip\} = \left\{\begin{pmatrix}1&0&0&0\\0&1&0&0\\0&0&1&0\\0&0&0&1\end{pmatrix}, \begin{pmatrix}0&1&0&0\\1&0&0&0\\0&0&0&1\\0&0&1&0\end{pmatrix}, \begin{pmatrix}-1&0&0&0\\0&-1&0&0\\0&0&-1&0\\0&0&0&-1\end{pmatrix}, \begin{pmatrix}0&-1&0&0\\-1&0&0&0\\0&0&0&-1\\0&0&-1&0\end{pmatrix}\right\}$

Or 3 generators: $\{I, R_{180}, Flip\} = \left\{\begin{pmatrix}1&0&0&0\\0&1&0&0\\0&0&1&0\\0&0&0&1\end{pmatrix}, \begin{pmatrix}0&1&0&0\\1&0&0&0\\0&0&0&1\\0&0&1&0\end{pmatrix}, \begin{pmatrix}-1&0&0&0\\0&-1&0&0\\0&0&-1&0\\0&0&0&-1\end{pmatrix}\right\}$

Turn over for second question!

2. a.(*4pts*) Using the spacetime diagram below label three events (A,B and C) that occur at the same spatial location, but different times in the (ct'-x')-frame. Also, label three events (D,E and F) that occur simultaneously but at different spatial locations in the (ct'-x')-frame

b.(*4pts*) In what order would these events be seen in the (ct-x) and (ct"-x")-frames?

ct-x : ABC, DEF

ct"-x": ABC, FED

c.(*2pts*) Could these events be seen in any other order for any other frame? If so, in what order?

The orders given in (b) are the only ones (aside from simultaneity of D, E, F). This is because D, E, F are colinear, and because A can cause B can cause C.