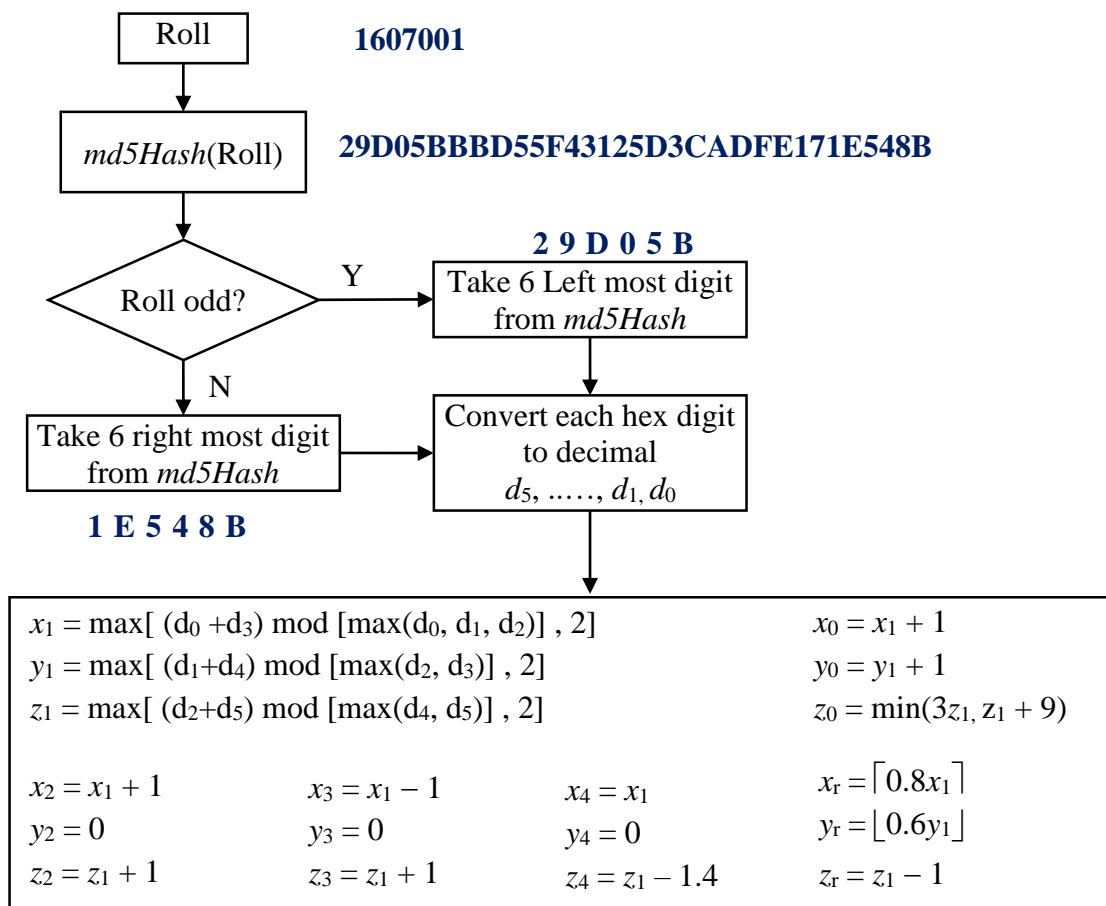
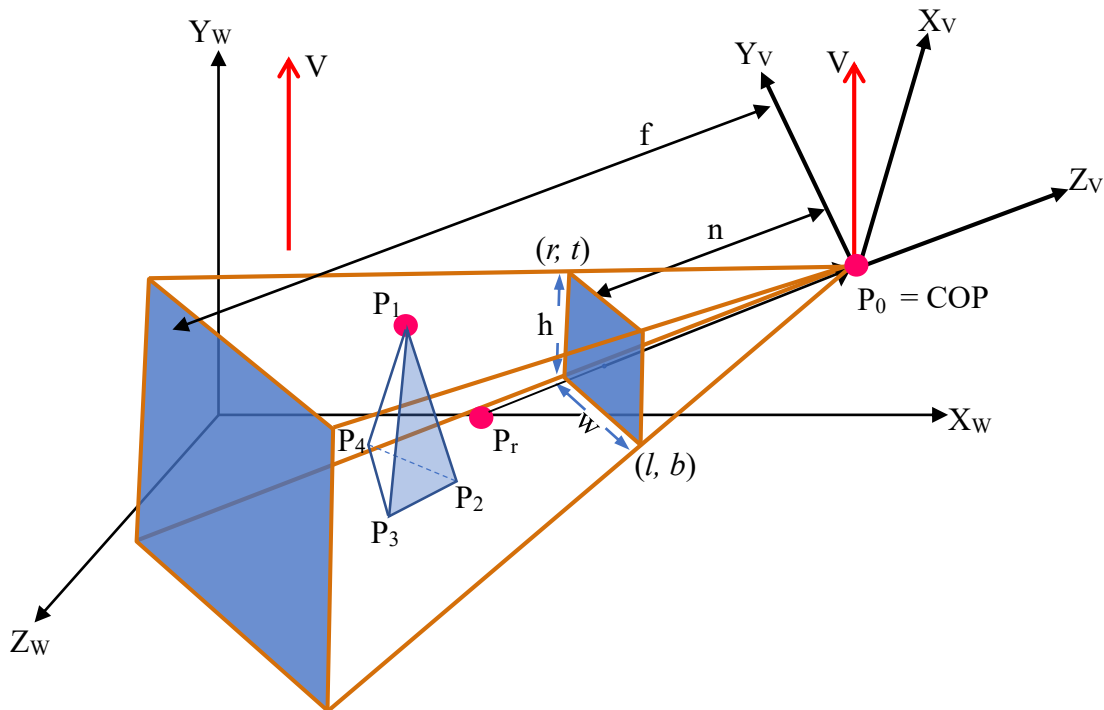


Consider the following figure, where a triangular pyramid is defined by the points $P_1(x_1, y_1, z_1)$, $P_2(x_2, y_2, z_2)$, $P_3(x_3, y_3, z_3)$ and $P_4(x_4, y_4, z_4)$, in World Coordinate System (WCS). A View Coordinate System (VCS) is defined by the parameters *eye* at $P_0(x_0, y_0, z_0)$, *look-at* $P_r(x_r, y_r, z_r)$, and *head-up* vector $V(1, 2, 0)$ specified in WCS. How to choose P_1 to P_4 , P_0 , and P_r are presented in the flowchart below.



1. Determine the corresponding VCS values (P_{1_v} to P_{4_v}) for the WCS points P_1 to P_4 ;
2. Also, determine the **Normalized Device Coordinate System (NDCS)** values (P_{1_n} to P_{4_n}) corresponding to the VCS points P_{1_v} to P_{4_v} , when a perspective projection is performed considering the VCS origin as a Center of Projection (COP) and the view plane perpendicularly cuts the VCS z -axis at *near* position. The view volume used by the

projective transformation is an asymmetric view frustum which is defined by the parameters:

$$\begin{aligned} right &= \lceil \max(x_{1v}, x_{2v}, x_{3v}, x_{4v}) + 1 \rceil; & left &= \lfloor \min(x_{1v}, x_{2v}, x_{3v}, x_{4v}) - 1 \rfloor; \\ top &= \lceil \max(y_{1v}, y_{2v}, y_{3v}, y_{4v}) + 1 \rceil; & bottom &= \lfloor \min(y_{1v}, y_{2v}, y_{3v}, y_{4v}) - 1 \rfloor; \\ near &= \lfloor \max(z_{1v}, z_{2v}, z_{3v}, z_{4v}) / 2 \rfloor; & far &= \lfloor \min(z_{1v}, z_{2v}, z_{3v}, z_{4v}) - 2 \rfloor \end{aligned}$$

3. Draw the NDCS points P_{1n} to P_{4n} as 2D points excluding z coordinate values.

Submission date: 5:00pm, **02/03/2021**.

Be noted that, there will be 10% reduction of marks for each day of delayed submission.