EECS 366/466 Homework # 4 Written Part

*This homework needs to be done individually.*

1. Given a line *P*(*t*) through the points *P*0 = [1*,*0]*T* and *P*1 = [2*,*4]*T* in 2D.
   1. Extend *P*(*t*) to homogeneous coordinates.
   2. Compute the intersection of *P*(*t*) with the homogeneous plane 2*x* = 3*h* in homogeneous coordinates.
   3. What is the point of intersection in non-homogeneous coordinates?
2. Given a triangle 4*ABC* with vertices *A*, *B*, and *C*, and normal *n*1 = [*nx,ny,nz,*0]*T*, we can compute the plane equation *ηTp* = 0, where *ηT* = [*nx,ny,nz,d*], and *p* = [*x,y,z,*1]*T*.
   1. Suppose we apply an invertible transformation *M* to the vertices *A*, *B*, and *C*. What is the transformation *N* (in terms of *M*) applied to *η* to get the equation of the plane defined by the transformed triangle (with vertices *MA*, *MB*, and *MC*)? (Hint: We would like (*Nη*)*TMp* = 0)
   2. What is the normal *n*2 of the transformed plane and transformed triangle?
   3. Could we also compute the transformed normal *n*2 (normal of the transformed triangle) by multiplying the original normal *n*1 by *M*? In other words, is the transformed normal *n*2 equal to *Mn*1? Explain.
   4. Under what conditions might *Mn*1 give you the transformed normal?

For the questions below, you are given a scene with the following viewing parameters:

* Camera is located at coordinates [10*,*10*,*10], with look at direction *N* = [−1*,*−1*,*−1], and up vector *V* = [0*,*0*,*1].
* Image plane is located at a distance of 6 units along the viewing direction (−*z* axis of the view frame) and is orthogonal to the viewing direction with center of projection of the camera at the origin of the view frame. Near and far clipping planes are located at −5 and −25.
* Image window extends from (*xmin,ymin*) = (−4*,*−4) to (*xmax,ymax*) = (4*,*4) in view frame coordinates, and is displayed on a 2-D viewport of size 200x200 pixels, such that the center of the image window is mapped to the center of the viewport, with +*x* and +*y* axes of the view frame pointing right and up, respectively. The viewport coordinate frame is centered on the upper left hand corner of the viewport, with +*x* and +*y* axes pointing **right** and **down**, respectively.

1. What are the viewing (*MVW*), perspective projection (*Mpersp*), and window-to-viewport (*Mviewport*) transformation matrices?
2. If the user clicks at a point with viewport coordinates (*x* = 20, *y* = 50) using the mouse, what is the view frame coordinates of the corresponding point on the image plane? What is the parametric equation of the line that goes through the camera center and the clicked point, in view frame?