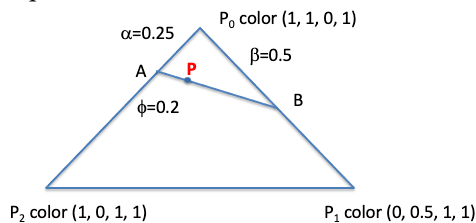


### CSCI 4250/5250 Homework 3

You are required to type your solutions. Submit your answers as **PDF file** to D2L dropbox labelled "Homework 3".

- Given a vector  $a = (3, -2, 2)$ , the magnitude of  $a$  is \_\_\_\_\_;  
and the normalized vector of  $a$  is \_\_\_\_\_;
- Given vector  $a = (2, 3, 1)$  and  $b = (4, 2, 2)$ , the dot product of the two vectors,  $a \cdot b =$  \_\_\_\_\_; if  $\alpha$  is the angle between the two vectors, then  $\cos(\alpha) =$  \_\_\_\_\_;  
the cross product of the two vectors,  $a \times b =$  \_\_\_\_\_ (show calculation steps below).
- Show the parametric form of the line that passes through points  $A(3, 6, 1)$  and  $B(2, 10, 5)$ :  
\_\_\_\_\_. Compute the point  $C$  which is  
 $1/3$  way from  $A$ , and  $2/3$  way from  $B$  \_\_\_\_\_.
- Given 3 points:  $A(2, 1, 1)$ ,  $B(2, 2, 2)$ , and  $C(4, 2, 2)$ , compute the normal vector for the triangle  $ABC$ . Show step-by-step computation involved.
- Given a triangle  $P_0P_1P_2$ . The color of the three points  $P_0$ ,  $P_1$ , and  $P_2$  are marked on the picture below. The location of the point  $A$  is  $a=0.25$  away from  $P_0$ , and point  $B$  is  $b=0.5$  away from  $P_0$ . Applying Gouraud shading, what is the color of the point at location  $P$ ? Show computation steps.



6. A ray of light  $a = \langle 2, 2, 1 \rangle$  from the light source reaches a reflective surface  $s$  and bounces off in direction  $r$ . The normal vector to this surface is  $n = \langle 1, 0, 1 \rangle$ . Compute the reflected light vector  $r$ . Show computation steps.

7. **Object transformation** problem:

- a. Write out the following 4x4 matrices and label each with the following names:  
T0: Translate along X-axis by 4 and along Y-axis by 3  
R: Rotate about the z-axis around the origin by 45 degrees  
T1: Translate along X-axis by -4 and along Y-axis by -3  
S: Scale along X-axis by a factor of 2 and along Y-axis by a factor of 4 (keep value along the Z-axis unchanged)
- b. Apply the transformation matrix T0 to the point  $P = (7, 5, 7)$  to find the transformed point Q by multiply it out.
- c. Apply the transformation matrix R to the point  $P = (7, 5, 7)$  to find the transformed point Q by multiply it out.
- d. Suppose two transformations are to be performed in the sequence, first scale an object with S, and then translate the object with T0. Show the combined effect of these two transformations by multiplying out the two matrices.
- e. How to apply these transformations to the point  $P (7, 5, 7)$ ? Write the matrix, matrix, point multiplication. Make sure the two matrices are multiplied to the point in the correct order.