

Name: \_\_\_\_\_

**Homework 1**  
**15-462 Computer Graphics, Spring 2012**  
**Due 2/28 at the beginning of class**

60 points

**Please show all of your work.**

**Please list any references that you used to research or obtain your solution.**

1. **(5 points)** Write a parametric equation for a line between points  $[1 \ 4]^T$  and  $[2 \ 1]^T$
2. **(5 points)** Write an implicit equation for the same line.
3. **(5 points)** Suppose that we wish to align a 2D coordinate frame  $\mathbf{uv}$  to our world coordinate system  $\mathbf{xy}$ . Let  $u = [2 \ 3]^T$  and  $v = [3 \ -2]^T$ . Give a matrix that maps  $u$  to  $x$  and  $v$  to  $y$ . Show your work and demonstrate that this matrix is correct.
4. **(5 points)** Is your matrix in part 3 a rotation matrix? Why or why not?
5. **(10 points)** Derive a 2D perspective projection matrix for a camera at the origin pointed in the  $x$ -direction, with  $y$  up, an image plane at  $x=5$ . You do not have to preserve depth order. Show your derivation.
6. **(5 points)** Give several pros and cons (at least five total) of working with a mesh vs. an implicit surface
7. **(5 points)** what properties of a surface or material are required for the Phong Illumination Model? (Give specific parameter names and explain their meaning, referencing the equation in the first slide of lecture 9.)
8. **(5 points)** Surface / material properties are captured in a BRDF as a function. What is that function? (Explain any parameters you use.)
9. **(6 points)** Give three different examples of properties that can be captured in a BRDF that are not well captured in the Phong Illumination Model. Including and explaining effects in photos can be a good way to answer this question.
10. **(5 points)** Write the following quadratic spline in matrix form, as we have done for cubic splines in the class.

$$p(u) = p_1 + p_2(u - 1)u + (p_3 - p_1)u$$

11. **(2 points)** What is required for two adjacent such splines to be  $C_0$  continuous?
12. **(2 points)** What is required for two adjacent such splines to be  $C_1$  continuous?