CPSC 314
Assignment 2

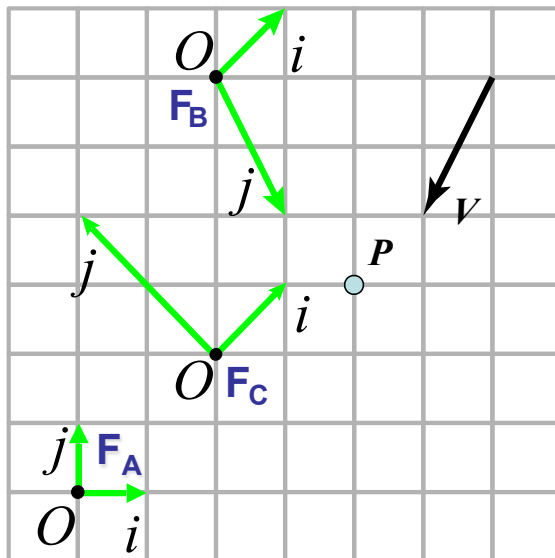### due: Friday, October 7, 2016, in class

> Answer the questions in the spaces provided on the question sheets. If you
> run out of room for an answer, continue on the back of the page.

Name: _____

Student Number: _____

Question 1	/ 8
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Question 3	/ 6
TOTAL	/ 20

1. Transformations as a change of coordinate frame

(a) (1 point) Express the coordinates of point P with respect to coordinate frames A, B, and C.

(b) (1 point) Express the coordinates of vector V with respect to coordinate frames A, B, and C.

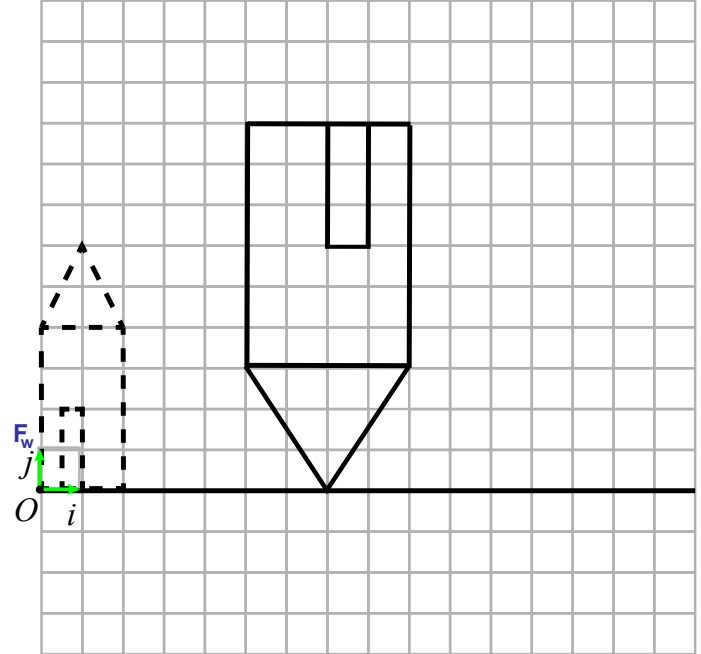$$\begin{bmatrix} \\ \\ 1 \end{bmatrix}_A = \begin{bmatrix} \\ \\ \\ \end{bmatrix} \begin{bmatrix} \\ \\ 1 \end{bmatrix}_C$$

$$\begin{bmatrix} \\ \\ 1 \end{bmatrix}_B = \begin{bmatrix} \\ \\ \\ \end{bmatrix} \begin{bmatrix} \\ \\ 1 \end{bmatrix}_A$$

(c) (2 points) Fill in the 2D transformation matrix that takes points from F_C to F_A, as given to the right of the above figure.

(d) (2 points) Fill in the 2D transformation matrix that takes points from F_A to F_B, as given to the right of the above figure.

(e) (2 points) Using the above two matrices, develop a 2D transformation matrix that takes points from F_C to F_B. Test your solution using point P.

2. Composing Transformations

(a) (2 points) Oh no! After a rowdy party, your roommates the decepticons have made a mess of the house! It's up to the transformers to defuse the situation with your landlord. You must help them put the house on the ground where it was and make it the correct size (the initial house is drawn in dashed line). What sequence of primitive affine transformations (translate, rotate, scale, shear) should you do?

(b) (2 points) Give the resulting 4×4 transformation matrix. Assume that the transformation leaves z to be unaltered.

$$
\begin{bmatrix} \\ \\ \\ 1 \end{bmatrix}_W = \begin{bmatrix} & & & \\ & & & \\ & & & \\ & & & \end{bmatrix} \begin{bmatrix} \\ \\ \\ 1 \end{bmatrix}_{obj}
$$

(c) (2 points) What values would need to be assigned to `theta, a, b, c, i, j, k, x, y, z` in order for the following transformations to yield an identical final transformation? Note, `THREE.Matrix4()` constructs an identity matrix. Also note that here we pretend that * does matrix multiplication. In actual JS code, you'd use multiplyMatrices() function instead.

```
var m = new THREE.Matrix4();
    var m1 = new THREE.Matrix4();
    var m2 = new THREE.Matrix4();
    var m3 = new THREE.Matrix4();
m1.makeRotateAxis(new THREE.Vector3(i,j,k), theta);
m2.makeScale(a,b,c);
m3.makeTranslate(x,y,z);
m = m3*m2*m1;
house.geometry.applyMatrix(m);
```

3. Decompose the following complex transformations in homogeneous coordinates into a product of simple transformations (scaling, rotation, translation, shear). Pay attention to the order of transformations.

(a) (1 point)   (b) (1 point)

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ -1 & 0 & -1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad\qquad \begin{bmatrix} 2 & 0 & 0 & -3 \\ 0 & 0.2 & 0 & 1 \\ 0 & 0 & 5 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(c) (2 points) What are the inverses of the matrices of parts (a) and (b) above?

Hint: if $M = AB$, then $M^{-1} = B^{-1}A^{-1}$

(d) (2 points) Give the sequence of THREE.js transformations that would produce the same transformation matrix as in part (a) of this question.