

# CGRA 151 Introduction to Computer Graphics Mathematics Worksheet 2019

due 13<sup>th</sup> August 2019, 9:00am

Give answers to the following twenty mathematics questions. You may handwrite or typeset your answers but you must submit your answers as a PDF file via the ECS submission system.

You are given the following vectors and matrices:

$$\mathbf{a} = \begin{bmatrix} 1 \\ 4 \\ 8 \end{bmatrix} \quad \mathbf{b} = \begin{bmatrix} 8 \\ -4 \\ 8 \end{bmatrix} \quad \mathbf{c} = \begin{bmatrix} 2 \\ -2 \\ 1 \end{bmatrix} \quad \mathbf{d} = \begin{bmatrix} 8 \\ 0 \\ 6 \end{bmatrix}$$
$$\mathbf{A} = \begin{bmatrix} 2 & 5 & 0 \\ -2 & 3 & 0 \\ -1 & 0 & 2 \end{bmatrix} \quad \mathbf{B} = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \mathbf{C} = \begin{bmatrix} 1 & 0 & 5 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}$$

1.  $\mathbf{a} + \mathbf{b}$
2.  $\mathbf{c} + \mathbf{d}$
3.  $3\mathbf{a}$
4.  $-2\mathbf{b}$
5.  $\mathbf{a} - \mathbf{b}$
6.  $|\mathbf{a}|$
7.  $|\mathbf{b}|$
8.  $\mathbf{a} \cdot \mathbf{b}$
9.  $\mathbf{c} \cdot \mathbf{d}$
10. What is the angle between vectors  $\mathbf{a}$  and  $\mathbf{b}$ ?
11. What is the angle between vectors  $\mathbf{c}$  and  $\mathbf{d}$ ?
12. How long is the projection of vector  $\mathbf{c}$  onto vector  $\mathbf{d}$ ?
13. Calculate  $\mathbf{e}$ , the linear interpolation between  $\mathbf{c}$  and  $\mathbf{d}$ ,  $\mathbf{e} = (1 - t)\mathbf{c} + t\mathbf{d}$ , for  $t = 0.8$ .
14.  $\mathbf{A}\mathbf{b}$
15.  $\mathbf{B}\mathbf{c}$
16.  $\mathbf{A} + \mathbf{B}$
17.  $\mathbf{A}\mathbf{B}$
18.  $\mathbf{B}\mathbf{C}$
19. What two-dimensional transformation is represented by the  $3 \times 3$  matrix  $\mathbf{C}$ ?
20. Give a  $3 \times 3$  matrix that represents a rotation in two-dimensional space of  $60^\circ$ .