# DVA338 – Fundamentals of Computer Graphics

Date: Aug. 14th 2019

Time: 8:10 – 13:30

Help: Small calculator is allowed in the exam

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The exam has 32 points. The grades will be awarded as follows:

- 3 : 16 Points
- 4 : 21 Points
- 5 : 27 Points

Important Notes:

- Give as full an answer as possible to obtain full marks. All calculations, approximations, assumptions and justifications must be reported for full credit unless stated otherwise. Please use figures and examples to clarify.
- If you do not understand a question clearly, make an assumption, write down the assumption and solve the problem based on that.
- Write the question and part number on each page clearly.
- Answer each question on a separate page.
- Do NOT use pencil. No pencil. Papers written with pencil will not be corrected.

May the force be with you.

# Some Useful Information

$S(S_x, S_y) = \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix}$

$T(d_x, d_y) = \begin{bmatrix} d_x \\ d_y \end{bmatrix}$

$R(\theta) = \begin{bmatrix} cos\theta & -sin\theta \\ sin\theta & cos\theta \end{bmatrix}$

$Shear(m_x) = \begin{bmatrix} 1 & m_x \\ 0 & 1 \end{bmatrix}$ this means that $(x', y') = (x + m_x \times y, y)$

$Shear(m_y) = \begin{bmatrix} 1 & 0 \\ m_y & 1 \end{bmatrix}$ this means that $(x', y') = (x, y + m_y \times x)$

$\sin 30° = \frac{1}{2}, \cos 30° = \frac{\sqrt{3}}{2}$

$\sin 45° = \frac{\sqrt{2}}{2}, \cos 45° = \frac{\sqrt{2}}{2}$

$\sin 60° = \frac{\sqrt{3}}{2}, \cos 60° = \frac{1}{2}$

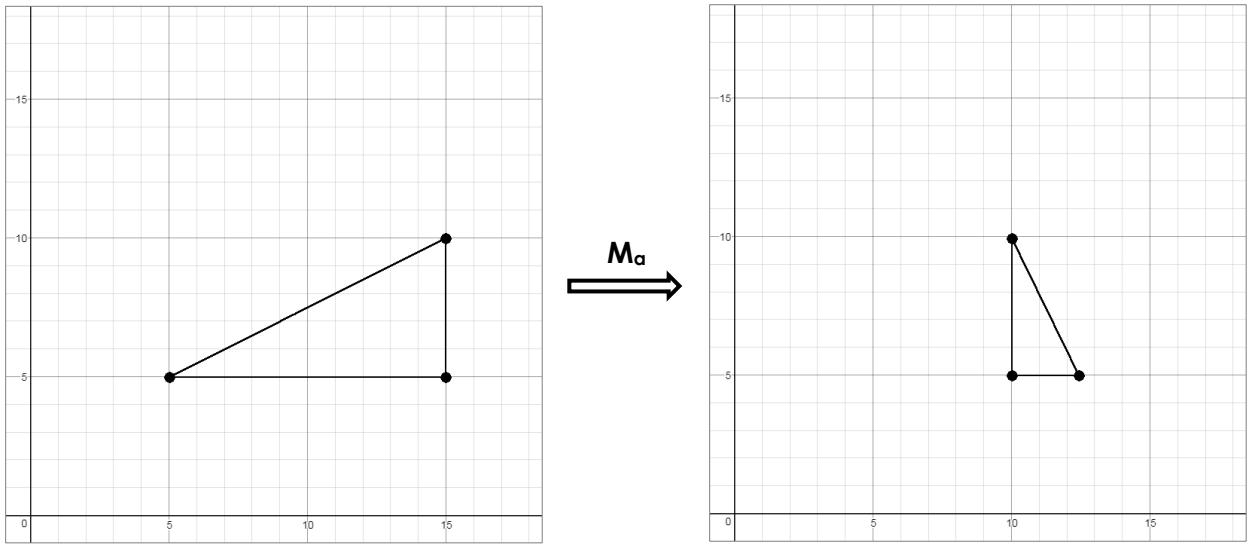
$\sin 90° = 1, \cos 90° = 0$

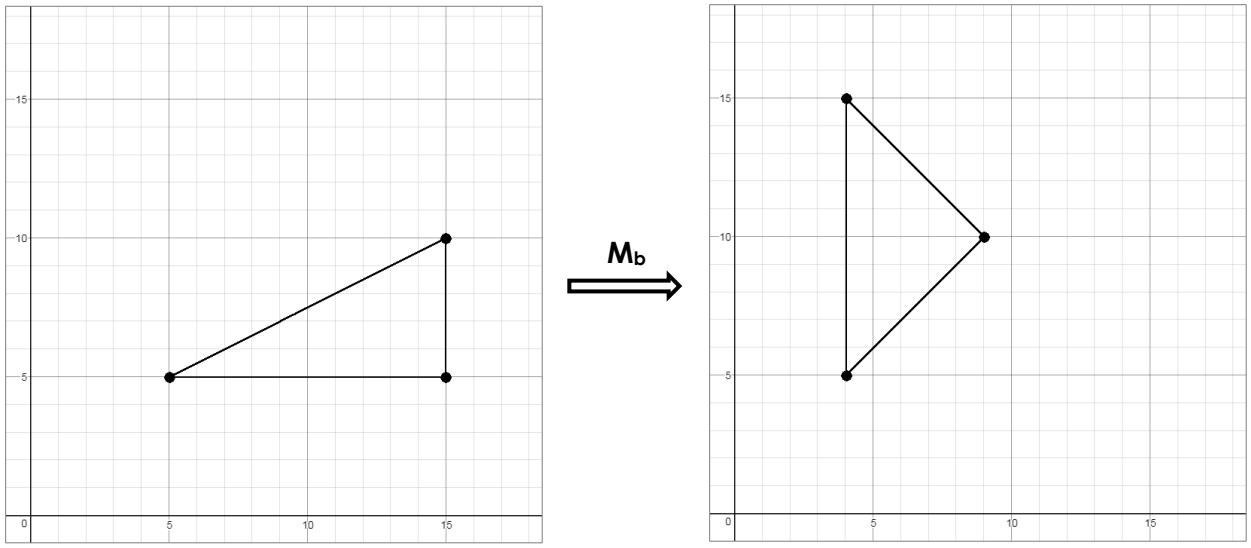
## Task 1 (6p)

In a rasterizing rendering pipeline, 3D models go through a series of transformations to produce the final 2D rendered image. What are these transformations? Name each of them, explain what they do and name the space (coordinate system) that the model ends up after each transformation.

## Task 2 (7p)

Find a composite transformation matrix **M** that can be used to perform the transformations illustrated in the figures below: (a: 3p, b: 4p)



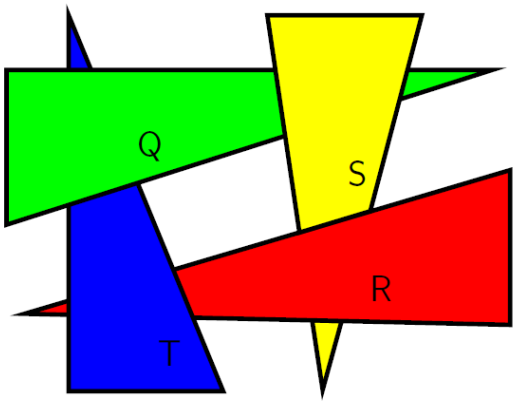
## Task 3 (7p)

a) What is a vertex shader? (2p)
b) What is a fragment shader? (2p)
c) Do you know any other types of shaders? If so, for one of them, explain what their job is and what are they used for?(3p)

## Task 4 (7p)

The figure below shows four primitives rendered using depth-buffering techniques (Z-buffer) in the following order: Q, R, S, T. (They have been sent to the Z-Buffer algorithm in that order and the result is as follows).

a) Explain depth-buffering algorithm using pseudo-code (3p)
b) If we change the order of rendering to S, T, R, Q, how would you update the figure to show the final result of the rendering using depth-buffering? (2p)
c) What are the pros and cons of depth-buffering? (Name at least two reasons for each) (2p)




## Task 5 (5p)

We use many different techniques to improve the quality of the results. Some of them are listed below. Explain each of them and describe what problem are they trying to solve and how they solve it.

a) Mip-mapping
b) Pre-filtering
c) Super sampling
d) Anisotropic Filtering