Graphics (INFOGR 2017-2018) – Midterm Exam

Tuesday May 22nd, 08.30 – 10.30 – EDUC-BETA

- Write your answers, along with solution steps, on the supplied answer sheets.
- State your name and student ID at the top of every answer sheet you want to turn in.
- **Write clearly:** we cannot allocate points for answers that we cannot read.
- No documents allowed. Use of all electronic devices is forbidden.
- If a question is unclear to you, write down how you interpret the question, then answer it.
- The font used for this exam is OpenDyslexic, for your comfort.

PART 1 – MATH - ~1:30 hours – max 36 points

1. [2+5=7 points] Given are two points: $P = (1,2,3)$ and $Q = (5,10,11)$ in $\mathbb{R}^3$, which lie on line L.
   a. Write down the general implicit equation of a plane perpendicular to line L.
   b. We draw a line from point $R = (3,8,5)$ that is perpendicular to line L, intersecting it at point S. Calculate the length of line segment RS.

2. [3+3=6 points] Consider three points in $\mathbb{R}^2$: $A = (1,1)$, $B = (-3,4)$ and $C = (1,7)$.
   a. We place a light at point C. What is the length of the shadow of the line segment AB on the x-axis?
   b. We place a camera at point B, viewing line segment AC, rendering it on the y-axis as the one-dimensional 'screen' as $A'C'$. What is the length of the line segment $A'C'$?

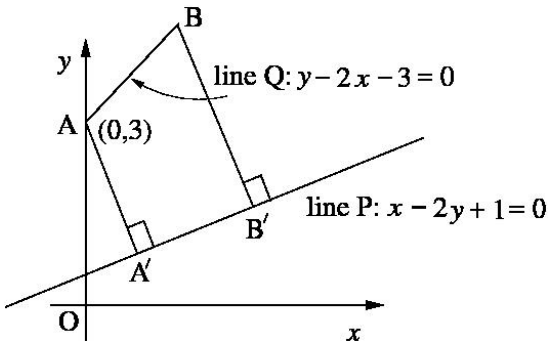
3. [1+5+3=9 points] Given: a sphere in $\mathbb{R}^3$, with centre $C = (3,3,3)$ and a point on the surface of the sphere: $P = (2,5,1)$.
   a. Write down the implicit equation for the sphere.
   b. Calculate the point on the surface of the sphere closest to point $Q = (6,9,1)$.
   c. Unit vector $\hat{u} = \frac{1}{\sqrt{2}}\begin{bmatrix}0\\1\\1\end{bmatrix}$ is a tangent vector of the sphere at point P. Calculate the bitangent vector of the sphere at point P.

4. [4 points] We define a coordinate system in $\mathbb{R}^2$ (i.e., x- and y-axes and the origin). Draw this coordinate system and shade the region for which two conditions hold: $x + y > 1$ and $x + 1 < y$.

5. [3 points] Write down the implicit equation of the tangent plane to the sphere $(x-3)^2+(y-4)^2+z^2=9$ at point $P=(5,5,2)$.

6. [2+1+4=7 points] Consider *Figure 1* below, which depicts a situation in $\mathbb{R}^2$. Given:

   - Line P, defined as $x-2y+1=0$ and line Q, defined as $y-2x-3=0$
   - Points A and B on line Q. The location of A is $(0,3)$. The length of line segment AB is w.
   - The points A and B are projected onto line P at A' and B' respectively, i.e. AA' and BB' are both perpendicular to line P.



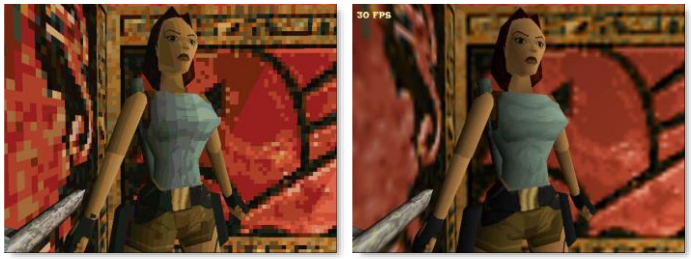
   a. Calculate the length of line segment AA'.
   b. Determine the location of point A'.
   c. Express the length of $A'B'$ as a function of w.

PART 2 – THEORY - ~0:30 hours – max 10 points

7. [6 points] A texture is stored as a palettized image. The dimensions of the texture are 512 x 512 pixels, and it uses exactly 256 unique colors. How much memory (in bytes) is needed to store this texture?

8. [4 points] Complete the following sentence. Write down the four terms that complete the sentence on your answer sheet.

   "The flickering and Moiré-patterns we see on distant textured objects are symptoms of ..... . This problem can be reduced by using ..... . When a textured object is close to the camera, the texture may appear blocky. This is caused by ..... . We can smooth out the blocky texture using ..... .



That's all, good luck!

Check your answers (and writing clarity) carefully.