Graphics (INFOGR 2018-2019) – Midterm Exam

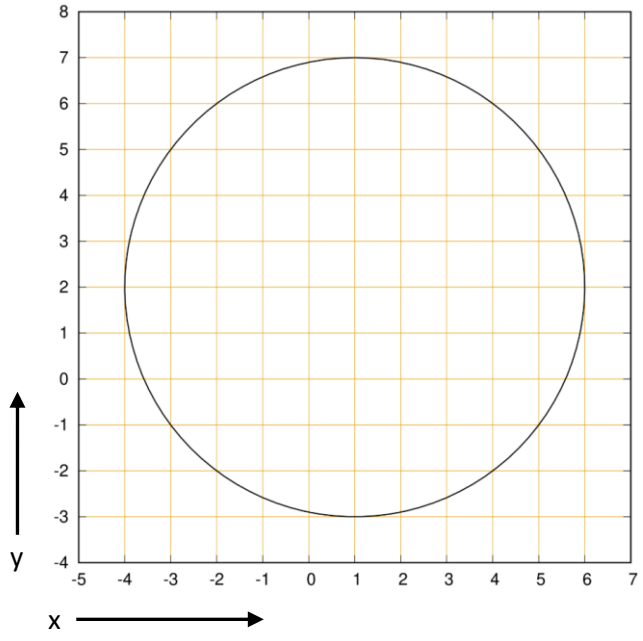
Thursday May 16th, 17.00 – 19.00 – EDUC-GAMMA

- 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 - max 36 points

1. [3+4=7 points] Given are two points: $P = (2,1)$ and $Q = (-1,5)$ in $\mathbb{R}^2$.
   a. Write down the implicit equation of the line passing through P and Q.
   b. The line segment PQ is one edge of a full square $PQRS$. The vertices of the square are labelled in the clockwise direction. Find the coordinates R and S.

2. [2+4=6 points] Consider the circle shown below this question. The centre of the circle is located at $(1,2)$.
   a. Write down the equation of this circle.
   b. Copy the figure below to your answer sheet. Identify clearly the two points A and B on the circle, such that on the arc AB the condition $x - 2y + 8 \leq 0$ holds. Shade this arc (e.g. by making it bold).



3. [3 points] Given: two points $P = (3,3,3)$ and $Q = (5,4,1)$ on the plane $x + 2y + 2z = 15$ in $\mathbb{R}^3$. Determine the unit vector $\vec{v}$ perpendicular to PQ and parallel to the plane.

4. [3+3=6 points] Consider the point $L = (7,4,7)$ in $\mathbb{R}^3$ at which a light source is placed. Consider also a bar between $P = (5,3,5)$ and $Q = (1,2,4)$, casting a shadow $P'Q'$ on the $z = 1$ plane. Find the coordinates of P' and Q'.

5. [4+3=7 points] Consider the plane $2x + 3y + 6z = 8$ and a point $P = (5,6,13)$ in $\mathbb{R}^3$.
   a. Obtain the minimum distance between the point P and the plane.
   b. Find the coordinates of the point Q on the plane corresponding to the minimum distance in part (a).

6. [2+4+2=8 points] Consider the sphere $x^2 + y^2 + z^2 - 6x - 6y - 6z + 18 = 0$ in $\mathbb{R}^3$.
   a. What is the centre and the radius of this circle?
   b. Consider the point $C = (3,-1,4)$, where a camera is located. A ray is shot in the direction $\vec{u} = \frac{1}{\sqrt{2}}\begin{bmatrix} 0 \\ 1 \\ -1 \end{bmatrix}$. Find the coordinates of the points where this ray intersects the sphere. Which one(s) is/are visible to the camera?
   c. Write down the equation of the plane tangent to the surface of the sphere at the point that is not visible to the camera.

PART 2 – THEORY - max 12 points

7. [3 points] Describe in no more than 30 words what a discrete value is.
8. [3 points] Describe in no more than 30 words how MIP-mapping solves undersampling.
9. [3 points] Explain in no more than 30 words why we scale incoming light by $N \cdot L$ before calculating how much light is reflected by a surface.
10. [3 points] Explain in no more than 31 words what shadow acne is.

For inspiration, a screenshot of a ray tracer for blocks that fits in 64 bytes ===>

That's all, good luck!

Check your answers (and writing clarity) carefully.