

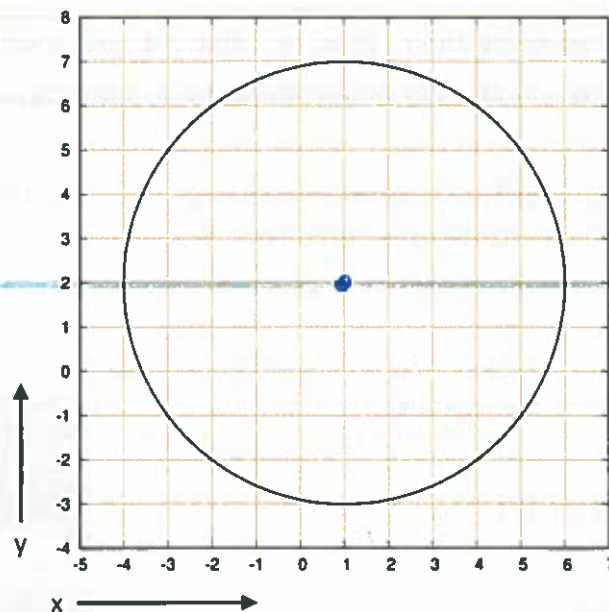
# Graphics (INFOGR 2018-2019) – Midterm Exam

Thursday May 16<sup>th</sup>, 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

- [3+4=7 points]** Given are two points:  $P = (2,1)$  and  $Q = (-1,5)$  in  $\mathbb{R}^2$ .
  - Write down the implicit equation of the line passing through  $P$  and  $Q$ .
  - 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+4=6 points]** Consider the circle shown below this question. The centre of the circle is located at  $(1,2)$ .
  - Write down the equation of this circle.
  - 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.

