Geometry, 30.10.2020

Feedback 1-2

Overall, it was an easy assignment and most of students did it very well.

- Question 2.1:
 - $\circ~$ Useful ideas:
 - know the classification of isometries;
 - look at decompositions into reflections.
 - Typical mistakes:
 - some of you have not explained why to look only at rotations and translations (classification of isometries + orientation);
 - when demonstrating that translations are compositions of rotations, some students assumed that

if f(A) = A' and g(A) = A' then f = g,

which is wrong, you need to check images of 3 points to derive that.

- Major source of confusion:
 - Absence of clear understanding what does it mean when a group G is generated by a set $S \subset G$ of elements $\{s_i \in S\}$. Informally, it means that G is the smallest group containing all elements of S (in particular, containing all their inverses). Formally:

Definition. A group G is generated by a set $S \subset G$ of elements $\{s_i \in S\}$ if for every $g \in G$ there exist $n \in \mathbb{Z}$ and $s_{i_1}, s_{i_2}, \ldots, s_{i_n} \in S$ such that $g = s_{i_n}^{\pm 1} \circ \cdots \circ s_{i_2}^{\pm 1} \circ s_{i_1}^{\pm 1}$. The elements of S in this case are called generators.

In particular, **elements** of $Isom^+(\mathbb{E}^2)$ are identity, rotations and translations. **Generators** for the group may be chosen in many ways. Here are some options:

- all elements of $Isom^+(\mathbb{E}^2)$;
- all rotations;
- rotations preserving the origin and translations.

• Question 2.4:

- Typical mistakes:
 - Some of you forgot that a rotation may be by an angle $\alpha \pi$ where α is irrational.
 - Others forgot that there are rational numbers other than $1/n, n \in \mathbb{Z}$.

• Question 2.7:

- \circ Comments:
 - It is straightforward to figure out *what* to compute in part (a). To make this computation shorter, compute in the vector form, not in coordinates! See solutions.
 - The idea of this question was to obtain two different solutions:
 - (a)-(c): prove f is isometry by a computation,
 - then use the fixed points to see it is a reflection;

(d): see that f is a reflection directly from geometry.

- (First solution is straightforward, second is not).
- To demonstrate the geometric solution, it is very useful to draw a diagram.