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And of course - **Good Luck!**

Voliš rješavati teške probleme koristeći kreativno matematičko razmišljanje? I mi!

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I naravno - **Puno sreće!**

14TH European Mathematical Cup

13th December 2025 - 21st December 2025

Senior Category

Problem 1. Let $k \geqslant 2$ be an integer. Let m and n be coprime positive integers with exactly k positive divisors such that $m < n$.

For $i \in \{1, \ldots, k\}$, denote by f_i and d_i the i-th smallest divisor of m and n, respectively. Suppose that

$$d_i - f_i \mid n - m$$

for all $i \in \{2, \ldots, k\}$. Prove that $d_i \geqslant f_i$ for all $i \leqslant \frac{k}{2}$.

(Ivan Novak)

Problem 2. Let $f \colon \mathbb{N} \to \mathbb{N}$ (where $\mathbb{N}$ is a set of positive integers) be a function such that for every positive integer k, the set $\{f(1), f(2), \ldots, f(k)\}$ contains exactly $f(f(k))$ elements. Prove that

$$f(f(f(k))) = f(k)$$

for every positive integer k.

(Ivan Novak)

Problem 3. Let ABC be an acute triangle with circumcircle ω. Let the angle bisector of $\angle B$ intersect AC, ω, and the parallel to AB from C in D, E and F respectively. Let X be the intersection of ω and the circumcircle of triangle DCF, and let Y be a point on CF such that $YF = YD$. The line XF intersects ω and DY in T and P respectively. The circumcircle of triangle $\triangle TDE$ meets the lines PF and EY in R and S.
Prove that the circumcircles of triangles $\triangle PRS$ and $\triangle BDC$ are internally tangent.

(Yasser Merabet)

Problem 4. Determine all sequences of positive real numbers $a_1, a_2, a_3, \ldots,$ such that for each positive integer n the following equality holds:

$$a_n + \max(a_{n+1}, a_{n+2}) = \frac{1}{\min(a_n, a_{n+1})}.$$

(Ivan Novak)

Time: 240 minutes. *Each problem is worth 10 points.*

The use of calculators or any other instruments except rulers and compasses is not permitted.
Cheating in any form is strictly prohibited. Sharing or posting the problems or solutions before the end of the competition (22nd of December) to anyone who might participate is strictly prohibited.