Time limit: 15 minutes.

Instructions: This tiebreaker contains 3 short answer questions. All answers must be expressed in simplest form unless specified otherwise. You will submit answers to the problem as you solve them, and may solve problems in any order. You will not be informed whether your answer is correct until the end of the tiebreaker. You may submit multiple times for any of the problems, but only the last submission for a given problem will be graded. The participant who correctly answers the most problems wins the tiebreaker, with ties broken by the time of the last correct submission.

No calculators.

1. A square $ABCD$ with side length 1 is inscribed in a circle. A smaller square lies in the circle with two vertices lying on segment $AB$ and the other two vertices lying on minor arc $AB$. Compute the area of the smaller square.

2. Let $ABC$ be a triangle with sides $AB = 19$, $BC = 21$ and $AC = 20$. Let $\omega$ be the incircle of $ABC$ with center $I$. Extend $BI$ so that it intersects $AC$ at $E$. If $\omega$ is tangent to $AC$ at the point $D$, then find the length of $DE$.

3. Circle $O$ has three chords, $AD$, $DF$, and $EF$. Point $E$ lies along the arc $AD$. Point $C$ is the intersection of chords $AD$ and $EF$. Point $B$ lies on segment $AC$ such that $EB = EC = 8$. Given $AB = 6$, $BC = 10$, and $CD = 9$, find $DF$. 

![Diagram with labeled points A, B, C, D, E, F and a circle.](image)