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 $\overline{AB}$ and the other two vertices lying on minor arc $\overset{\frown}{\text{AB}}$. Compute the area of the smaller square.

2. Let ABC be a triangle with sides $AB = 19$, $BC = 21$ and $AC = 20$. Let ω be the incircle of ABC with center I. Extend BI so that it intersects AC at E. If ω 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.