Before you begin read these instructions carefully.
This exam begins at 8AM and ends at 8AM, 24 hours later.
Begin each answer on a separate sheet.
Answers should be handwritten.
You should ensure that your answers are legible; otherwise you place yourself at a disadvantage.
You are advised to write on one side of the paper only.
Make scans of the solutions and send them to biuro@fenix.club with subject line 'Workshop Test Jan Kowalski' where Jan Kowalski is replaced with your name.

1

A square hoop $ABCD$ is made of smooth wire and has side of length $2a$. Plane $ABCD$ is horizontal and hoop rotates about a vertical axis through A at constant angular speed ω. A small bead that can slide along the wire is initially at rest at the midpoint of the side BC. Choose axes fixed relative to the hoop, and let x be the distance of the bead from the vertex B on the side BC. Write down the position vector of the bead in the rotating frame.

Using expression for acceleration in a rotating frame, show that

$$\ddot{x} - \omega^2 x = 0. \tag{1}$$

Hence show that the time that the bead takes to reach a corner of the hoop is $\omega^{-1} \cosh^{-1} 2$. Using dimensional analysis, explain why this time is independent of a.

2

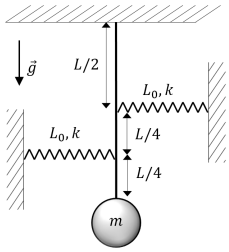

Figure 1

Find the period of small oscillations for the system presented in the figure.

3

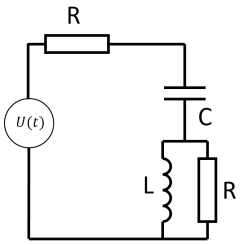

Figure 2

For the system presented in the figure find its impedance. Assuming that voltage $U(t) = U_0 \cos(\omega t)$ find ω for which the current flowing through the system has the largest magnitude of oscillations.