

Simulation Proficiency Assessment

Variable Capacitor Dynamics

October , 2025

Question A

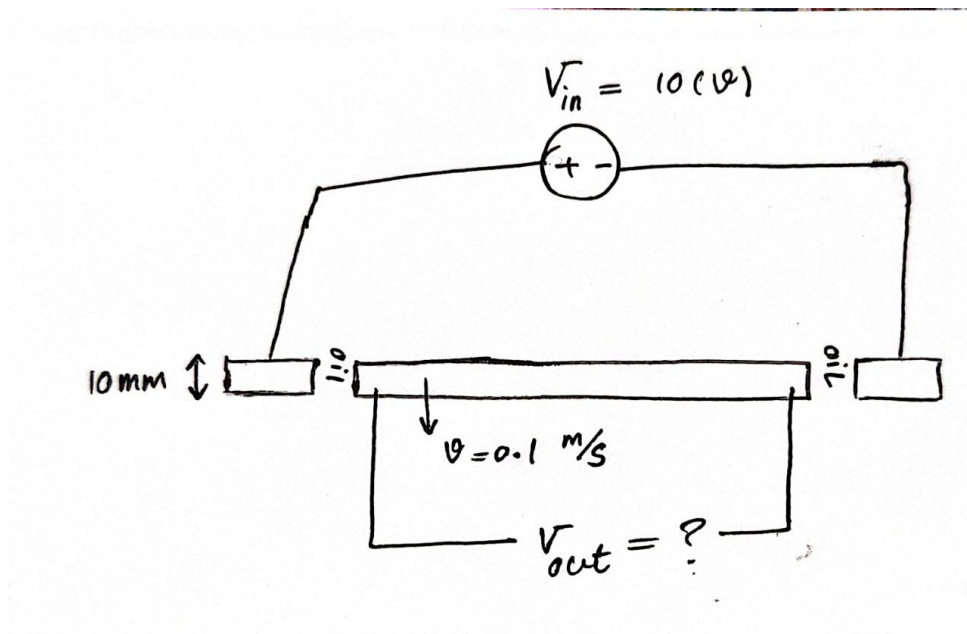


Figure 1: Schematic of a moving bar capacitor.

Problem Description

A central conducting bar is inserted between two stationary outer plates, separated by a dielectric (oil). An input voltage of $V_{in} = 10 \text{ V}$ is applied to the outer plates. The central bar moves at a speed of $v = 0.1 \text{ m/s}$. The simulation begins at $t = 0$ as the bar starts to enter the plates. The output voltage, V_{out} , is measured across the two ends of the **moving central bar**.

Assume the central bar is an ideal conductor (zero resistance).

1. What is the voltage V_{out} at the first moment after the capacitor is charged?
2. Draw a graph of the output voltage $V_{out}(t)$ over time as the conductor moves. Provide a brief physical explanation for your answer.

Question B

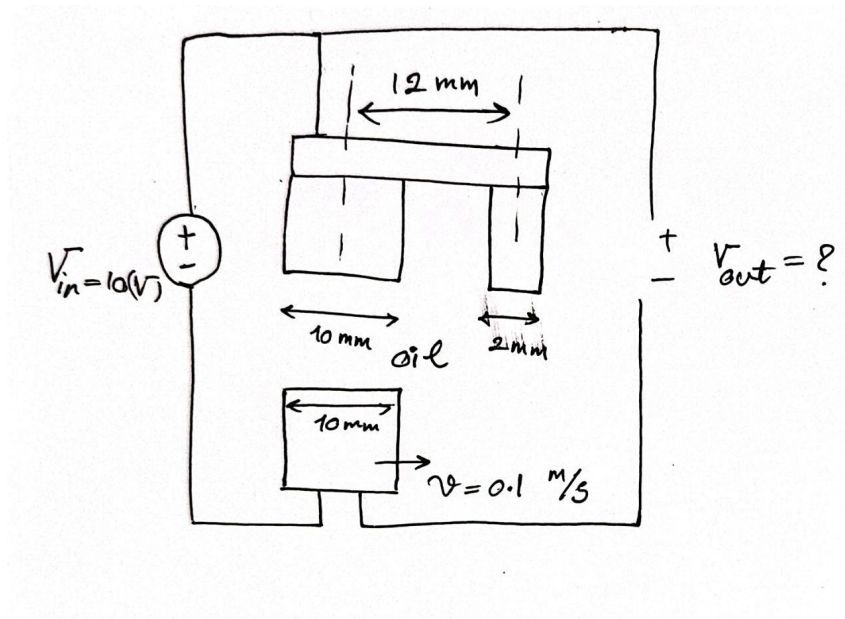


Figure 2: Schematic for the differential capacitor system.

Problem Description

Consider the circuit shown above. A lower conducting plate ($10 \text{ mm} \times 10 \text{ mm}$) moves horizontally at $v = 0.1 \text{ m/s}$, creating a variable capacitor with a stationary U-shaped electrode. The system is connected to an ideal DC voltage source of $V_{in} = 10 \text{ V}$. The dielectric is oil. The output voltage, V_{out} , is measured across the terminals connected to the voltage source.

Task

Using circuit analysis and/or a simulation tool of your choice, determine the output voltage V_{out} as the lower conductor moves.

1. Provide a plot of the output voltage, $V_{out}(t)$, versus time.
2. Justify your answer with a concise explanation based on the circuit diagram.

Question C

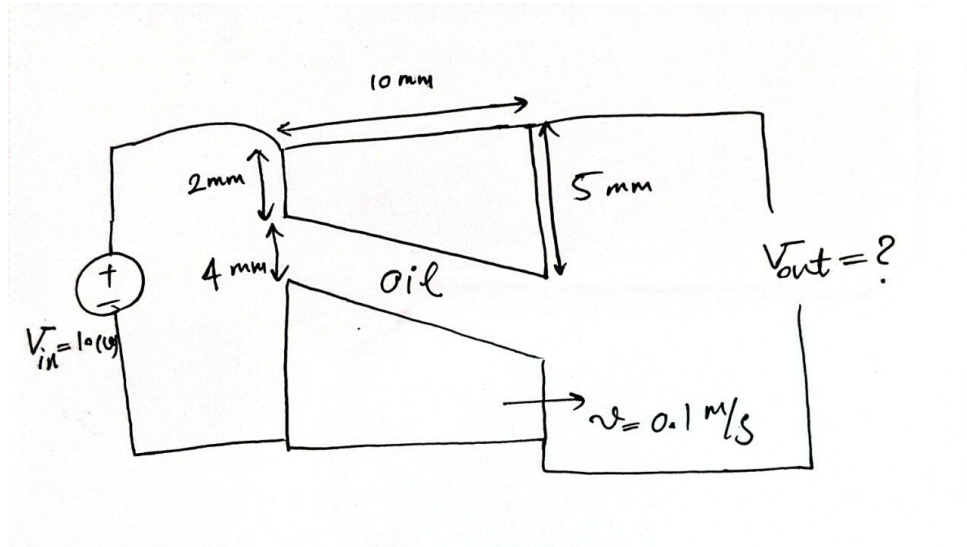


Figure 3: Schematic for the wedge capacitor system.

Problem Description

In this case, two stationary conductors form an inclined (wedge) shape. The gap between them varies linearly from 4 mm on one end to 1 mm on the other, over a length of 10 mm. A lower conductor moves into this gap at a constant speed of $v = 0.1 \text{ m/s}$. The system is powered by an ideal DC voltage source of $V_{in} = 10 \text{ V}$, and the dielectric is oil. The output voltage, V_{out} , is measured across the same terminals where the source is connected.

Task

The lower conductor starts outside and moves leftward into the gap.

1. Draw a graph of the output voltage, $V_{out}(t)$, versus time for the duration of the movement.
2. Provide a clear and direct explanation for the behavior shown in your plot, paying close attention to the circuit schematic.