



**UNIVERSITY OF MORATUWA, SRI LANKA**  
**Faculty of Engineering**  
**Department of Electronic and Telecommunication Engineering**  
**Semester 4 (Intake 2020)**

**BM2102 Analysis of physiological systems**  
**Assignment 1**  
**Simulation of Respiratory Mechanics**

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## 1. Normal Subject

Typical values of parameters related to the Respiratory Mechanics,

- Lung Compliance: Refers to the ease with which the lungs to expand during inhalation and contract during exhalation. Typical values for lung compliance range from 0.1-0.2 L/cmH<sub>2</sub>O.
- Thoracic Compliance: Refers to the ability of the chest wall to expand during breathing. Typical values for thoracic compliance are in the range of 0.1-0.2 L/cmH<sub>2</sub>O.
- Central Airway Resistance: In healthy individuals, central airway resistance is relatively low, allowing for smooth airflow through the large airways. Typical values for central airway resistance are around 0.5-2.5 cmH<sub>2</sub>O/L/s.
- Peripheral Airway Resistance: Peripheral airway resistance is also relatively low in normal individuals. Typical values for peripheral airway resistance are around 0.5-2.0 cmH<sub>2</sub>O/L/s.

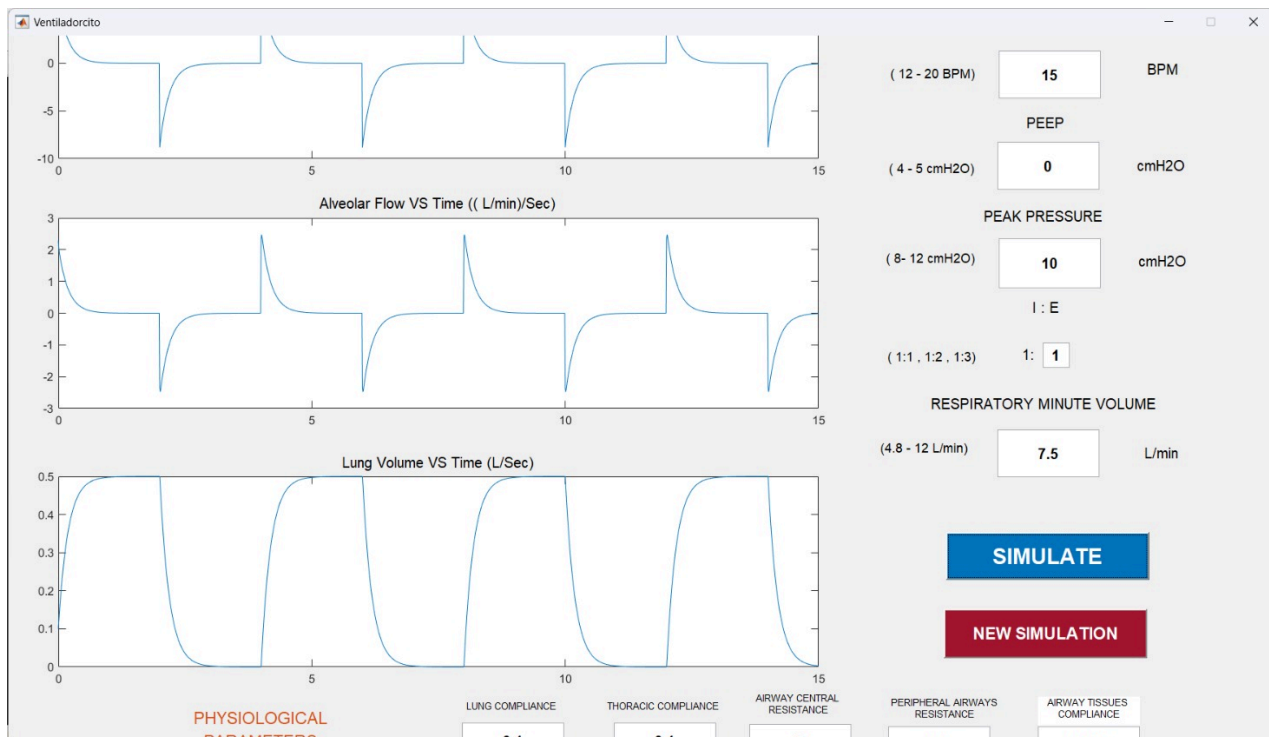
### Values used for Simulation

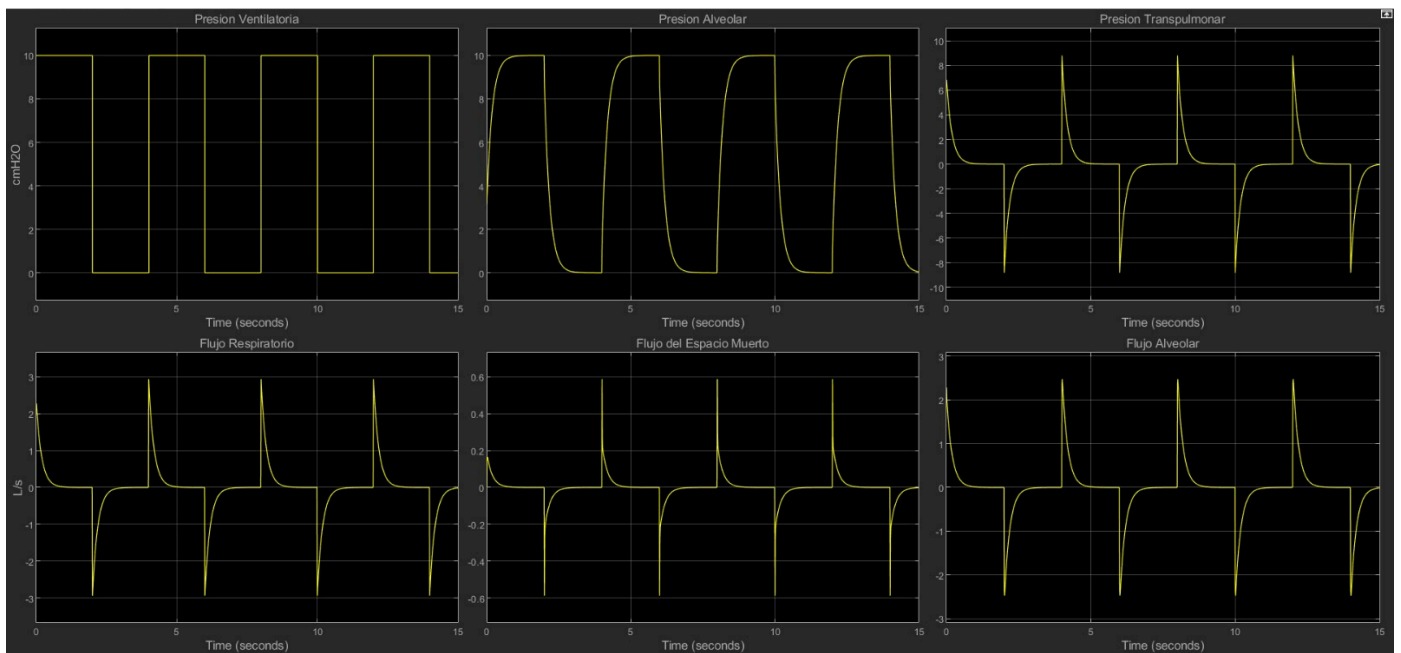
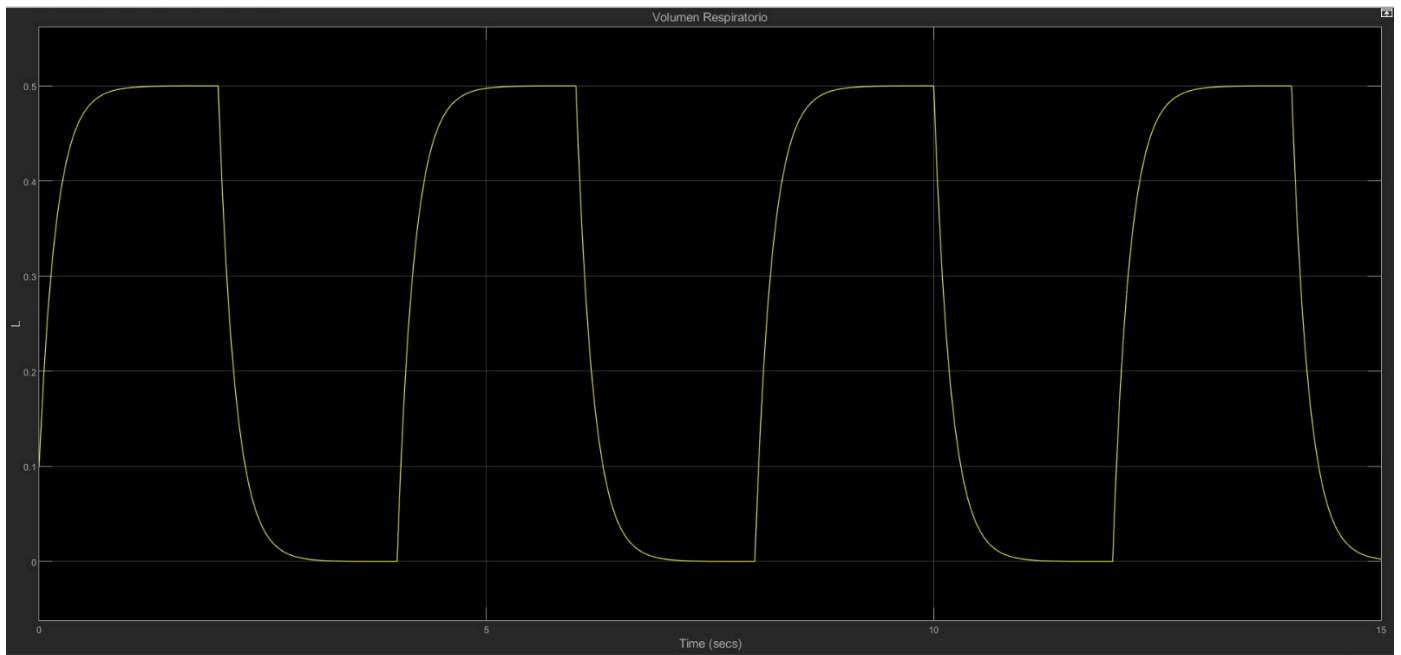
Physiological Parameters:

- Lung Compliance: 0.1 L/cmH<sub>2</sub>O
- Thoracic Compliance: 0.1 L/cmH<sub>2</sub>O
- Central Airway Resistance: 3 cmH<sub>2</sub>O/L/s
- Peripheral Airway Resistance: 0.5 cmH<sub>2</sub>O/L/s
- Airway Tissue Compliance: 0.005 L/cmH<sub>2</sub>O

Ventilator Settings:

- Breathing Frequency: 15 BPM
- PEEP: 0 cmH<sub>2</sub>O
- Peak Pressure: 10 cmH<sub>2</sub>O





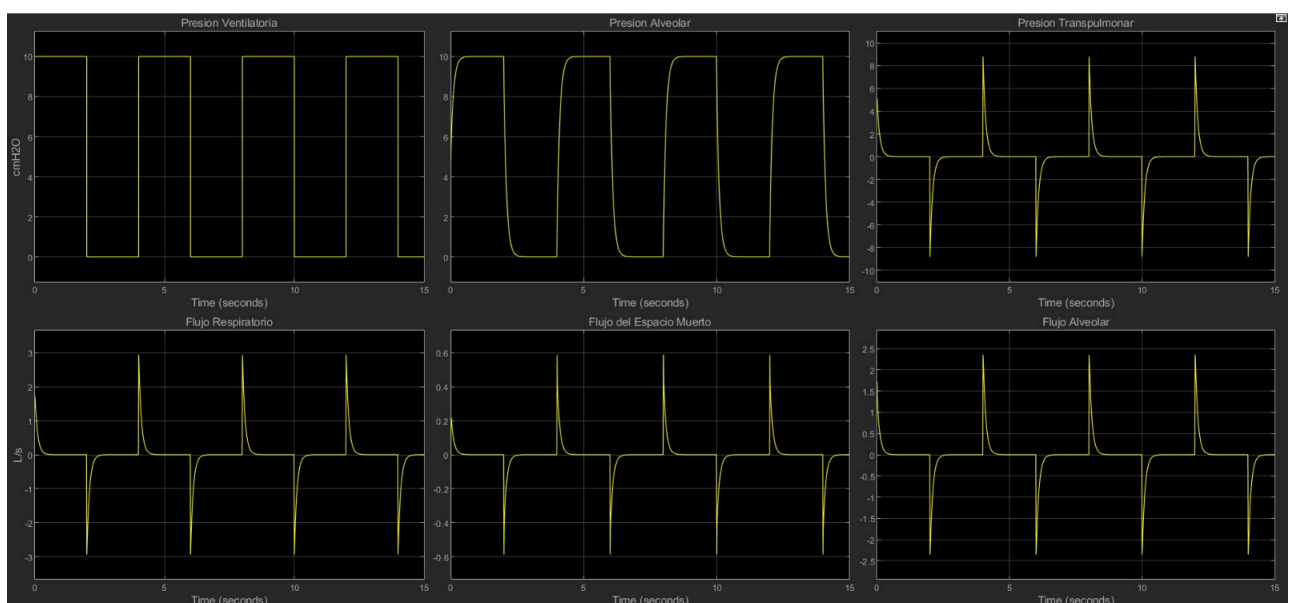
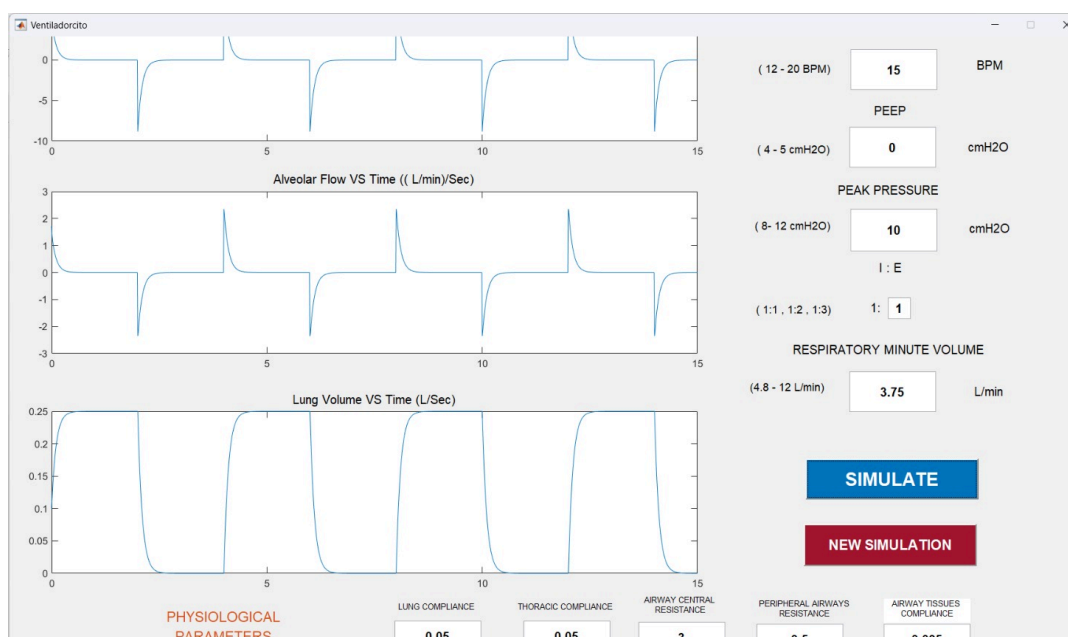
## 2. Restrictive Pulmonary Disease (Pulmonary Fibrosis)

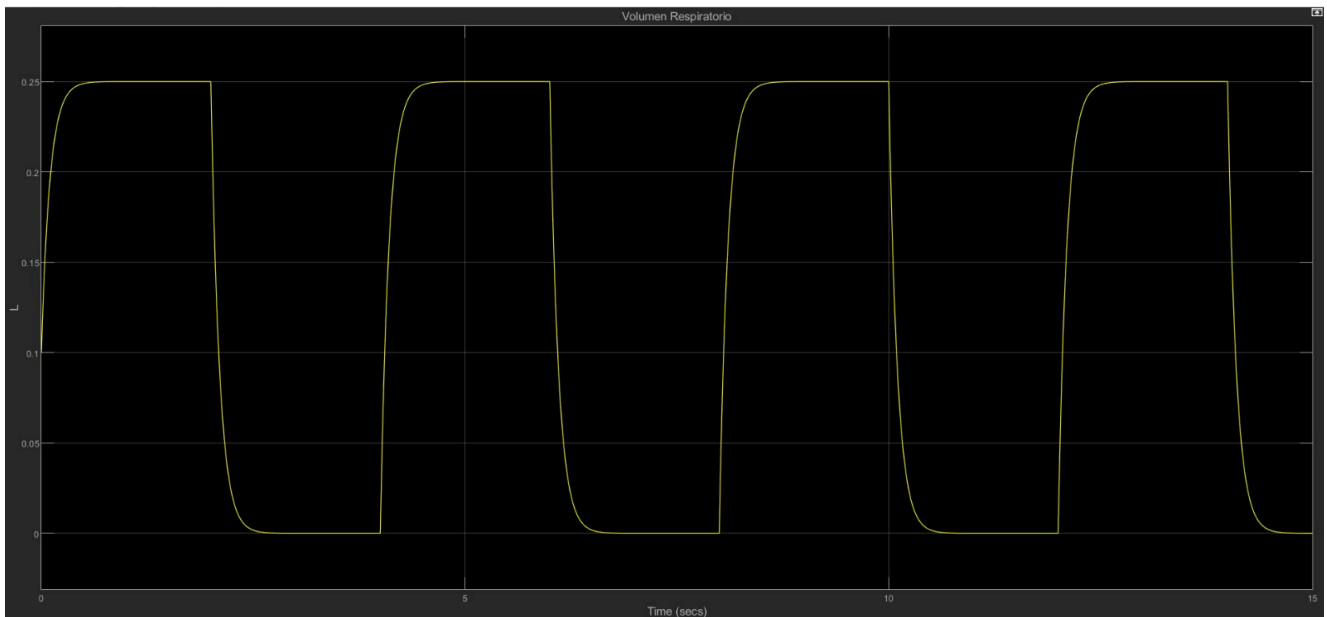
In restrictive pulmonary diseases, such as pulmonary fibrosis, the lung tissue becomes stiff, leading to a reduction in lung compliance and impaired lung expansion. As a result, the lungs have difficulty fully inflating during inspiration, leading to a decrease in the volume of air that can be inspired and expired during each breath.

To simulate this both lung compliance and thoracic compliance should be reduced.

Physiological Parameters:

- Lung Compliance: 0.05 L/cmH<sub>2</sub>O
- Thoracic Compliance: 0.05 L/cmH<sub>2</sub>O
- Central Airway Resistance: 3 cmH<sub>2</sub>O/L/s
- Peripheral Airway Resistance: 0.5 cmH<sub>2</sub>O/L/s
- Airway Tissue Compliance: 0.005 L/cmH<sub>2</sub>O

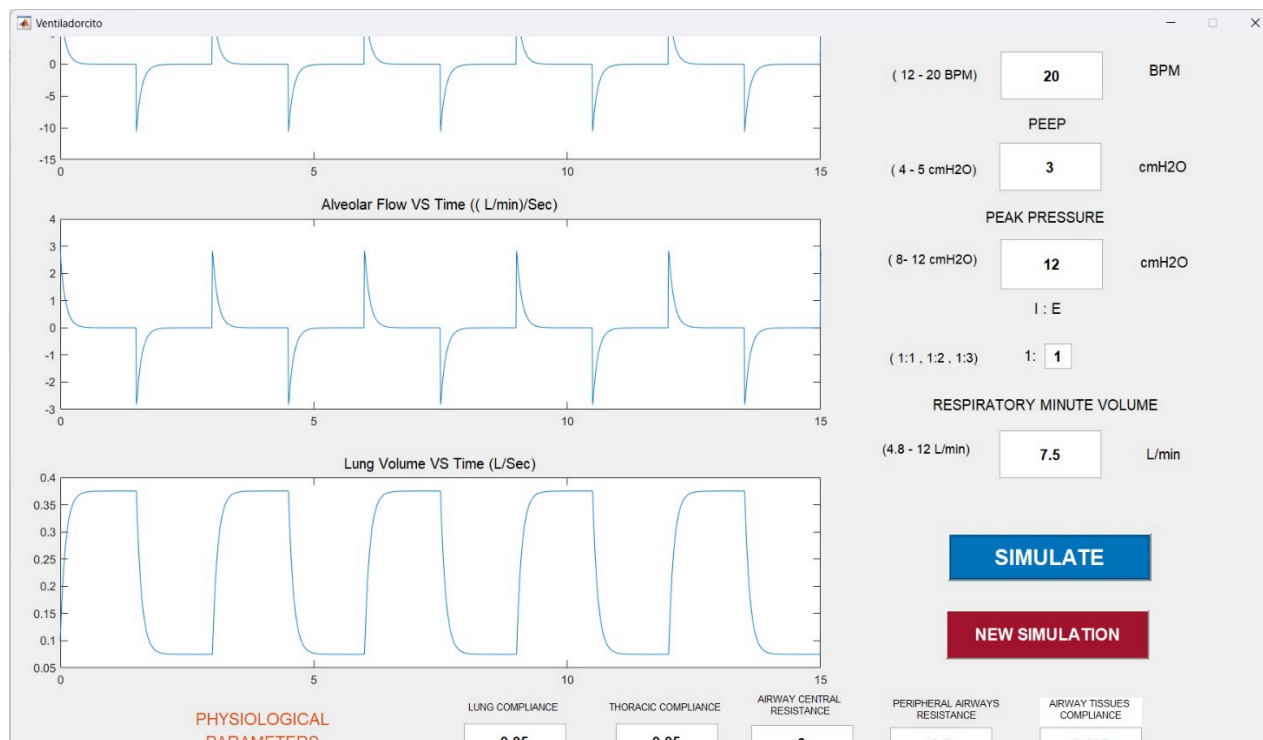




Due to the restrictive pulmonary disease, the tidal volume and the **respiratory minute volume of the subject has been significantly reduced.**

To facilitate proper respiration through the ventilator, the following settings of the ventilator can be changed to following values.

- Breathing Frequency: 20 BPM
- PEEP: 3 cmH<sub>2</sub>O
- Peak Pressure: 12 cmH<sub>2</sub>O



Due to the change in ventilator settings, respiratory minute volume and tidal volume has been restored to a normal value.

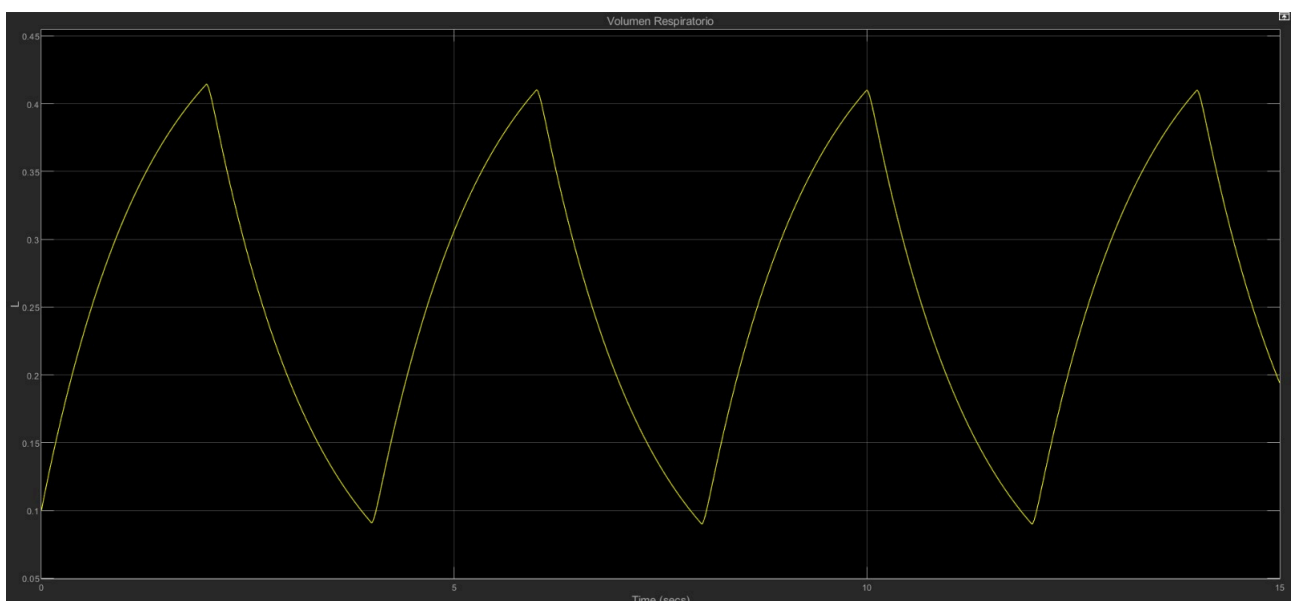
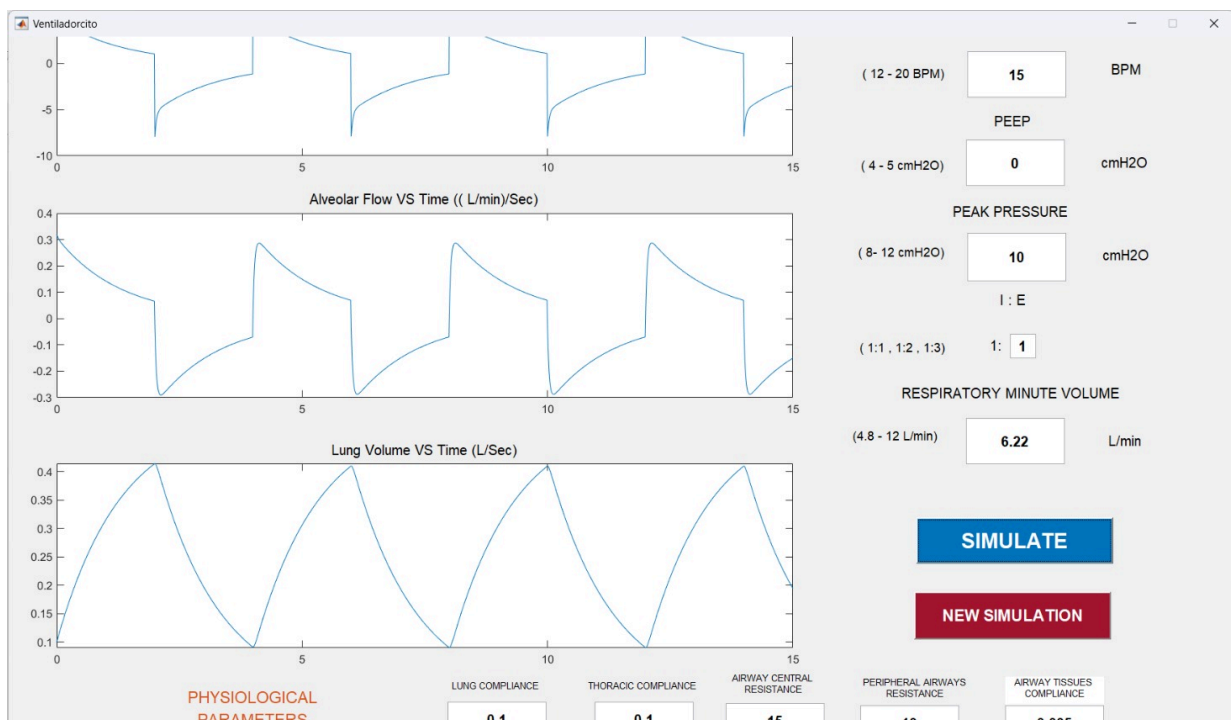
### 3. Obstructive Pulmonary Disease (COPD)

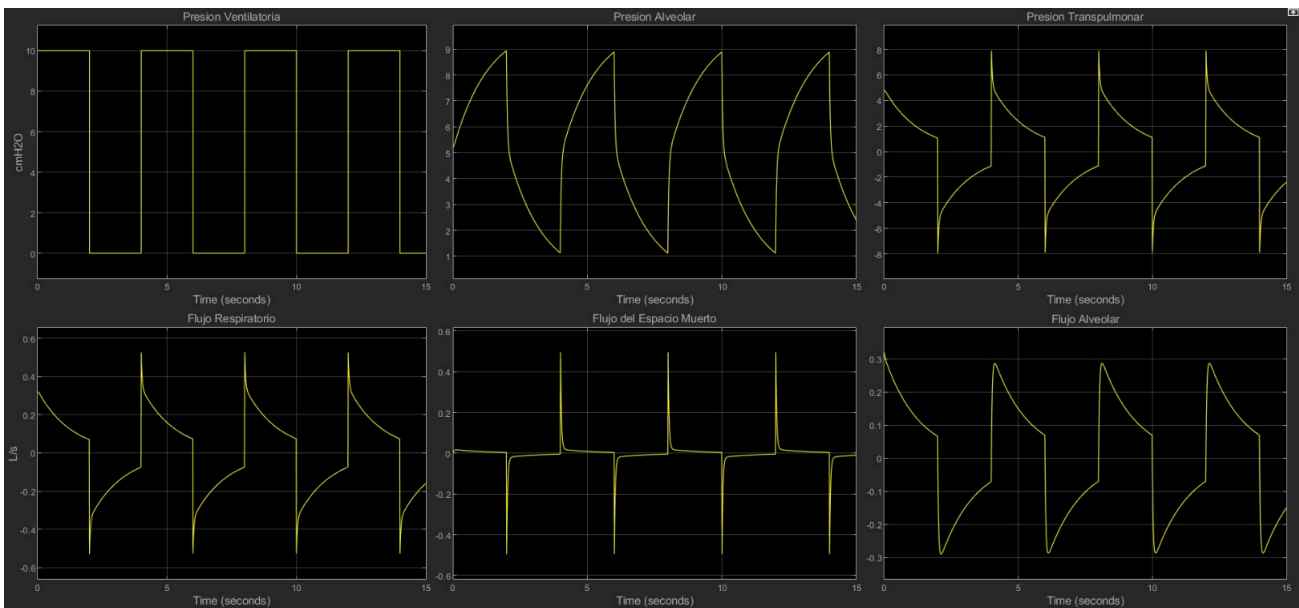
In obstructive pulmonary diseases, the primary characteristic is increased resistance to airflow in the airways, making it difficult for the individual to exhale fully. The most common example of obstructive pulmonary disease is Chronic Obstructive Pulmonary Disease (COPD), which includes conditions like chronic bronchitis and emphysema.

To simulate this both central airway resistance and peripheral airway resistance should be increased.

Physiological Parameters:

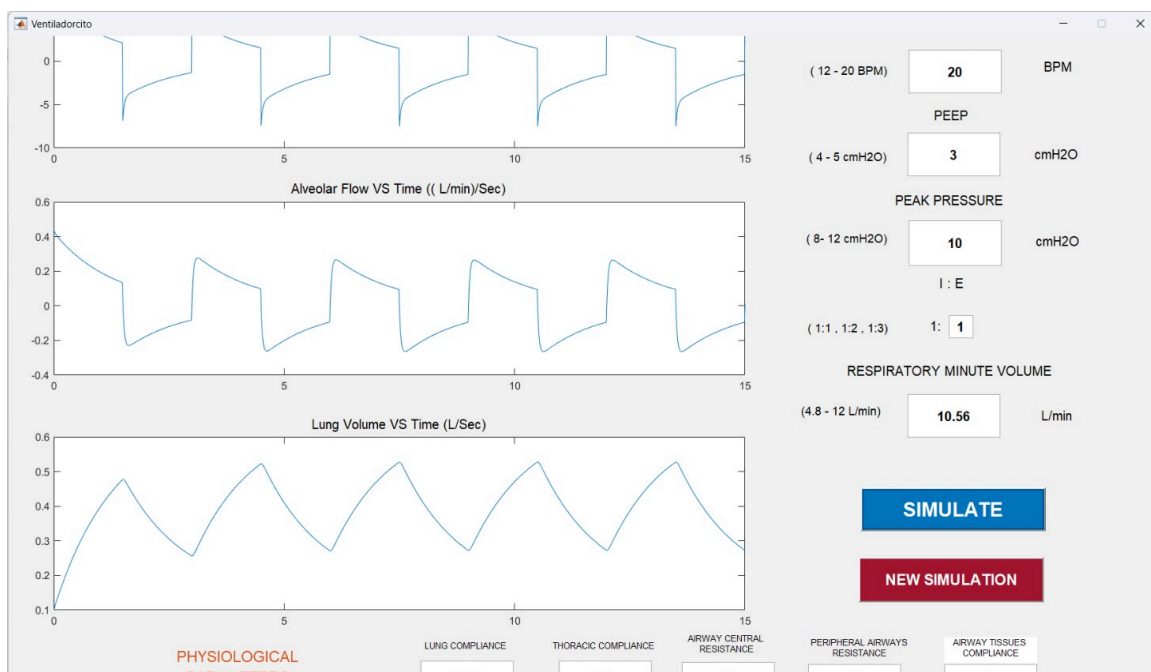
- Lung Compliance: 0.1 L/cmH<sub>2</sub>O
- Thoracic Compliance: 0.1 L/cmH<sub>2</sub>O
- Central Airway Resistance: 15 cmH<sub>2</sub>O/L/s
- Peripheral Airway Resistance: 10 cmH<sub>2</sub>O/L/s
- Airway Tissue Compliance: 0.005 L/cmH<sub>2</sub>O





To facilitate proper respiration through the ventilator, the following settings of the ventilator can be changed to following values.

- Breathing Frequency: 20 BPM
- PEEP: 3 cmH2O
- Peak Pressure: 10 cmH2O



Due to the change in ventilator settings, respiratory minute volume and tidal volume has been restored to a normal value.

### Comparison of Respiratory Minute Volume

In a normal subject, minute ventilation is achieved through a balanced combination of normal tidal volume and respiratory rate.

In restrictive pulmonary disease, minute ventilation may be decreased due to a reduction in tidal volume, even though the respiratory rate is increased.

In obstructive pulmonary disease, minute ventilation may be increased due to an elevated respiratory rate compensating for airflow limitations, despite the tidal volume being relatively preserved.