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Leibniz Universität Hannover

Simulation Engineering

Homework 4 : Simulation Project (Break System on ICE Train)

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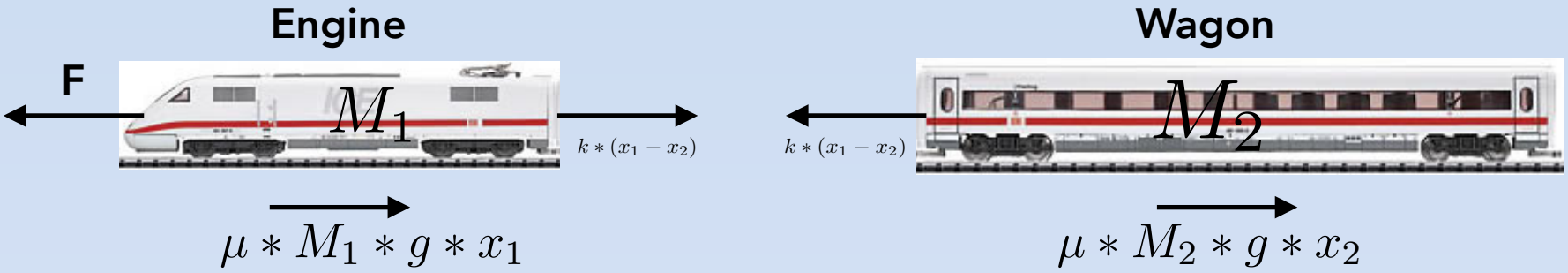
Problem

- Problem : Design of the braking system on ICE train.
  - If train moving at high speed starts and stops suddenly, the heat due to friction will damage the wheels as well as the tracks.
  - Sudden stopping can also lead to derailment of train from track which would be very dangerous.
- Requirements :
  - The braking system should be such that the train has a constant speed and gradually and smoothly starts and stops
  - Damage to the train as well as the tracks should be prevented (unless emergency braking is needed) as repair will also incur money and will lead to delay of train service.
  - Input (start and stop) signal can be a square wave, we need plot of velocity

Conceptual Model

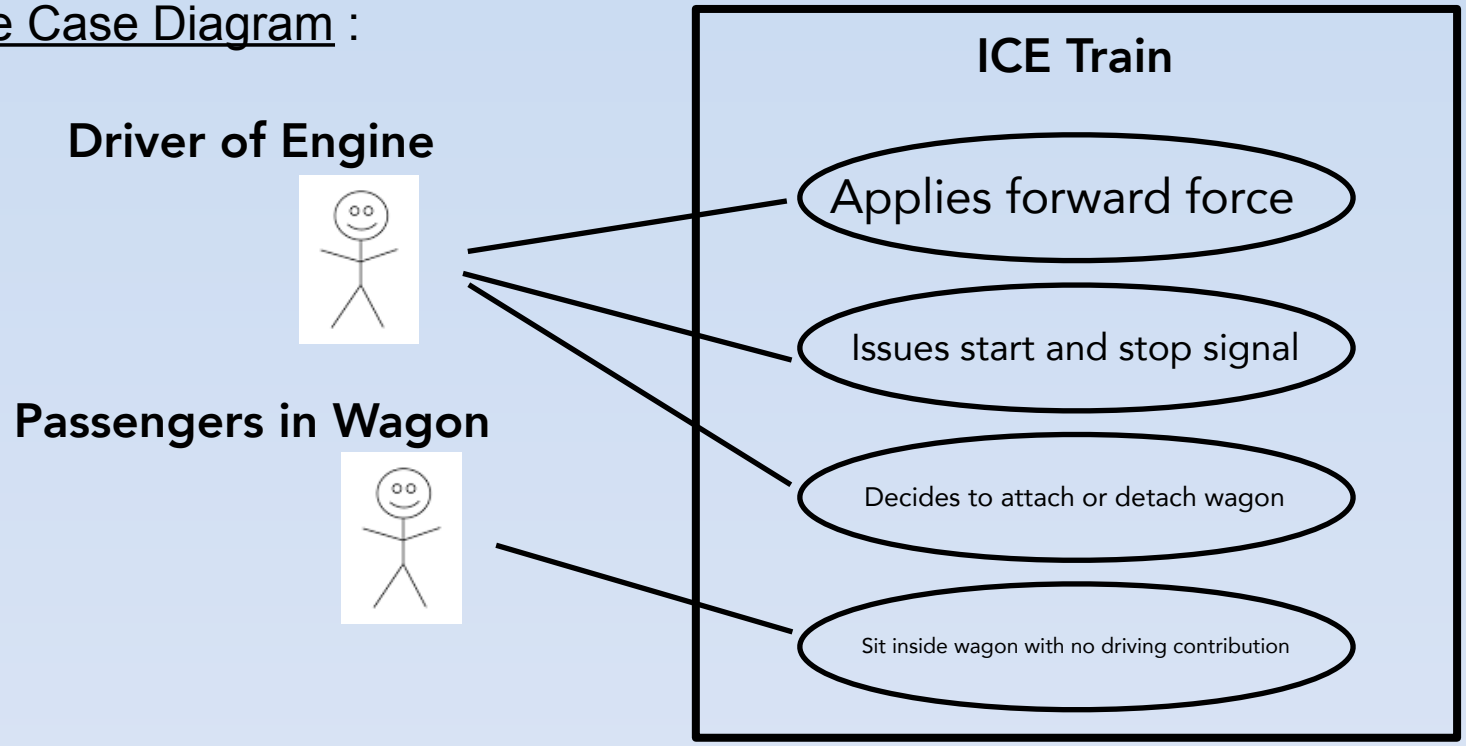
- Physics of System :



- Engine applies forward force F to move, has two backward forces acting on it which are force due to friction ($\mu * M_1 * g * x_1$) and due to spring force attaching it to wagon which is $k * (x_1 - x_2)$
- Wagon has two forces acting on it : forward force due to spring force attaching it to engine which is $k * (x_1 - x_2)$ and backward force due to friction ($\mu * M_2 * g * x_2$)
- Coefficient of friction is μ and g is the gravitational constant

Conceptual Model

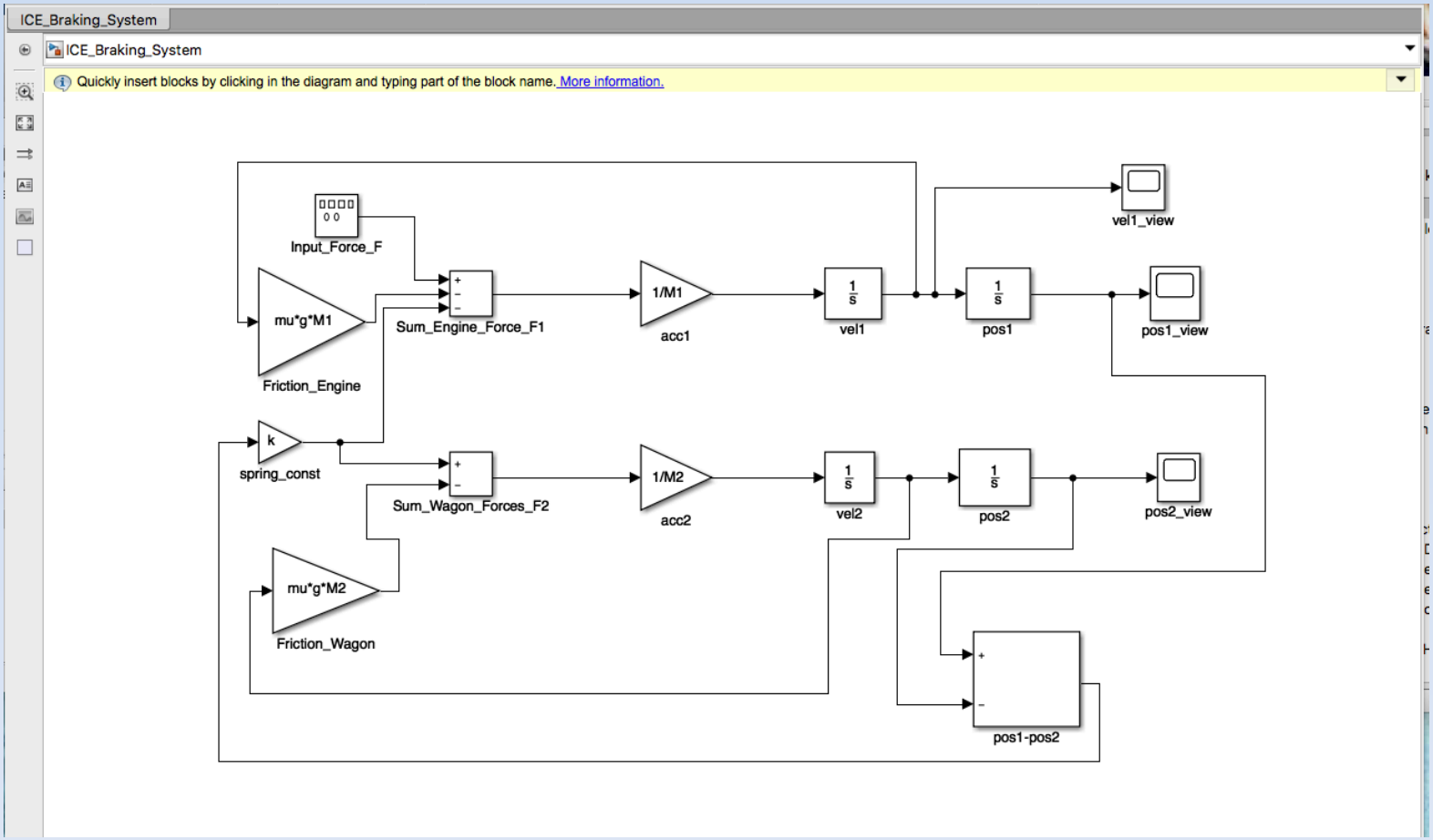
- Use Case Diagram :



  - External view of the ICE train system
  - The two users of the system are driver sitting in the engine and passengers sitting in the wagon
  - The ticket collector can be assumed as a passenger

Design and Implementation

- Model built in MATLAB Simulink (Ice_Braking_System.slx)



Verification and Validation

- Inspection and Face Validation and Verification

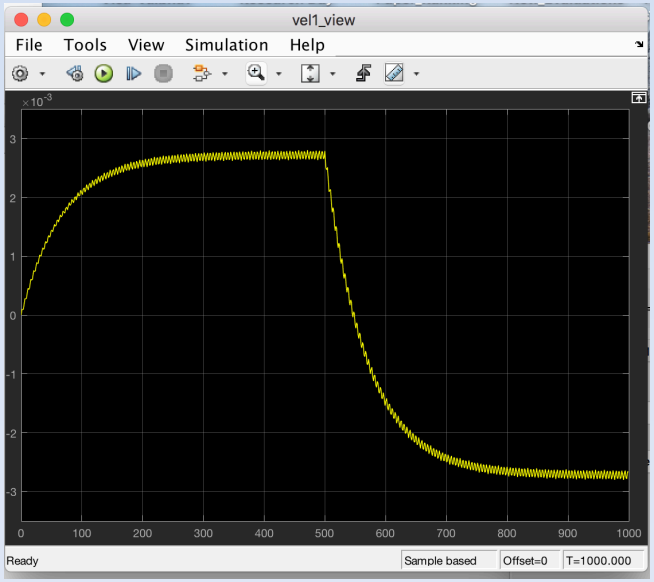
- Verification performed by a friend (Shruti Shetty) in the simulation engineering course and having knowledge of physics.

- Suggested initially that individual wagon could also be considered instead of whole wagons together but since modelling even all the wagons together will be same as modelling individual wagons (since if the wagons are attached by a spring then spring forces on the wagons due to each other will cancel out each other), she agreed that the model was correctly implemented

- Upon observing the output velocity, she agreed that it was close to the behaviour of the real train and validated the model

Test Results

- Input force by engine as square wave (+1 to start and -1 to stop train)
- Frequency of wave as 0.001 Hz so that Time Period of simulation becomes 1000 sec which would be the simulation time
- Velocity gradually and smoothly increases during the first half the wave generation (start signal of train) and gradually and smoothly decreases during the second half of the wave generation (stop signal of train).
- Scope vel1_view (Velocity of Engine) shows the velocity



Q & A