ENPM662 Introduction to Robot Modelling

Homework 2 (Due 8th October 11:59pm)

Assumptions and given data:

1. Weight of mass M = 20kg and mass m = 10kg. Acceleration due to gravity, g = 10m/s^2.
2. The values of limiting and kinetic friction are the same as given μ.
3. Coefficient of friction (μ) between mass M and ground is 0.4 and that between mass M and mass m is 0.7.
4. All the lengths (AB, BC,…, EF) are equal to 250 meters.
5. Location of the mass M can be considered as its midpoint's location.
6. About the transition between different surfaces, let's say between AB and BC: when the mass is on AB, it's horizontal till point B. As soon as it crosses B, it will be inclined (along BC). This transition doesn't affect the system (i.e. any kind of jerk or impulse is NOT to be taken into consideration here). The whole point of the inclined surface is to introduce force due to gravity and nothing else. This same logic applies to the rest of the points.
7. The max value of force F that can be applied (both positive and negative) is 300N and the velocity of the system should not exceed 20 m/s.
8. The applied force F is always along the surface; i.e. suppose the mass is on BC, then the applied force is also along BC. If a negative force is to be applied, then its direction can be reversed keeping the magnitude positive, but it should be along the surface the mass is on.
9. The initial and final velocity of the system is zero. That means, positive force has to be applied to get the system into motion and then negative force would have to be applied to get the system to rest at point F.

Problem 1: (20 marks)

Refer to the figure below and apply force F on mass M so that it travels from point A to point F in minimum possible time.

1) Draw a Force-Time graph (applied force vs time) for the entire journey (It's fine if the graph is not upto scale).
2) Find the value of minimum possible time.
   Show all the points A to F on the time axis of the Force-Time graph. Draw proper free body diagrams and show all the calculations for full marks.

Problem 2: (30 marks)

Refer to the figure below and apply force F on mass M so that it travels from point A to point F in minimum possible time. Here, at any point, the mass m should not fall down from mass M or they should not have any relative motion between them.

1) Draw a Force-Time graph (applied force vs time) for the entire journey (It's fine if the graph is not upto scale).
2) Find the value of minimum possible time.
   Show all the points A to F on the time axis of the Force-Time graph. Draw proper free body diagrams and show all the calculations for full marks.