ELEC-C9420 Introduction to Quantum Technologies, Fall 19
Midterm exam 1, 25.10.2019
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Instructions: Read carefully before you start working on the exam!

- Allowed tools: writing equipment, one A4-sized hand-written cheat sheet.
- The exam consists of three compulsory exam problems. Max 10 points per problem. Write your answers on the official answer sheets.
- Full points require explanations, not only computations!
- The answers must be given in terms of those quantities, for which symbols are given in the problem description.
- Rememeber to write your name on all the exam sheets you use. Prepare to prove your identity when you hand over your answers.

Problem 1

A time-dependent net force $\vec{F}(t) = \alpha\hat{\imath} + \beta t^2\hat{\jmath}$ is exerted on a particle of mass m, where α and β are positive constants. The particle is at rest at time $t = 0$. Find the distance of the particle at time t from its starting position at time $t = 0$.

Problem 2

A solid ball (moment of inertia $I = \frac{2}{5}MR^2$) is rolling down an inclined ramp (length L), while being affected by the gravitational acceleration g. The ramp is inclined at an angle θ from the horizontal. The coefficient of static friction between the ball and the ramp is μ. Assume that the other frictional forces are negligible.
a) What is the linear speed of the ball at the end of the ramp, if the ball is released from rest at the top of the ramp? Assume that the ball rolls without slipping.
b) Find the maximum angle of inclination for the ramp, at which the ball can still roll down the ramp without slipping.

Problem 3

Two cars A and B (masses m_A and m_B) collide head on with initial velocities v_A and v_B. In the collision, the cars get stuck together, and after the collision they slide together on the road. The coefficient of kinetic friction between the wreckage and the road is μ, and the gravitational acceleration g. Assume that the cars move only in the horizontal direction.
a) How far from the point of collision do the cars slide?
b) How long does it take (in time) for the cars to stop after the collision?