Due Sep. 29, Thursday.
10 points for each problem. (5 problems, not 6 problems, in total)

**Problem 1** Assume that $\overleftrightarrow{O}_1$ and $\overleftrightarrow{O}_2$ are arbitrary orthogonal matrices of the same dimensions. For each of the following statements, prove it if it is true, or provide one counter-example (using $2 \times 2$ matrices is good enough) if it is not true.

(a) $\overleftrightarrow{O}_1 + \overleftrightarrow{O}_2$ is also orthogonal.

(b) $\overleftrightarrow{O}_1\overleftrightarrow{O}_2$ is also orthogonal.

(c) $r\overleftrightarrow{O}_1$ is also orthogonal, where $r$ is an arbitrary real number.

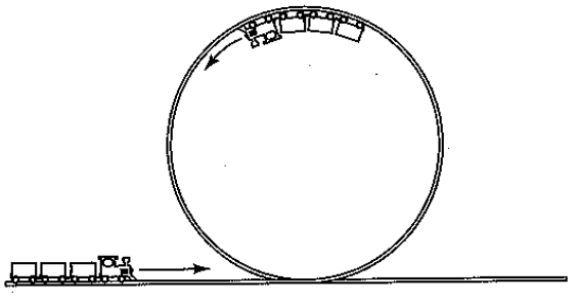
(d) $\overleftrightarrow{O}_1^t$ is also orthogonal.

**Problem 2** Problem 1-15 (the problem 15 of chapter 1) of the textbook.

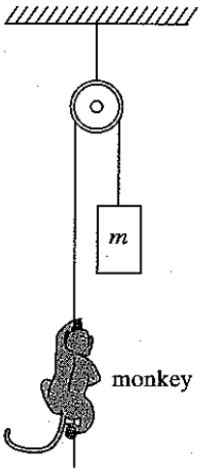
**Problem 3** For any matrices $\overleftrightarrow{A}$ and $\overleftrightarrow{B}$ for which the product $\overleftrightarrow{A}\overleftrightarrow{B}$ is well-defined, show that (a) $\left(\overleftrightarrow{A}\overleftrightarrow{B}\right)^t = \overleftrightarrow{B}^t\overleftrightarrow{A}^t$ and (b) $\left(\overleftrightarrow{A}\overleftrightarrow{B}\right)^{-1} = \overleftrightarrow{B}^{-1}\overleftrightarrow{A}^{-1}$. (c) With $\overleftrightarrow{A}$ and $\overleftrightarrow{B}$ physically interpreted (e.g. as rotations), explain why the result of (b) was to be expected.

**Problem 4** This problem has been removed. The problem will re-appear as part of homework set 2, and so if you already solved it, please hold on to your solution.

**Problem 5** [Provide your full analysis of the following problem as presented in the Phys/Math questionnaire.] A toy train travels around a loop-the-loop track. Is there a normal force exerted by the track on the train at the instant the train is at the top of the loop? If there is, why? If there is not, why not?



**Problem 6** [Provide a full solution to the "monkey problem" in the Phys/Math questionnaire.] A monkey clings to a rope that passes over a pulley. The monkey's weight is balanced by the mass $m$ of a block hanging at the other end of the rope. Both monkey and block are motionless. In order to get to the block, the monkey climbs a distance $L$ (measured along the rope) up the rope. (a) Does the block move as a result of the monkey's climbing? (b) If so, in which direction and by how much?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monkey