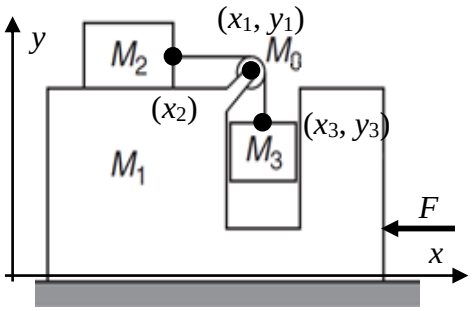
**AMERICAN UNIVERSITY OF ARMENIA**
*College of Science and Engineering*
**ENGS 121 Mechanics**
# Computational Project 02

**Deadline**: Saturday, March 28, 2020, **NO LATER THAN 22:00 SHARP**
**Reference**: Chapter 2. Newton's Laws, pages 48-77, Problems 2.13, 2.14 (page 79); Chapter 3. Forces and Equations of Motion, section 3.4, pages 89-95; Quiz03_solutions.pdf

**Description**: Consider a system of a massless pulley $M_0 = 0$ and three masses $M_1$, $M_2$ and $M_3$, as shown. The body $M_1$ can slide on a table, and the friction coefficient between $M_1$ and the table is $\mu_1$. $M_2$ can slide on a horizontal surface of $M_1$, and the friction coefficient between $M_1$ and $M_2$ is $\mu_2$. $M_3$ can slide in the vertical hole of $M_1$, and the friction coefficient between $M_1$ and $M_3$ is $\mu_3$. The pulley is rigidly mounted on $M_1$. The acceleration of gravity $g$ is directed downwards. The length of the rope connecting $M_2$ and $M_3$ is guaranteed to be such that $M_3$ cannot escape from the hole, $M_2$ cannot fall beyond the left edge of $M_1$, and $M_2$ stops at the pulley when $M_3$ hits the bottom of the hole. Generally, the system moves under the action of an external horizontal force $F$ that may act in either in negative (as shown) or positive $x$ direction. The list of main parameters includes:




- $\mathbf{0} < M_1, M_2, M_3 \leq \mathbf{10}$ kg; $M_0 = 0$;
- $\mathbf{0} \leq \mu_1, \mu_2, \mu_3 \leq \mathbf{0.5}$;
- $\mathbf{-300}$ N $\leq F \leq \mathbf{300}$ N;
- Take $g = \mathbf{10}$ m/s$^2$.

**Tasks**:

1. Create project subfolders \Project02\Preliminary and \Project02\Final in the same repository already created for the previous Project. If the repository link was not submitted for Project 01, submit the link to skhachat@aua.am and irina_tirosyan@edu.aua.am before or on **Wednesday, March 18 2020, no later than 22:00 SHARP**.
2. Write a program that inputs several time moments $t_0 = 0$, $t_1$, $t_2$, … $t_n$ in seconds and the values of the force $F_0 = F(0)$, $F_1 = F(t_1)$, $F_2 = F(t_2)$, … $F_n = F(t_n)$ in Newtons from the specified range; the parameters $M_1$, $M_2$, $M_3$, $\mu_1$, $\mu_2$ and $\mu_3$ from the specified ranges; the initial positions of $M_1$, $M_2$ and $M_3$ in meters at $t_0 = 0$; and computes the subsequent positions of $M_1$, $M_2$ and $M_3$ for several values $t > 0$. Assume a linear interpolation of $F$ for the points between $t_0$, $t_1$, $t_2$, … $t_n$. **Hint**: refer to the solutions of Problems 2.13, 2.14 (page 79) and Quiz03_solutions.pdf for the frictionless case.
3. Run the program for different sets of input parameter values and prepare a short report that summarizes the most interesting cases. Include in the report the computed outputs in graphical or tabular formats
4. (Optional, but exciting) Enhance the program with a graphical animation of the computed motion of $M_1$, $M_2$ and $M_3$.

**Submission Conditions**:

1. The project will be checked in online regime – no separate submissions needed.
2. Identical or similar files / results / reports / etc. will be disqualified – both the source(s) and receiver(s) will collect 0 point.

3. You are welcome to use project artifacts from external sources, including the projects of your classmates. Each such case, however, must be explicitly stated with the link to the source. Such artifacts will not be graded.
4. The project will be graded in two stages. The initial or draft version, ideas, pseudocodes, discussion of problems / difficulties, etc., must be uploaded in the \Project02\Preliminary sub-folder before or on **Sunday, March 22 2020, not later than 22:00 SHARP**.
5. The final working version and the report must be uploaded in the \Project02\Final sub-folder before or on **Saturday, March 28 2020, not later than 22:00 SHARP**.
6. You are strongly encouraged to communicate by writing to:


- Suren Khachatryan, skhachat@aua.am
- Irina Tirosyan, irina_tirosyan@edu.aua.am
- Varazdat Stepanyan, varazdat_stepanyan@edu.aua.am
- Sergey Hovhannisyan, sergey_hovhannisyan@edu.aua.am