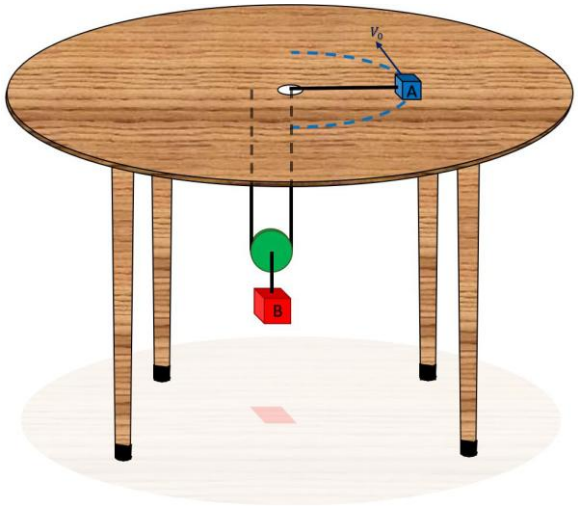
DYNAMIC PROJECT

Dr. Sadeghnejhad ***Submission Deadline: 1404/04/03***

A block **A** is placed on a smooth horizontal table and connected to a light cord that passes through a small hole at the center of the table, which has a diameter of 10 cm. Beneath the table, the cord passes through a moving pulley, to which block **B** is attached. Block A moves initially in a circular path with a radius of r = 0.75 m and an initial velocity of $v_0 = 5\ m/s$. The radius of the table is 1.3 m. The surface of the table is rough. The masses of block A and block B are $m_A = 2\ kg$ and $m_B = 6\ kg$, respectively.

Derive the governing **parametric equations** describing the system's motion. Solve these equations numerically using MATLAB's **ode45** function.



Part a) Assuming a smooth (frictionless) surface for the table, solve the system for the following values of m_B: 6 kg, 15 kg and 50 kg. For each case, use MATLAB to:

1. Generate an **animation of block A**'s motion on the table.

2. Plot the **speed of block A**, the **vertical position of block B**, and the **tension in the cord** as functions of time.

Compare the results for the three cases. Discuss how the variation in mB affects the behavior of the system.

Part b) Consider the case where the table has a rough surface and the coefficient of kinetic friction (μ_k) is non-zero. Let $m_B = 6\,kg$ and solve the system for the following values of μ_k: 0.03, 0.15 and 0.9. Similar to **Part a**, generate an animation of block A's motion on the table and plot the required figures. Compare and discuss how increasing friction affects the system's dynamics.

Part c) Assume $m_A = 5$ kg, $m_B = 4$ kg, $\mu_k = 0.7$ and $v_0 = 3$ m/s. Simulate the motion of the blocks until they reach their final positions. Determine:

1. The final position of block A on the table.

2. The final vertical position of block B (relative to its initial position).

3. The tension in the cord when the blocks come to rest.

Discuss the final state of the system and the effect of friction on it. In your explanation, consider special scenarios such as:

• Block A passing through the hole (falling through the center).

• Block A falling off the edge of the table.

• Block A coming to rest due to friction.

Note: The animation of the motions for all parts must be submitted along with your MATLAB code and report file. It is recommended to limit the simulation time to **20 seconds** to avoid unnecessarily long MATLAB runtime. Additionally, implement a **stopping condition** for cases where block A passes through the central hole.

Project Guidelines and Instructions

To ensure a high-quality submission that meets academic standards, adhere to the following guidelines:

- Begin the report by clearly stating the problem data and all assumptions made for simplification.
- Provide a thorough analysis of all results, including detailed explanations of curves and outputs. Results without interpretation are not acceptable.
- Number all equations sequentially.
- Include captions and numbers for all figures and tables, with clear specification of units, titles, and labeled axes for all quantities used.
- Avoid black backgrounds for figures (e.g., MATLAB Simulink Scope block outputs with black backgrounds are not permitted).
- Provide a comprehensive list of references and sources, formatted according to academic standards.
- Include and analyze all required outputs, such as code results and plots, in the report.
- Include the written code in the report's appendix, formatted clearly and in a copyable format.
- Ensure the submitted code is readable and includes appropriate comments for clarity.
- The project is a collaborative effort to be completed by groups of two students.
- Any similarity in reports or code will be considered academic misconduct, resulting in a zero score for all involved parties.
- Submit the project as a single ZIP file including the report, code files, and simulation outputs.
- Ensure all submitted files are functional. Responsibility for corrupted or faulty files lies with the student, and such submissions will receive a zero score.
- **Be happy and healthy!**