ENED 1100 – Fall 2023
Homework 4.1: Sequential Flow

INDIVIDUAL ASSIGNMENT: See the course syllabus for a definition of what constitutes an individual HW assignment.

OVERVIEW:
For this assignment, you will be asked to use the **Problem Presentation Method** (PPM) to develop your solutions to the task outlined below.

When using the PPM to develop a solution to an algorithmic/computational thinking problem, the **Diagram** section should include a flow diagram depicting the logic being implemented in the solution in addition to any diagrams needed to help describe the problem (system models, free-body diagrams, circuit diagrams, physical models, etc.).

The **Theory** section should include all necessary formulas needed to solve the problem. It should not include computer code or logical elements such as counters, error checks, etc.

The **Assumptions** section should include all necessary assumptions needed to solve the problem. Assumptions should be included for both the problem (e.g. no air resistance for a projectile motion problem) and the solution (e.g. a user of the solution will enter appropriate values). If no assumptions are needed, still include the section and write "No assumptions needed."

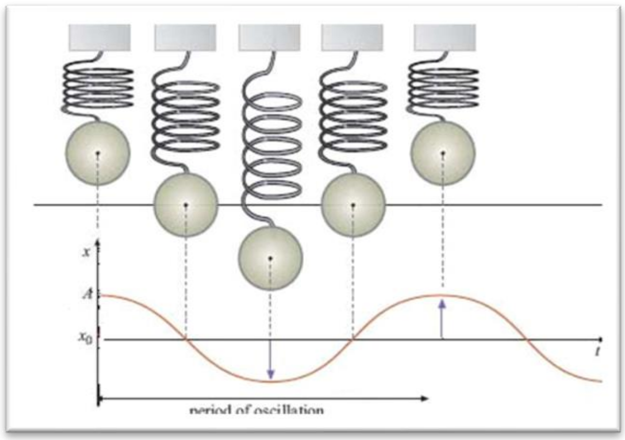
The solution to the problem is the actual coded solution. The **Solution** section should simply include a reference to the file containing the solution (do not actually put the code in the PPM solution).

The **Verification** section should include the results of several test cases that have been run through the code to show the solution is correct. If test cases are not provided in the problem statement, they should be developed such that they test all possible outcomes of the program's execution.

The **Conclusion** section should provide a high-level summary of the structure of the solution.

Please see the example PPM solution for this type of problem posted on the Community Site using the Course Information link.

Task 1 (of 1):
Sinusoids can be used to model simple harmonic motion of an object attached to a spring as illustrated in the figure below. If we assume no loss of energy, the displacement of the object looks like a cosine wave. For this task, we will assume the oscillations are un-damped (i.e., continue indefinitely).



Assuming simple harmonic motion, the displacement of the object, p, as a function of time is given by:

$$\mathrm{p} = A\cos\left(\sqrt{\frac{K}{M}}\cdot t\right)$$

A	=	Initial Displacement of object (m)
K	=	Spring Constant (N/m)
M	=	Mass of suspended object and spring (kg)
t	=	Time (s)

The velocity of the object is the derivative of displacement with respect to time:

$$\mathrm{v(t)} = \frac{dp(t)}{dt} = -A\sqrt{\frac{K}{M}}\sin\left(\sqrt{\frac{K}{M}}\cdot t\right)$$

The acceleration of the object is the derivative of velocity with respect to time:

$$\mathrm{a(t)} = \frac{dv(t)}{dt} = -\frac{AK}{M}\cos\left(\sqrt{\frac{K}{M}}\cdot t\right)$$

The kinetic energy and potential energy of the object at time t, both in units of Joules (J), are computed as follows:

$$\mathrm{KE(t)} = \frac{1}{2}\mathrm{Mv(t)}^2$$

$$\mathrm{PE(t)} = \frac{1}{2}\mathrm{Kp(t)}^2$$

Note: The v(t) and p(t) in the above equation just implies that v and p are functions of time. It is not the velocity multiplied by time. Velocity multiplied by time would be v(t) * t. The same is true for position, p(t).

- Create a Flow Diagram to solve this problem that has the initial displacement of the spring, A, the spring constant, K, the mass of the suspended object and spring, M, and the time, t as inputs. The outputs will be the displacement, velocity, acceleration, kinetic energy, and potential energy of the object at time, t. The flow diagram should be placed in the diagram portion of your PPM solution along with the schematic of the oscillator.
- Create a trace table of test cases for various values of A, K, M, and t. Using your test values, compute the displacement, velocity, acceleration, kinetic energy, and potential energy of the object at time, t, using a calculator. These test values will be used in your verification section of your PPM Solution. Note: your calculator should be in radian mode for the trigonometric functions.
- Develop a LabVIEW program named **HW4p1_UCusername.vi** based on the inputs and outputs described above. The inputs and outputs should be located on the front panel. Be sure to include units in your control and indicator descriptions on the front panel.

When Finished

Please create a legible scan or pdf containing your PPM solution and submit it, along with your LabVIEW VI, to your Section Site by 11:59pm on Thursday, September 21st. You should be submitting the following two files:

- PPM Solutions: **HW4p1_PPM_ UCusername.pdf where** ***UCusername*** **is your 6+2 CANVAS login.**
- Task 1 VI: **HW4p1_UCusername.vi**