CEE 3804 Final Exam (Spring 2026)

Computer Applications in CEE

Open Book and Notes (Take Home)

Your Name _____

Your Signature * _____

* The answers in this exam are the product of my own work. I certify that I have not received nor I have provided help to others while taking this examination.

Directions:

Solve the problems. Copy and paste the Matlab and VBA code and solutions such as graphs in a Word Document and convert to a single PDF file. **Make sure your code is not too small for me to be able to read it.**

Problem 1 (25 points)

Use Simulink, to solve the differential equation of the wrecking ball problem depicted in Figure 1. The wrecking ball problem can be solved using the equation of the motion of a pendulum. The fundamental equation to predict the angular acceleration ($\ddot{\theta}$), angular speed ($\dot{\theta}$), and angular displacement of the pendulum (or the wrecking ball) is:

$$\ddot{\theta} = \frac{-gsin(\theta)}{l} - \frac{K\dot{\theta}}{m}$$

Where:

θ is the angular displacement of the wrecking ball (radians)

$\dot{\theta}$ is the angular speed of the wrecking ball (radians/second)

$\ddot{\theta}$ is the angular acceleration of the wrecking ball (radians/second^2)

l is the length of the cable attached to the wrecking ball (meters)

g is the acceleration of gravity (m/s^2)

K is the wrecking ball drag damping constant (kg/s)

m is the mass of the wrecking ball (kilograms)

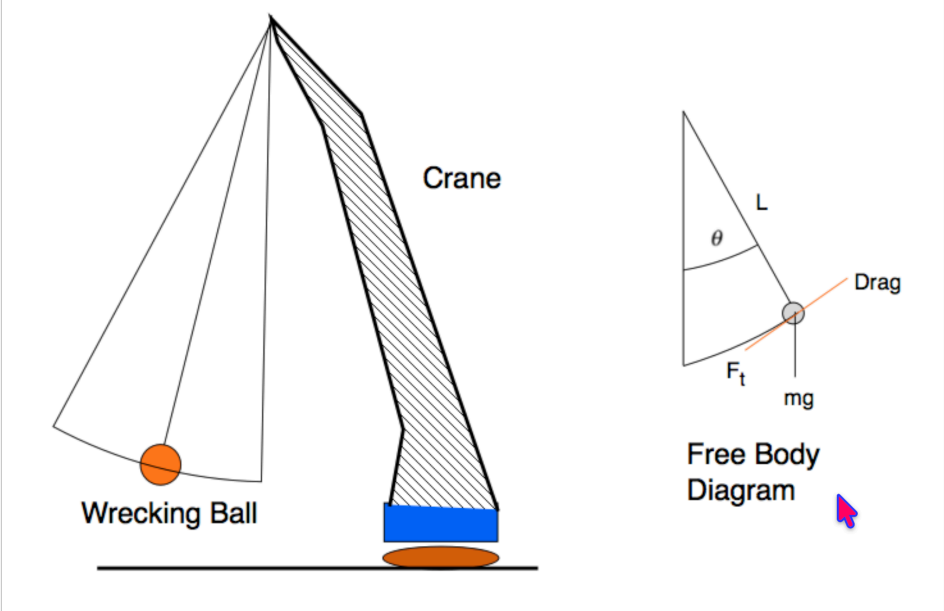

Figure 1. Free-Body Diagram for a Rigid Pendulum and the Equivalent Wrecking Ball.

Task 1

Create a Simulink model to solve the second order differential equation to estimate the values of $\ddot{\theta}$, $\dot{\theta}$, and θ as a function of time. Use the following values for the model parameters.

l = 12 meters

K = 75 kg/s

m = 2000 kgs

Test the model using initial conditions of zero angular speed and 0.3 radians of the angular displacement.

Task 2

Export the values values of $\ddot{\theta}$, $\dot{\theta}$, and θ as a function of time from Simulink to Matlab. Make a **Matlab script** to plot the following:

A) Angular speed versus time

B) Angular displacement versus time

C) Angular acceleration versus time

D) Angular displacement versus angular speed

Comment on the shape and meaning of the last plot.

Task 3

Improve the Matlab script created in Task 2 to find the time when the angular displacement is less than 0.005 radians.

Include screen captures of Matlab code, Simulink and plots.

Problem 2 (25 points) Use MATLAB to Do this Problem.

A medium-size dam is instrumented to detect the flow of water released by the dam spillway. Table 1 shows the water flows as a function of time. The water flow rate is provided in a separate Excel file.

Table 1. Measured Water Flow Rates after a Controlled Spillway Event.

Time (seconds)	Water Flow Rate (cubic feet per second)
0	0
100	0
120	7540
140	13500

Task 1

Create a MATLAB script to read the data in Table 1. Read the data in column vector form.

Task 2

Add code to the script in Task 1 to plot the water flow rate as a function of time. Label your plots accordingly. For the plot, write the MATLAB code to define circle with market size 10 and use a solid red line (line width 3) to plot the water flow rate versus time.

Task 3

Add code to the script in Task 1 to find the total water discharged after the spillway event. State your approach to solve the problem. Modify the plot in Task 1 to show the total water discharged and make sure to include the units of the volume of water discharged.

Task 4

Add code to the script in Task 1 to find the maximum water flow rate and the time when the maximum value of water flow rate detected by the sensor.

Include screen captures of Matlab code required to make the calculations.

Problem 3 (25 points)

Brief answers or True/False (T/F)

Number	Question	Answer
1	A VBA subroutine can produce a single output given four inputs (T/F)	
2	The Matlab code **x=strcmp(State,'FL')** produces vector **x** of equal length as **'FL'** (T/F)	
3	A flat file with 1.2 million rows can be read by Excel (T/F)	
4	The Matlab code **y=interp1(station, deflection,0.6)** finds the value of deflection at two stations along a beam by interpolation (T/F)	
5	The **function [strain, stress]=myCalculator(x,y,z)** produces three outputs (T/F)	
6	Excel macros can be reused in multiple Excel files as long as the files have similar format (T/F)	
7	The Matlab code **y=find(deflection)** finds the zero values of the vector deflection (T/F)	
8	Name the person who developed the Simplex Method.	
9	Number of Basic Variables in the first tableau of a linear program problem with three decision variables and five constraint equations of the type Ax <= B.	
10	Number of books in the bookstore problem demonstrated using Access with price above $23 and by Publishers 2 and 3	

Problem 4 (25 points)

A company makes two types of concrete products: x_1 is a high-strength concrete developed for high-rise building construction. x_2 is a moderate-strength concrete developed for building foundations. The company makes $705 in profit for every ton of high-strength concrete. The profit for the moderate-strength concrete is $670 per ton.

The following constraint equations are suggested in the production and delivery of the two concrete products.

Subject to:

$0.95x_1 + x_2 <= 1030$ Production constraint

$1.35x_1 + x_2 <= 1200$ Delivery constraint

In addition, emission regulations at the site where the concrete is produced limit the number of tons for each product as follows:

$x_1 <= 820$

$x_2 <= 890$

Task 1

Convert the problem shown above into standard (canonical) form to be solved by hand using the Simplex Method. Write down the transformed equations and add slack and artificial variables as needed.

Task 2

Show me the first two tables in the Simplex solution. Indicate the values of all the variables in every table. Indicate the value of the objective function Z in every table. This task requires hand calculations.

Task 3

Solve the problem using Excel Solver.

Include screen captures of the Solver panel, Excel spreadsheet setup and two tables of the Simplex method.