CEE 3804: Computer Applications in Civil Engineering Spring 2020

Final Exam Solution

Open Notes and Internet Access Instructor: Trani

Due Date:

Honor Code Pledge

The information provided in this exam is my own work. I have not received information from another person while doing this exam.

_____ (your signature)

Use the Word processor of your choice to assemble your solutions. Include all screen captures of your Matlab scripts, Excel, Simulink, and plots created as outputs. Create a single PDF file and submit to Canvas.

Problem 1 (30 points)

Show all your work. Include screen captures of your code.

Problem 1

A bus leasing company has 740 buses placed in 5 cities around the country. A sample of the bus data is shown in the table below and provided to you in a companion Excel file.

Task 1:

Using Excel create a Pivot Table to display the average number of miles in the odometer as a function of bus type, and city leasing the vehicle. Show a screen capture of the Pivot Table created.

Average of Miles Driven	Column Labels						
Row Labels	**Atlanta**	**Chicago**	**Los Angeles**	**New York**	**San Francisco**	**(blank)**	**Grand Total**
GMC RTS II	339,824	416,494	328,978	404,072	382,467		380,519
New Flyer 40/60LFA	327,859	367,102	341,733	391,323	344,323		356,262
Orion V	363,863	372,402	349,355	368,721	343,481		361,264
Van Hol AG500	355,029	376,123	378,875	357,232	386,391		368,766
(blank)							
Grand Total	**345,000**	**382,805**	**348,283**	**380,431**	**361,163**		**365,988**

Task 2:

Using the Pivot Table created in Task 1 find the average mileage of all bus types in the fleet with 6 years of age

Row Labels	**Average of Miles Driven**
GMC RTS II	319,100
New Flyer 40/60LFA	313,429
Orion V	318,718
Van Hol AG500	311,474
Grand Total	**314,895**

Task 3:

Create a Pivot Table to find the average mileage of Van Hol AG500 buses leased by the City of New York.

Average of Miles Driven	Column Labels						
Row Labels	**Atlanta**	**Chicago**	**Los Angeles**	**New York**	**San Francisco**	**(blank)**	**Grand Total**
GMC RTS II	339,824	416,494	328,978	404,072	382,467		380,519
New Flyer 40/60LFA	327,859	367,102	341,733	391,323	344,323		356,262
Orion V	363,863	372,402	349,355	368,721	343,481		361,264
Van Hol AG500	355,029	376,123	378,875	357,232	386,391		368,766
(blank)							
Grand Total	**345,000**	**382,805**	**348,283**	**380,431**	**361,163**		**365,988**

Problem 2 (40 points)

A company that makes concrete has to products in the market. **Product A is a premium concrete** mix that sells for $100 per ton. **Product B is a standard concrete** mix that is easier to make and sells for $85 per ton.

With the mixing hardware available, the company can produce up to 320 tons of premium concrete per day or up to 400 tons of the standard product. Because the concrete mixes are produced using the same machinery, linear combinations of both products not exceeding their maximum individual productions can be produced in one day. For example, the company could produce 150 tons of Product A and 200 tons of Product B in one day.

The company employs special trucks to deliver the concrete to various clients in the region. Because the specific weight of both products is not the same, the delivery trucks can haul up to 350 tons of premium concrete per day or up to 375 tons per day of standard concrete. Linear combinations of both products not exceeding their maximum individual hauling rates can be delivered in one day. For example, the company could haul 150 tons of Product A and 210 tons of Product B in one day.

Task 1:

Formulate the problem as a linear programming problem. The idea is to maximize the revenue to the company.

$$\text{Max } Z = 85x_1 + 100x_2$$

subject to:

$$x_2 + 0.8x_1 \le 320$$

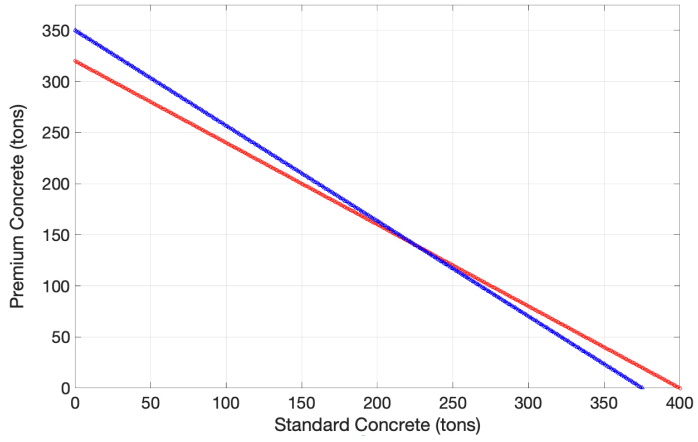
$$x_2 + 0.933x_1 \le 375$$

$x_1 =$ tons of standard concrete produced daily

$x_2 =$ tons of premium concrete produced daily

Task 2:

Solve the problem graphically. Clearly indicate corner points and plot the lines of constant Z value.



Intersection point occurs at (225.6,139.5) (Standard,Premium)

Standard Conc. (tons)	Premium Conc. (tons)	Z	Optimal
0	320	32,000	No

225.6	139.5	33,126	Yes
375	0	31,875	No

Task 3:

Solve the problem using the Simplex Method. Clearly show your tables and indicate which variables are the basic variables in every tableau.

$$Z - 85x_1 - 100x_2 = 0$$

subject to:

$$x_2 + 0.8x_1 + x_3 = 320$$

$$x_2 + 0.933x_1 + x_4 = 375$$

Initial Tableau

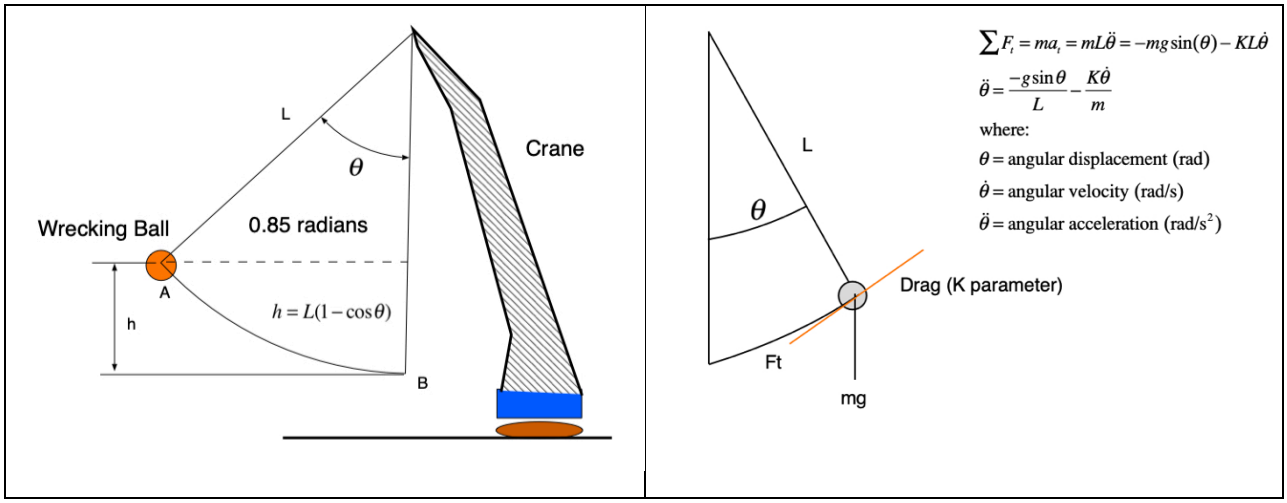
BV	Z	X1	X2	X3	X4	RHS
Z	1	-85	-100	0	0	0
X3	0	0.8	1	1	0	320
X4	0	0.933	1	0	1	375

Task 4:

Solve the problem using Excel Solver.

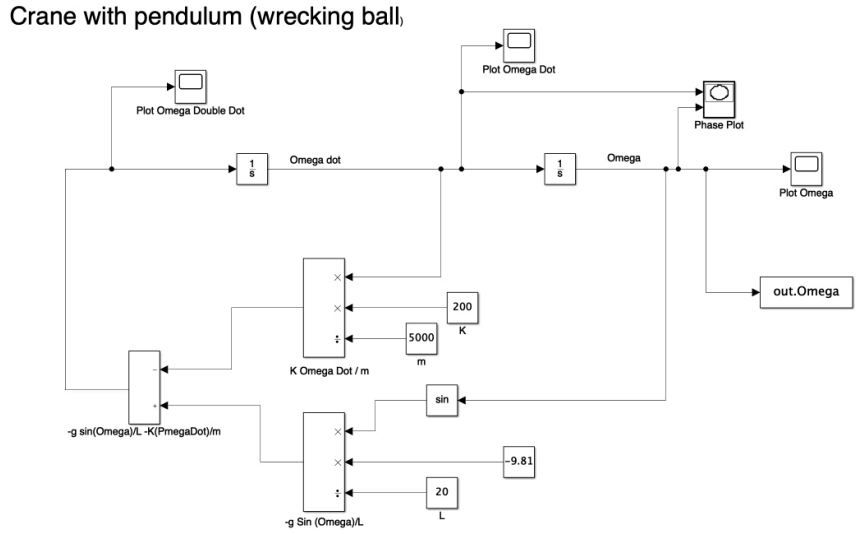
Problem 3 (30 Points)

A construction company uses a crane with a wreck ball to demolish buildings. A simple diagram of the crane is shown below. The differential equation of motion of the wrecking ball is also shown in the diagram.



Task 1

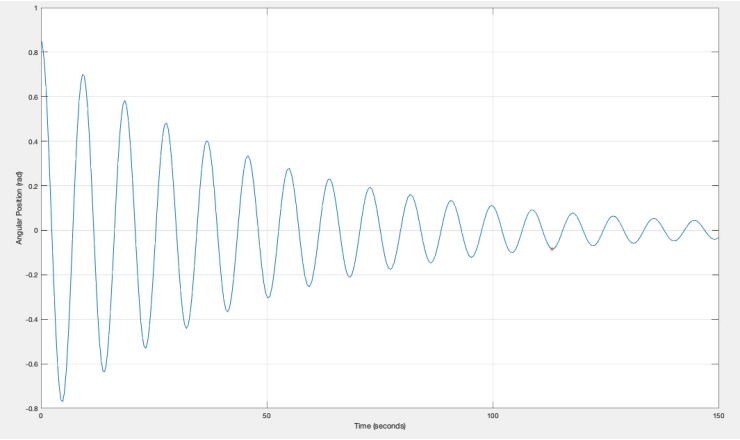
Create a Simulink model to solve the differential equations of the system to calculate the angular displacement and the angular velocity of the wrecking ball over time. Use the initial conditions shown in the figure above. Assume that when the ball is released from a height h, the initial angular velocity is zero (i.e., ball is static prior to release). Assume the initial angular displacement is 0.85 radians as shown in the figure. The wrecking ball has a mass of 5,000 kg and the value of *K* is 200 kg/s. (all units are consistent). The length of the cable (L) holding the ball is 20 meters.



Task 2

Export the values of velocity, position and acceleration vs. time from your Simulink model and make necessary plots to visualize the system over time. Estimate the time for the wrecking ball peak angular displacement to reach 1/10 of the angular displacement when the ball is released.

Time ~ 123 seconds to damp out to 1/10 of the initial angular displacement



Task 3

Make a plot of angular displacement versus angular speed (so-called phase plot). Comment on the shape and behavior of the two state variables.