Final Exam

Open Notes and Internet Access

Instructor: Trani

Due Date: Tuesday, May 12, 2020 at 7 PM

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.

City	Bus Type	Age (years)	Miles Driven	Route length
Los Angeles	New Flyer 40/60LFA	7	313,836	47.7
Chicago	Van Hol AG500	8	392,329	29.4
Chicago	New Flyer 40/60LFA	9	563,185	24.1
Los Angeles	New Flyer 40/60LFA	10	414,021	47.8
Atlanta	New Flyer 40/60LFA	6	372,113	24.1
Chicago	New Flyer 40/60LFA	5	310,217	30.7
San Francisco	Van Hol AG500	8	337,669	27.9
Atlanta	New Flyer 40/60LFA	8	382,694	21.0
Los Angeles	Orion V	4	165,449	48.2
New York	New Flyer 40/60LFA	4	184,490	53.0
San Francisco	GMC RTS II	7	393,237	27.2

where:

Column 1 = City

Column 2 = Bus type and model

Column 3 = Age of

the vehicle Column

4 = Miles in

odometer

Column 5 = Average route length (miles) for the vehicle

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.

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

Task 3:

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

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.

Task 2:

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

Task 3:

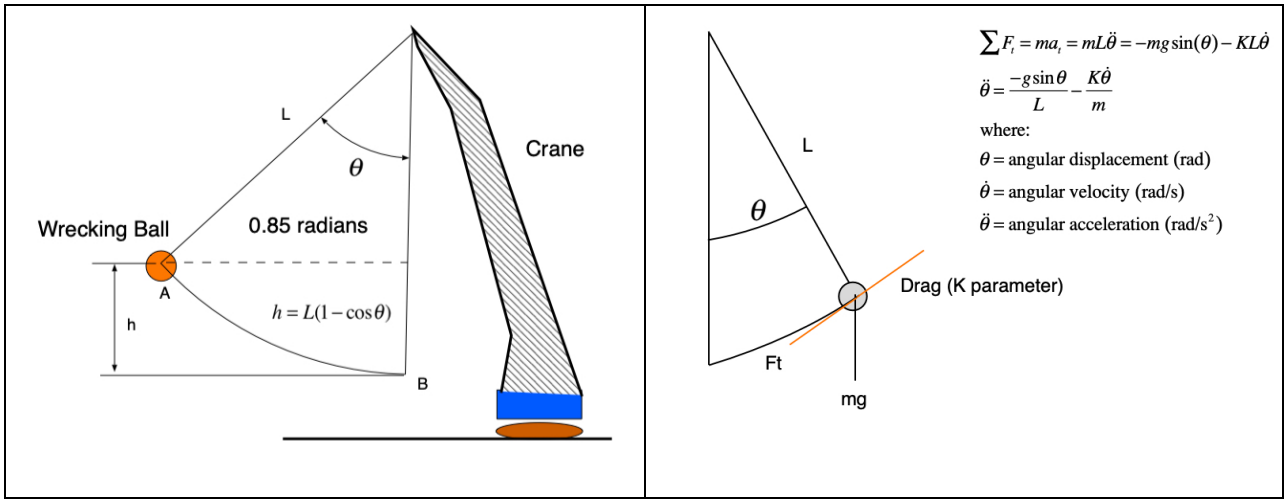
Solve the problem using the Simplex Method. Clearly show your tables and indicate which variables are the basic variables in every tableau.

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.

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.