MAE 8 -Spring 2022
Midterm Exam
Form B
Time: 80 min

Instructions: Open book, open note, open homework solution. No access to internet. Follow the homework solution template by filling in your name, id, hw_num = 'midterm' and form (e.g., form = 'B'). Put the code and answers in a MATLAB script named **midterm.m**. Submit **midterm.m** through CANVAS before 4:50 PM on Tuesday May 3^{rd}, 2022. Use double precision unless otherwise stated.

Problem 1: (10 points)

In this exercise, you are to compute the following series:

$$\frac{1}{\sqrt{3}} + \frac{2}{\sqrt{4}} + \frac{3}{\sqrt{5}} + \frac{4}{\sqrt{6}} + ... + \frac{198}{\sqrt{200}} + \frac{199}{\sqrt{201}}$$

(a) Create vector **p1a** to store the numerators of the fractions in the series.

(b) Create vector **p1b** to store the denominators of the fractions in the series.

(c) Use the answers in parts (a) and (b) to compute the series. Put the answer in **p1c**.

Problem 2: (10 points)

Consider the following system of linear equations:

$$\begin{aligned} 7x_1 + 2x_2 + 8x_3 &= 5 \\ 8x_1 + 3x_2 + 4x_3 &= 2 \\ x_1 + 5x_2 + 6x_3 &= 7 \end{aligned}$$

Use \ operator to solve the system of equations in the form **Ax=b** to obtain **x**. Set **p2=x**.

Problem 3: (40 points)

Make sure that you have filled in the **form** at the top of the midterm script (e.g., **form = 'B'**) before starting this problem. Create 2-dimensional matrix **matA** using the following commands: **rng(int8(form)); matA = randi(60,10)**. Perform the following exercises with **matA**:

(a) Find the sum of the elements on the last column of **matA**. Put the answer in **p3a**.

(b) Find the average value of the elements that are on the first, third, fifth, seventh and tenth column of **matA**. The answer should be a single number. Put the answer in **p3b**.

(c) Find the product of the elements that are not prime numbers in **matA**. Put the answer in **p3c**.

(d) Copy **matA** into **p3d**. Modify **p3d** by replacing the minimum value(s) with the maximum value. The max/min values are taken over the entire matrix, i.e., the min value should be one number (but may appear in the matrix more than once).

(e) Write the last five elements on the first row in **matA** into string **p3e**. Use a field width of 8 characters and include 3 digits after the decimal place for each element. The string **p3e** must show a 5-element row vector. Do not fill in the leading empty space with zero.

Problem 4: (40 points)

Figure 1 shows the plot of the following parametric function:

$$\begin{aligned} x &= 2cos(\theta) + 3cos(2\theta/3) \\ y &= 2sin(\theta) - 3sin(2\theta/3) \end{aligned}$$

for $1^\circ \leq \theta \leq 1080^\circ$.

(a) Create a vector **theta** to include values from 1 to 1080 with a consecutive difference of 1. Use the expressions above to obtain the values for vectors **x** and **y**. Use the linear piecewise approximation to estimate the arc length of the star function as discussed in class. Put the answer in **p4a**.

(b, c) Use forward finite difference method to approximate the derivatives $dx/d\theta$ and $dy/d\theta$. Put the answers in **p4b** and **p4c**, respectively.

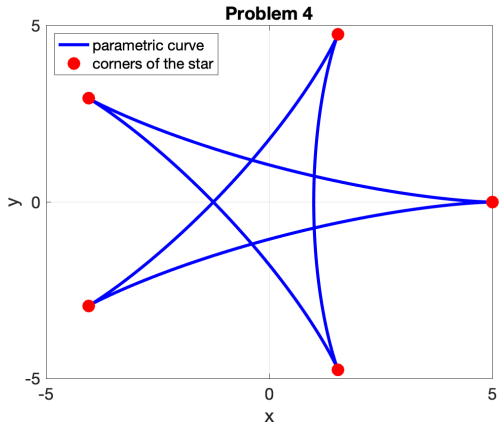

Figure 1:

(d) Consider the function $l(\theta)$:

$$l = \sqrt{\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{d\theta}\right)^2}.$$

Use the derivatives in parts (b, c) to compute the values of l and put the answer in **p4d**.

(e) Use trapezoidal method to evaluate the integral: $\int_{1^\circ}^{1080^\circ} l(\theta)d\theta$ and put the answer in **p4e**.

(f) Compute the absolute difference between the answers in parts (a) and (e) and put the answer in **p4f**.

(g) Reproduce **figure 1**. The figure needs to include the following items:

- Use blue solid line with a line width of 3 to mark the star curve.
- Use solid red circle markers to mark the five corners of the star curve. Set marker size to 12.
- Remember to provide axis labels, legend and figure title.

Set **p4g= 'See figure 1'**.