Problem 1. (3 pts) For each of the following citations, indicate if the work in question is a book or a journal article. Explain your reasoning.


1. **IS A JOURNAL ARTICLE: IT HAS A VOLUME # (12) AND A RANGE OF PAGES, PLUS ARTICLE AND JOURNAL TITLES.**

2. **IS A BOOK: IT CITES A TOTAL # OF PAGES AND A PUBLISHER.**

Problem 2. (4 pts) Suppose your uncle runs a business that makes a particular model of stapler he designed, using a factory full of machine tools. Your genius cousin has just invented an extremely cool, foolproof device to prevent staples from jamming in the stapler that uses a mechanical gadget that would be added on to each stapler. Identify and describe two reasons why your uncle might not want to change his stapler design to incorporate this improvement.

(2 pts each reason)

- Stapler's function just fine as is: no demand for innovation
- New part might increase costs
- New part might decrease reliability
- New part might be hard to machine w/ existing equipment
  
  Etc.
Problem 3. (5 pts) Consider the three sets of points \((x_i, y_i)\) plotted below. One of these sets of points has correlation coefficient \(r = 0.89\), another has \(r = -0.69\), and the third has \(r = -0.18\). Assign these \(r\) values to the appropriate plots.

\[
\begin{align*}
\text{Plot 1:} & \quad r = -0.69 \quad \text{Slope} < 0 \quad \text{(slope less than 0)} \\
\text{Plot 2:} & \quad r = -0.18 \quad \text{Small} \quad |r| \quad \text{Magnitude} \quad \text{(small magnitude)} \\
\text{Plot 3:} & \quad r = 0.89 \quad \text{Slope} > 0 \quad \text{(slope greater than 0)}
\end{align*}
\]

Problem 4. (5 pts) Suppose your doctor's office has an analog scale with a big dial that has three rows of markings: the first row is marked in one-pound increments, the second is marked in one-third kilogram increments, and the third is marked in one-tenth stone increments. There are 2.2 pounds in a kilogram and 14 pounds in a stone. Which row of markings (pounds, kgs, stone) should your doctor use to get the smallest measurement uncertainty? What is that smallest uncertainty, expressed in pounds?

- **Finest Markings:**
  - 1 lb
  - \(\frac{1}{3} \text{ kg} = 0.73 \text{ lb}\)
  - \(\frac{1}{10} \text{ stone} = 1.4 \text{ lb}\)

  Measurement uncertainty is \(\frac{1}{2}\) of finest markings:

- **Smallest uncertainty arises using kg markings:**
  \[\text{uncertainty} = \frac{1}{6} \text{ kg} = 0.36 \text{ lb}\]

  (2 pts)

  (8 pts)
Problem 5. (5 pts) I have a piece of wood, 2 feet long and with a square cross-section measuring 4 inches on a side.

(a) What machine tool should I use if I want to turn my piece of wood into a cylindrical chair leg? Explain briefly.

(b) What machine tool should I use to cut a square groove, a centimeter deep, lengthwise on one of the long sides of my piece of wood? Explain briefly.

\[ \text{a) USE A LATHE: PART HAS AXIAL SYMMETRY.} \]

\[ \text{b) USE A MILL: IT CAN MAKE A STRAIGHT CUT AS YOU MOVE YOUR PART SIDEWAYS.} \]

(one part: 3 pts)

Problem 6. (6 pts) Imagine that after the semester is over, you have two data vectors, in Matlab, that describe your academic performance. These data vectors are called A and B, and each has five elements, corresponding to the number of courses you took. The elements of A are the number of credit hours for each of your classes, and the elements of B are your grades in each class on a 4.0 scale. Write a Matlab script that computes your grade point average for the semester and names that value gpa.

\[
\begin{align*}
\text{(For example)} & \quad \text{SUM} & \quad \text{TOTAL POINTS} & \quad \text{TOTAL CREDIT HOURS} & \quad \text{TOTAL GRADE POINTS} \\
\text{SUM} & \quad A \cdot B; \quad \text{TOTAL POINTS} & \quad \text{TOTAL CREDIT HOURS} & \quad \text{TOTAL GRADE POINTS} \\
\text{SUM} & \quad A; \quad \text{TOTAL CREDIT HOURS} & \quad \text{TOTAL POINTS} & \quad \text{TOTAL GRADE POINTS} \\
\text{GPA} & \quad \text{TOTAL POINTS} \div \text{TOTAL CREDIT HOURS} \\
\text{GPA} & \quad \text{TOTAL GRADE POINTS} \\
\text{(2 pts procedure)} & \quad \text{4 pts syntax} \\
\end{align*}
\]

(TERM-BY-TERM)
**Problem 7.** (Total 12 pts) Oil prices are notoriously volatile, but 2008 was crazy. The monthly average crude oil prices (per barrel, in dollars) in the U.S. in 2008 were:

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price (USD)</td>
<td>85.24</td>
<td>86.94</td>
<td>96.37</td>
<td>103.15</td>
<td>115.12</td>
<td>122.64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price (USD)</td>
<td>121.84</td>
<td>105.16</td>
<td>93.34</td>
<td>67.19</td>
<td>49.29</td>
<td>32.94</td>
</tr>
</tbody>
</table>

(a) (3 pts) What's the mean value of these prices?

(b) (6 pts) Put the price data in a properly normalized bin histogram with five bins. You can pick the bin size, but use bins with equal width.

(c) (3 pts) For bin histograms, the mode can be interpreted as the middle value of the tallest bin. What's the mode for the histogram in (b)?

\[
\left[ a \right] \quad \text{Mean Price} = \frac{\text{Sum of all prices}}{12 \text{ (months)}} = \$89.94.
\]

\[
\left[ b \right] \quad \text{Use bins with width$\$20$, spanning from$\$25 - \$125$
\]

\[
\text{(3 pts Shape)} \quad \text{(3 pts Normalization)}
\]

\[
\begin{align*}
\text{Bin 1 ($\$25-45$):} & \quad \text{Population 1} \\
\text{Bin 2 ($\$45-65$):} & \quad 1 \\
\text{Bin 3 ($\$65-85$):} & \quad 1 \\
\text{Bin 4 ($\$85-105$):} & \quad 5 \\
\text{Bin 5 ($\$105-125$):} & \quad 4 \\
\end{align*}
\]

*Total population = 12; bin width = $\$20; divide populations by 240 so total area = 1 (required for proper normalization)*

\[
\left[ c \right] \quad \text{Tallest bin is Bin 4: middle value is} \quad \$95 \quad \text{(this is the mode for the above histogram)}
\]

\[
\left[ 3 \text{ pts} \right]
\]
Problem 8. (10 pts) After graduating you are fortunate to get a job in the testing department at the Ford Motor Company, where you are assigned to drive a prototype car back and forth across the country, closely followed by a fuel truck. The prototype car has a fuel tank that holds 16 gallons of gasoline. Your task is to drive the car on the highway until it runs out of fuel, record the distance covered in miles, fill up from the truck, then repeat the procedure a bunch of times. Back at your office you create a Matlab vector D that includes the distance values for all of the legs that you drove. Write a Matlab script that (a) computes the average fuel consumption rate (in miles per gallon) that you achieved on your trip and calls that value mpg, then (b) computes the standard deviation of the fuel consumption rate for each of the legs you drove and calls that value sdev. You may not use the built-in Matlab standard deviation function.

(For example)

```matlab
>> T = length(D);  % (NUMBER OF LEGS DRIVEN)
>> DISTANCE = sum(D);  % (TOTAL MILEAGE COVERED)
>> MPG = DISTANCE / (16 * T);  % (TOTAL FUEL CONSUMED IN GALLONS)

>> MPG_EACH = D / 16;  % (VECTOR OF FUEL CONSUMPTION IN EACH LEG)
>> SDEV = (MPG_EACH - MPG) * 12;  % Computes \[ \sum_{i} (x_i - \bar{x})^2 \]
>> SDEV = sqrt(SDEV/T);  % Gives \[ \sqrt{\frac{\sum_{i} (x_i - \bar{x})^2}{N}} \]

(MPG: 2 pts procedure
3 pts syntax
SAME FOR SDEV)
Bonus questions from geography.

1. Chicago sits on the shore of this body of water:
   - a) Lake Erie
   - b) Lake Michigan
   - c) Illinois Bay
   - d) Lake Huron

2. The easternmost and largest Hawaiian island is:
   - a) Oahu
   - b) Maui
   - c) Kauai
   - d) Hawaii

3. Which of these countries isn’t in sub-Saharan Africa?
   - a) South Africa
   - b) Namibia
   - c) Malawi
   - d) Libya

4. To get to New Zealand from Australia by the shortest path, head this way:
   - a) North
   - b) East
   - c) West
   - d) South

5. Minsk is the capital of which country?
   - a) Russia
   - b) Ukraine
   - c) Latvia
   - d) Belarus