Signature:

Instructions:
- You should have 12 pages (6 sheets), 12 problems.
- Write the answers and show the main steps of your work on this test sheet.
- Your final answers must include the appropriate units (e.g. dollars, dollars per week, miles per hour, etc.)
- If you use a table, state the table used: for example, 1.887 (from table W).
- If you use a function on the TI83 or (TI89), write out the command you entered as well as the result:
  For example, 0.0668 (normalcdf (-10, -1.5, 0, 1)).

DO NOT WRITE ON THE REST OF THIS COVER SHEET!
(Your instructor will use this sheet for recording your scores.)

Problem 1\(_{(8)}\)  Problem 4\(_{(4)}\)  Problem 8\(_{(8)}\)
Problem 2\(_{(10)}\)  Problem 5\(_{(3)}\)  Problem 9\(_{(9)}\)
Problem 3\(_{(15)}\)  Problem 6\(_{(9)}\)  Problem 10\(_{(11)}\)
Problem 7\(_{(10)}\)  Problem 11\(_{(10)}\)
Problem 12\(_{(10)}\)
PART 1\(_{(33)}\)  PART 2\(_{(34)}\)  PART 3\(_{(33)}\)
TOTAL\(_{(100)}\)
Part 1: Chapters 1 & 2

**Problem 1** (8 points) Babe Ruth's yearly home run totals for the 22 years 1914-1935 are:

0, 4, 3, 2, 11, 29, 54, 59, 35, 41, 46, 25, 47, 60, 54, 46, 49, 46, 41, 34, 22, 6.

Barry Bonds’ yearly home run totals for the 18 years 1986-2003 are:

16, 25, 24, 19, 33, 25, 34, 46, 37, 33, 42, 40, 37, 34, 49, 73, 46, 39.

a) (3 points) Make a back-to-back stem plot of these data.

b) (3 points) Give the five-number summaries of these data.

c) (2 points) List any suspected outliers of each data set using the 1.5 x IQR rule. If you think that there are none, say so.
Problem 2 (10 points) In a certain population the birth weight $X$ of infants in pounds is normally distributed with mean $\mu_X = 7.75$ and $\sigma_X = 1.25$.

a) (3 points) Find the probability that an infant will have a birth weight of less than or equal to 6 pounds and 10 ounces (recall there are 16 ounces in one pound).

b) (2 points) Draw a labeled normal distribution curve for $X$ and shade the area that represents the percentage of infants whose weight fall between 7 pounds and 9.75 pounds.

c) (3 points) What is the weight of the infant who is in the 90th percentile?

d) (2 points) Professor Judy has invented a charm index $C$ which she asserts is related to birth weight $X$ by the formula $C = 2X + 10$. Find the mean $\mu_C$ and standard deviation $\sigma_C$ of $C$. 

**Problem 3** (15 points) Consider the following data on heights (in inches) of dating couples:

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<tr>
<th>Observation</th>
<th>#</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tr>
<td>Men</td>
<td>(y-data)</td>
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<td>68</td>
<td>70</td>
<td>68</td>
<td>71</td>
<td>65</td>
</tr>
</tbody>
</table>

a) (5 points) Make a scatter plot of the data

b) (4 points) Given the following information,

\[
\bar{x} = 65.14, \ s_x = 2.97, \ \sum x_i y_i = 31179, \ \bar{y} = 68.29, \ s_y = 2.98,
\]

compute the correlation coefficient. Circle your answer below. (If you cannot compute the correlation coefficient, circle the right-most option and use that value to complete this problem.)

\[
.77 \quad .27 \quad 0 \quad -.27 \quad -.77 \quad .5
\]

c) (4 points) Circle the equation of the linear regression line for predicting \( y \) from \( x \):

\[
\hat{y} = 35.72 + 5x, \quad \hat{y} = 68.29, \quad \hat{y} = 18.11 + .77x, \quad \hat{y} = 51.35 + .27x, \quad \hat{y} = 85.22 - .27x
\]

d) (2 points) Using this regression line, predict the height of the date of a 58 inch woman:
Part 2: Chapters 3 & 4

**Problem 4** (4 points) A research team is interested in the possibility that aspirin or extra vitamin A will decrease the number of heart attacks in adult males. They plan a multiyear study involving 21,996 male physicians. Each will take an aspirin tablet or a placebo each day and a vitamin A tablet or a placebo each day.

a) (1 point) Who are the subjects?

b) (2 points) List the treatment(s):

c) (1 Point) What are the response variable(s):

**Problem 5** (3 points) We wish to take a sample of MAT 221 students. For each of the following, circle the correct description of the sampling technique.

a) Select all of the students in section 1.
   Circle one: Simple random sample
   Stratified random sample
   Multistage sample
   None of these

b) Write all student names on slips of paper and randomly select 30.
   Circle one: Simple random sample
   Stratified random sample
   Multistage sample
   None of these

c) Randomly select 3 sections and randomly select 10 students from each of these sections.
   Circle one: Simple random sample
   Stratified random sample
   Multistage sample
   None of these
Problem 6 (9 points) Let $A$, $B$, and $C$ denote events in a sample space with $P(A) = .4$, $P(B) = .75$, and $P(C) = .3$

a) (3 points) Given that $A$ and $B$ are independent, compute

   i. $P(A \text{ and } B) =$

   ii. $P(A \text{ or } B) =$

   iii. $P(A \mid B) =$

b) (3 points) Given that $P(A \text{ and } C) = .18$, compute

   i. $P(A^c) =$

   ii. $P(A \text{ or } C) =$

c) (3 points) Using the information above and that $P(A \text{ and } B \text{ and } C) = .1$ and $P(B \text{ and } C) = .15$ draw the Venn diagram for $A$, $B$ and $C$ and label the eight separate areas with their associated probabilities.
Problem 7 (10 points) On 8-sided die is rolled. Two of its sides are numbered 1, three sides are numbered 5 and the remaining sides are numbered 8. If \( X \) is the random variable that gives the number rolled, then

a) (2 points) Fill in the probability distribution for \( X \)

\[
\begin{array}{cccc}
X & 1 & 3 & 5 & 8 \\
\text{Prob} & & & & \\
\end{array}
\]

b) Compute

i. (2 points) \( \mu_X = \)

[ show computations]

ii. (2 points) \( \sigma_X = \)

[ show computations]

c) Say we also have two additional standard 4 sided dice, each numbered from 1 to 4. Take as given that the random variable \( Y \) representing the sum of numbers rolled on these two dice has the probability distribution.

\[
\begin{array}{cccccccc}
Y & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\
\text{Prob} & 1/16 & 1/8 & 3/16 & 1/4 & 3/16 & 1/8 & 1/16 \\
\end{array}
\]

For which \( \mu_X = 5 \) and \( \sigma_Y = \sqrt{\frac{8}{3}} \). Now let \( Z = X + Y \), i.e., the sum of the three numbers rolled on the three dice. Compute

i. (2 points) \( \mu_Z = \)

[ show computations]

ii. (2 points) \( \sigma_Z = \)

[ show computations]
Problem 8 (8 points) A hat contains 3 coins, a standard quarter (with a head and a tail) and two fake quarters each with both sides head! A coin is selected at random and is flipped with the result that head shows on top. Was this coin a fake???

a) (4 points) Give a tree diagram for this question, with labeled branches.

b) (4 points) Compute $P(\text{fake} \mid \text{head}) = \text{probability that the selected coin was fake, given that head showed on top.}$
Part 3: Chapters 5 & 6

Problem 9 (9 points) 75% of the members in Congress support a bill about gun control. A sample of 20 members of Congress is taken. Let $X$ count the number who are against the bill.

a) (2 points) How many members of the sample would you expect to be against this bill? (the answer need not be a whole number!)

b) (2 points) Find the standard deviation $\sigma_X$ for $X$.

c) (3 points) Find the probability that exactly 2 members in the sample are against the bill.

d) (3 points) Use the normal approximation with continuity correction to estimate the probability that at least 10 members of the sample are against the bill.
Problem 10 (11 points) A study of the writing ability of 125 4th graders yielded a mean score 75. The population standard deviation was assumed to be 8.

a) (3 points) What is the margin of error for a 95% confidence interval for this study?

b) (4 points) Give a 95% confidence interval for the mean score derived from this sample of 125.

c) (4 points) How many 4th graders should be sampled in order to estimate the mean score within 2 points at a 95% confidence?
Problem 11 (10 points) A manager for a plant that makes lawn gnomes has been receiving complaints his products are shorter than they claim to be. They are advertised as being 18.00 inches tall. The manager takes a simple random sample of 100 gnomes, in order to test the consumers complaints, and finds the average height to 17.78 inches. He knows that his machines cause the heights of the gnomes to have a normal distribution with a standard deviation of \( \sigma = 1 \) inch.

a) (2 points) State the hypotheses:

\[ H_0: \]

\[ H_a: \]

b) (3 points) Find the value of the \( z \)-statistic for testing the hypotheses in part (a).

c) (3 points) Compute the \( P \)-value of the \( z \)-statistic you found in part (b).

d) (2 points) Is this statistic significant (circle your answer)

- at the 5% level? Yes No
- at the 1% level? Yes No
Problem 12 (3 points) Consider the following test of significance:

\[ H_0: \quad \mu = 20 \]

\[ H_a: \quad \mu > 20 \]

At the \( \alpha = 5\% \) level of significance this test accepts the null hypothesis if \( \bar{x} \leq 22 \) and rejects the null hypothesis if \( \bar{x} > 22 \). Find the power of this test to detect a true mean of 21 if the sample standard deviation is \(( = \frac{\sigma}{\sqrt{n}} )\) is 1.216. (Note 22 is the value of \( \bar{x} \) such that \( \frac{\bar{x} - \mu_0}{\sigma} = \frac{22 - 20}{1.216} = 1.645 \) = the \( z \)-value corresponding to the 5\% level of significance.)
Formulas for MAT 221

Chapter 1: Looking at Data-Distributions

- Mean: $\hat{x} = \frac{x_1 + x_2 + \cdots + x_n}{n} = \frac{1}{n} \sum x_i$
- Variance: $s^2 = \frac{1}{n-1} \sum (x_i - \hat{x})^2 = \frac{(x_1 - \hat{x})^2 + (x_2 - \hat{x})^2 + \cdots + (x_n - \hat{x})^2}{n-1}$
- Standard deviation: $s = \sqrt{\frac{1}{n-1} \sum (x_i - \hat{x})^2} = \sqrt{\frac{1}{n-1} \sum x_i^2 - n\hat{x}^2}$
- z-score: $z = \frac{x - \mu}{\sigma}$ (where $x = \mu + 2\sigma$)

Chapter 2: Looking at Data-Relationships

- $r = \frac{\frac{1}{n-1} \sum (x_i - \hat{x})(y_i - \hat{y})}{\frac{1}{s_x s_y}}$ or $r = \left( \frac{1}{n-1} \right) \sum \frac{x_i y_i - \bar{x}\bar{y}}{s_x s_y}$
- Least-squares regression line: $\hat{y} = a + b\hat{x}$, where $b = r\frac{s_y}{s_x}$ and $a = \bar{y} - b\bar{x}$.

Chapter 4: Probability: The Study of Randomness

- Probability Rules
  - $P(A^c) = 1 - P(A)$.
  - If events A and B are disjoint, $P(A \text{ or } B) = P(A) + P(B)$.
  - For any events A and B, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$.
  - If events A and B are independent, $P(A \text{ and } B) = P(A) \cdot P(B)$.
  - For any events A and B, $P(A \text{ and } B) = P(A) \cdot P(B|A)$.
  - When $P(A) > 0, P(B|A) = \frac{P(A \text{ and } B)}{P(A)}$.
  - Bayes's Rule:
    $$ P(A|B) = \frac{P(B|A)P(A)}{P(B|A)P(A) + P(B|A^c)P(A^c)} $$

- Probability distribution
  - Mean: $\mu_X = \sum x_i p_i = x_1 p_1 + x_2 p_2 + \cdots + x_k p_k$.
  - Variance: $\sigma_X^2 = \sum (x_i - \mu_X)^2 p_i = \sum (x_1 - \mu_X)^2 p_1 + \cdots + (x_k - \mu_X)^2 p_k$.
  - Standard deviation: $\sigma_X = \sqrt{\sum (x_i - \mu_X)^2 p_i} = \sqrt{\sum x_i^2 p_i} - \mu_X^2$. 
- If $a$ and $b$ are fixed numbers, then
  
  \[ \mu_{(a+bX)} = a + b \mu_X, \quad \sigma_{(a+bX)} = b \sigma_X \]

- If $X$ and $Y$ are random variables, then $\mu_{(X+Y)} = \mu_X + \mu_Y$
- and if $X$ and $Y$ are independent, then
  
  \[ \sigma_{(X+Y)} = \sqrt{\sigma_X^2 + \sigma_Y^2} \quad \text{and} \quad \sigma_{(X-Y)} = \sqrt{\sigma_X^2 + \sigma_Y^2} \]

**Chapter 5: From Probability to Inference**

- Binomial distribution: $X \sim B(n, p)$
  
  - Binomial coefficient: \[ \binom{n}{k} = \frac{n!}{k!(n-k)!} \] where $n! = n \times (n-1) \times (n-2) \times \cdots \times 3 \times 2 \times 1$.
  
  - Binomial probability: $P(X = k) = \binom{n}{k} p^k (1-p)^{n-k}$ for $k = 0, 1, \ldots, n$
  
  - For the count, $X$, $\mu_X = np$, $\sigma_X = \sqrt{np(1-p)}$
  
  - For the sample proportion, $\hat{p}$, $\mu_{\hat{p}} = p$, $\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}}$

- Let $\bar{x}$ be the mean of an SRS of size $n$ from a population having mean $\mu$ and standard deviation $\sigma$. Then
  
  $\mu_{\bar{x}} = \mu$, $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$

**Chapter 6: Introduction to Inference**

- A level $C$ confidence interval for $\mu$ ($\sigma$ known, SRS from a normal population):
  
  $\bar{x} \pm z^* \frac{\sigma}{\sqrt{n}}$, $z^*$ from $N(0,1)$

  ($C = 90\%$, $z^* = 1.645$; $C = 95\%$, $z^* = 1.96$; $C = 99\%$, $z^* = 2.576$)

- Sample size for desired margin of error $m$
  
  $n = \left( \frac{z^* \sigma}{m} \right)^2$

- Test statistic for $H_0: \mu = \mu_0$ ($\sigma$ known, SRS from a normal population)
  
  $z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$
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For \( z \leq -3.00 \), the areas are 0.0000 to four decimal places.
TABLE C  Binomial probabilities (continued)

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