1. Please circle the name of your instructor; Write clearly your ID number, name and section number at the top of the page.

2. Do turn off the mobile and leave it aside.

3. Keep your answers to at least 4 decimal places.

4. Check that the exam paper has 5 questions.

<table>
<thead>
<tr>
<th>Marks Obtained</th>
<th>Strength/Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td></td>
</tr>
</tbody>
</table>

Mohammad H. Omar          Hassen A. Muttlak
Musawar A. Malik          Anwar H. Joarder
1. [10 Marks] The breaking strength of a rivet has a **mean** value of 10,000 psi and a **standard deviation** of 500psi.

a. [7 Marks] What is the **probability** that the sample **mean** breaking strength for a random sample of 40 rivets is **between** 9950 and 10,250? Comment on the distribution of the sample mean.

b. [3 Marks] If the sample size had been 15 rather than 40, could the probability requested in part (a) be calculated from the given information? **Briefly explain.**
2. [16 Marks] Tensile strength tests were performed on two different grades of aluminum spars used in manufacturing the wing of commercial transport aircraft. From past experience with the spar manufacturing process and the testing procedure, the standard deviations of tensile strengths can be assumed equal. The data obtained are shown in the table below.

<table>
<thead>
<tr>
<th>Spar Grade</th>
<th>Sample Size</th>
<th>Sample Mean $\bar{x}$</th>
<th>Sample Standard Deviation $s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$n_1 = 10$</td>
<td>$\bar{x}_1 = 87.6$</td>
<td>$s_1 = 1.0$</td>
</tr>
<tr>
<td>2</td>
<td>$n_2 = 12$</td>
<td>$\bar{x}_2 = 74.5$</td>
<td>$s_2 = 1.5$</td>
</tr>
</tbody>
</table>

a. [7 Marks] Find a 90% confidence interval of the difference in mean tensile strengths for the two grades of spars. Also interpret your results.

b. [2 Marks] Based on your confidence interval, briefly justify if there is any difference between the two grades of aluminum.

c. [7 Marks] The manufacturer claims that Grade 1 of the aluminum spar has higher tensile strength than that of Grade 2. Check the claim by an appropriate inferential (statistical) method.
3. [12 Marks] Measurements on the percent enrichment of 12 fuel rods used in a nuclear reactor were reported as follows:

3.11  2.88  3.08  3.01  
2.84  2.86  3.04  3.09  
3.08  2.89  3.12  3.00

a. [8 Marks] Assuming that the measurements on the percent enrichment follows normal distribution $N(\mu, \sigma^2)$, where neither $\mu$ nor $\sigma$ is known, test, at 5% level of significance, the hypothesis that the mean percent enrichment is 2.95?

b. [4 Marks] Assuming that the level of significance is 0.05, write out the critical region to check the hypothesis that the mean percent enrichment is 2.95 if $\sigma$ were known from the past records? Briefly mention any other assumption you make.
4. [11 Marks] In a random sample of 80 automobile engine crankshaft bearings, 10 have a surface finish that is rougher than the specifications allowed.

a. [7 Marks] A Consumer Group claimed that the proportion of bearings in the population that exceeds the roughness specification is more than 10%. Test the hypothesis by a p-value approach.

b. [4 Marks] How large a sample is required if we want to be 95% confident that the error in estimating the proportion of rougher bearings is less than 0.04?
5. [16 Marks] The accompanying data was read from a graph that appeared in a recent study. The independent variable $x$ is SO$_2$ deposition rate (mg/m$^2$ / day) and the dependent variable $y$ is steel weight loss (g/m$^2$). The resulting sample is given by

\[
\begin{array}{ccccccc}
 x & 14 & 18 & 40 & 43 & 45 & 112 \\
 y & 280 & 350 & 470 & 500 & 560 & 1200 \\
\end{array}
\]

with summary statistics:

\[
\begin{array}{c}
\sum x = 272 & \sum y = 3360 & \sum x^2 = 18538 & \sum y^2 = 2425400 & \sum xy = 210120 \\
\end{array}
\]

a. [3 Marks] Estimate the equation of the estimated regression line between deposition rate and steel weight loss.

b. [1Mark] Estimate the expected change in the steel weight loss if the deposition rate is increased by 1 unit.
c. [6 Marks] Test, at 5% level of significance, the hypothesis that the higher the deposition rate, the more is the steel weight loss.
d. [4] Estimate, with 95% confidence, the **expected steel weight loss** if the deposition rate is 50.

e. [2 Marks] What are the assumptions for your answers to be valid in parts (c) and (d) above.