INSTRUCTIONS TO CANDIDATES: This paper has 4 pages and 6 questions. There are two sections in this exam. You must do any TWO questions in Section A and any TWO (2) questions from Section B.

Section A

1. (a) A sample of 24 offshore oil workers took part in a simulated escape exercise, resulting in the accompanying data on time (sec) to complete the escape:

| 373 | 370 | 364 | 366 | 364 | 325 | 339 | 393 |
| 356 | 359 | 363 | 375 | 424 | 325 | 394 | 402 |
| 392 | 369 | 374 | 359 | 356 | 403 | 334 | 397 |

(i) Construct a stem-and-leaf display of the data. How does it suggest that the sample mean and median will compare? [5 marks]

(ii) Calculate the values of the sample mean and median. [2 marks]

(iii) By how much could the largest time, currently 424, be increased without affecting the value of the sample median? By how much could that value be decreased without affecting the value of the sample mean? [5 marks]

(iv) What are the values of $\bar{x}$ and $\hat{x}$ when the observations are re-expressed in minutes? [3 marks]
Question 1 continued ...

(b) The article "Oxygen Consumption During Fire Suppression: Error of Heart Rate Estimation" (Ergonomics, 1991: 1469 – 2474) reported the following data on oxygen consumption (mL/kg/min) for a sample of ten fire-fighters performing a fire suppression simulation:

29.5  49.3  30.6  28.2  28.0  26.3  33.9  29.4  23.5  31.6

Compute the following:

(i) The sample range. [2 marks]
(ii) The sample variance $S^2$ from the definition (i.e. by first computing deviations, then squaring them, etc.) [3 marks]
(iii) The sample standard deviation. [2 marks]
(iv) $S^2$ using the short cut method. [3 marks]

2. Consider the following information: where A=Visa Cards, B=MasterCards,

$P(A) = .5$, $P(B) = .4$ and $P(A \cap B) = .25$. Calculate each of the following probabilities.

(a) $P(B \mid A)$ [5 marks]
(b) $P(B' \mid A)$ [5 marks]
(c) $P(A \mid B)$ [5 marks]
(d) $P(A' \mid B)$ [5 marks]
(e) Given that an individual is selected at random and that he or she has at least one card, what is the probability that he or she has a Visa card? [5 marks]
3. (a) Twenty five percent of all telephones of a certain type are submitted for service while under warranty. Of these, 60 percent can be repaired whereas the other 40 percent must be replaced with new units. If a company purchases ten of these telephones, what is the probability that exactly two will end up being replaced under warranty? [10 marks]

(b) The pmf for $X =$ the number of major defects on a randomly selected gas stove of a certain type is

<table>
<thead>
<tr>
<th>$x$</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P(x)$</td>
<td>.10</td>
<td>.15</td>
<td>.45</td>
<td>.25</td>
<td>.05</td>
</tr>
</tbody>
</table>

Compute the following:
(i) $E(X)$ [3 marks]
(ii) $V(X)$ [5 marks]
(iii) The standard deviation of $X$. [2 marks]
(iv) $V(X)$ using the short-cut formula. [5 marks]

Section B

4. (a) A random sample of soil specimens was obtained, and the amount of organic matter (%) in the soil was determined for each specimen, resulting in the accompanying data (from "Engineering Properties of Soil", Soil Science, 1998:93-102).

| 1.10 | 5.09 | 0.97 | 1.59 | 4.60 | 0.32 | 0.55 | 1.45 |
| 0.14 | 4.47 | 1.20 | 3.50 | 5.02 | 4.67 | 5.22 | 2.69 |
| 3.98 | 3.17 | 3.03 | 2.21 | 0.69 | 4.47 | 3.31 | 1.17 |
| 0.76 | 1.17 | 1.57 | 2.62 | 1.66 | 2.05 |

The value of the sample mean, sample standard deviation, and (estimated) standard error of the mean are 2.481, 1.616 and .295, respectively. Does this suggest that the true average percentage of organic matter in such soil is something other than 3%? Carry out a test of the appropriate hypothesis at significance level $\alpha = .10$. [10 marks]

(b) A sample of 12 radon detectors of a certain type was selected, and each was exposed to 100 pCi/L of radon. The resulting reading were as follows:

104.3 89.6 89.9 95.6 95.2 90.0 98.8 103.7 98.3 106.4 102.0 91.1

Does this data suggest that the population mean reading these conditions differs from 100? State and test the appropriate hypotheses using $\alpha = .05$. [15 marks]
5. (a) Suppose \( \mu_1 \) and \( \mu_2 \) are true mean topping distance at 50mph for cars of a certain type equipped with two different types of braking systems. The following statistics are given: \( n = 6, \bar{x}_1 = 116, s_1 = 5.0, \bar{x}_2 = 129, \) and \( s_2 = 5.5. \) Calculate a 95% CI for the difference between true average stopping distance for cars equipped with system 1 and cars equipped with system 2. Does the interval suggest that precise information about the value of this difference is available? [10 marks]

(b) Consider the accompanying data on plant growth after the application of different types of growth hormone.

<table>
<thead>
<tr>
<th>Hormone</th>
<th>1</th>
<th>15</th>
<th>19</th>
<th>9</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td>23</td>
<td>15</td>
<td>22</td>
<td>19</td>
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<td>3</td>
<td></td>
<td>20</td>
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<td>13</td>
<td>20</td>
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<tr>
<td>5</td>
<td></td>
<td>9</td>
<td>13</td>
<td>17</td>
<td>10</td>
</tr>
</tbody>
</table>

Perform an \( F \) test at level \( \alpha = .05. \) [15 marks]

6. The accompanying data on \( x = \) current density (mA/cm\(^2\)) and \( y = \) rate of deposition (\( \mu/min \)) appeared in a recent study. Do you agree with the claim by the article’s author “a linear relationship was obtained from the tin-lead rate of deposition as a function of current density”? Explain your reasoning.

\[
\begin{array}{cccc}
 x & 20 & 40 & 60 & 80 \\
 y & .24 & 1.20 & 1.71 & 2.22 \\
\end{array}
\]

[25 marks]