U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

October 2024 Supplementary Examinations

Programme: B.E. | **Semester: IV**
Branch: Industrial Engineering and Management | **Duration: 3 hrs.**
Course Code: 23IM4BSSFE | **Max Marks: 100**
Course: Statistics for Engineers

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

<table>
<tr><th></th><th></th><th>UNIT – I</th><th>CO</th><th>PO</th><th>Marks</th></tr>
<tr><td>1</td><td>a)</td><td>An engineer is someone who solves problems of interest to society by the efficient application of scientific principles. Justify the statement.</td><td>CO2</td><td>PO1</td><td>06</td></tr>
<tr><td></td><td>b)</td><td>The United States has an aging infrastructure as witnessed by several recent disasters, including the I-35 bridge failure in Minnesota. Most states inspect their bridges regularly and report their condition (on a scale from 1–17) to the public. Here are the condition numbers from a sample of 30 bridges in New York State (https://www.dot.ny.gov/main/bridgedata):
5.08 5.44 6.66 5.07 6.80 5.43 4.83 4.00 4.41
4.38 7.00 5.72 4.53 6.43 3.97 4.19 6.26 6.72
5.26 5.48 4.95 6.33 4.93 5.61 4.66 7.00 5.57
3.42 5.18 4.54
i) Find the sample mean and sample standard deviation of these condition numbers.
ii) Find the quartiles and median of the data.
iii) Draw a box plot for the data</td><td>CO2</td><td>PO1</td><td>08</td></tr>
<tr><td></td><td>c)</td><td>Considering example of a partnership business situation. You want to find the occurrences of certain bottlenecks in your business process. In this example, the categories will be different groups of bottlenecks in the workflow process. Let’s call these bottlenecks A, B, C, D, etc. Once the data has been collected and organized, the following table provides the information.
<table>
<tr><th rowspan="2">Bottle neck types/ Event Occurrence</th><th colspan="7">Days of the week</th></tr>
<tr><th>Sunday</th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th><th>Saturday</th></tr>
<tr><td>Bottleneck A</td><td>45</td><td>21</td><td>12</td><td>33</td><td>26</td><td>31</td><td>28</td></tr>
<tr><td>Bottleneck B</td><td>4</td><td>7</td><td>3</td><td>5</td><td>0</td><td>2</td><td>9</td></tr>
<tr><td>Bottleneck C</td><td>12</td><td>15</td><td>9</td><td>11</td><td>4</td><td>13</td><td>7</td></tr>
<tr><td>Bottleneck D</td><td>45</td><td>26</td><td>23</td><td>37</td><td>28</td><td>39</td><td>22</td></tr>
<tr><td>Bottleneck E</td><td>25</td><td>14</td><td>17</td><td>11</td><td>21</td><td>12</td><td>9</td></tr>
</table>
Construct the Pareto Chart to identify the vital few factors affecting business process.</td><td>CO3</td><td>PO2</td><td>06</td></tr>
</table>

UNIT – II

2 a) The analysis of results from a leaf transmutation experiment (turning a leaf into a petal) is summarized by the type of transformation completed: *(CO3, PO2, 08)*

		Total Textural Transformation	
		Yes	No
Total Color	Yes	243	26
Transformation	No	13	18

A naturalist randomly selects three leaves from this set without replacement. Determine the following probabilities.

i) Exactly one has undergone both types of transformations.
ii) At least one has undergone both transformations.
iii) Exactly one has undergone one but not both transformations.
iv) At least one has undergone at least one transformation.

b) The number of telephone calls that arrive at a phone exchange is often modeled as a Poisson random variable. Assume that on the average there are 10 calls per hour. *(CO3, PO2, 08)*

i) What is the probability that there are exactly 5 calls in one hour?
ii) What is the probability that there are 3 or fewer calls in one hour?
iii) What is the probability that there are exactly 15 calls in two hours?
iv) What is the probability that there are exactly 5 calls in 30 minutes?

c) The random variable X has a binomial distribution with $n = 10$ and $p = 0.01$. Determine the following probabilities. *(CO2, PO1, 04)*

i) $P(X = 5)$ ii) $P(X \leq 2)$
iii) $P(X \geq 9)$ iv) $P(3 \leq X < 5)$

OR

3 a) The thickness of a flange on an aircraft component is uniformly distributed between 0.95 and 1.05 millimeters. Determine the following: *(CO3, PO2, 08)*

i) Cumulative distribution function of flange thickness
ii) Proportion of flanges that exceeds 1.02 millimeters
iii) Thickness exceeded by 90% of the flanges
iv) Mean and variance of flange thickness

b) The fill volume of an automated filling machine used for filling cans of carbonated beverage is normally distributed with a mean of 12.4 fluid ounces and a standard deviation of 0.1 fluid ounce. *(CO3, PO2, 06)*

i) What is the probability that a fill volume is less than 12 fluid ounces?
ii) If all cans less than 12.1 or more than 12.6 ounces are scrapped, what proportion of cans is scrapped?
iii) Determine specifications that are symmetric about the mean that include 99% of all cans.

		c)	Cabs pass your workplace according to a Poisson process with a mean of five cabs per hour. i) Determine the mean and standard deviation of the number of cabs per 10-hour day. ii) Approximate the probability that more than 65 cabs pass within a 10-hour day. iii) Approximate the probability that between 50 and 65 cabs pass in a 10-hour day.	*CO3*	*PO2*	**06**
			UNIT - III			
	4	a)	Dairy cows at large commercial farms often receive injections of bST (Bovine Somatotropin), a hormone used to spur milk production. Bauman et al. (Journal of Dairy Science, 1989) reported that 12 cows given bST produced an average of 28.0 kg/d of milk. Assume that the standard deviation of milk production is 2.25 kg/d. i) Find a 99% confidence interval for the true mean milk production. ii) If the farms want the confidence interval to be no wider than ±1.25 kg/d, what level of confidence would they need to use?	*CO3*	*PO2*	**06**
		b)	A random sample of 50 suspension helmets used by motorcycle riders and automobile race-car drivers was subjected to an impact test, and some damage was observed on 18 of these helmets. i) Find a 95% two-sided confidence interval on the true proportion of helmets that would show damage from this test. ii) Using the point estimate of p from the 50 helmets, how many helmets must be tested to be 95% confident that the error in estimating p is less than 0.02? iii) How large must the sample be if we wish to be at least 95% confident that the error in estimating p is less than 0.02 regardless of the true value of p?	*CO3*	*PO2*	**08**
		c)	The compressive strength of concrete is being tested by a civil engineer who tests 12 specimens and obtains the following data: 2216 2237 2249 2204 2225 2301 2281 2263 2318 2255 2275 2295 i) Construct a 95% two-sided confidence interval on the mean strength. ii) Construct a 95% lower confidence bound on the mean strength. Compare this bound with the lower bound of the two-sided confidence interval and discuss why they are different.	*CO3*	*PO2*	**06**

<table>
<tr><td></td><td></td><td></td><td>UNIT – IV</td><td></td><td></td><td></td></tr>
<tr><td></td><td>5</td><td>a)</td><td>The life in hours of a battery is known to be approximately normally distributed with standard deviation $\sigma = 1.25$ hours. A random sample of 10 batteries has a mean life of $\bar{x} = 40.5$ hours.
i) Is there evidence to support the claim that battery life exceeds 40 hours? Use $\alpha = 0.05$.
ii) What is the P-value for the test in part (a)?
iii) What is the β-error for the test in part (a) if the true mean life is 42 hours?
iv) What sample size would be required to ensure that β does not exceed 0.10 if the true mean life is 44 hours?</td><td>CO3</td><td>PO2</td><td>12</td></tr>
<tr><td></td><td></td><td>b)</td><td>The number of defects in printed circuit boards is hypothesized to follow a Poisson distribution. A random sample of n = 60 printed circuit boards has been collected, and the following number of defects observed.
<table>
<tr><th>Number of Defects</th><th>Observed Frequency</th></tr>
<tr><td>0</td><td>32</td></tr>
<tr><td>1</td><td>15</td></tr>
<tr><td>2</td><td>9</td></tr>
<tr><td>3</td><td>4</td></tr>
</table>
i) Does the assumption of the Poisson distribution seem appropriate as a probability model for these data? Use $\alpha = 0.01$.
ii) Calculate the P-value for this test.</td><td>CO3</td><td>PO2</td><td>08</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>6</td><td>a)</td><td>A study was performed to determine whether men and women differ in repeatability in assembling components on printed circuit boards. Random samples of 25 men and 21 women were selected, and each subject assembled the units. The two sample standard deviations of assembly time were $s_{men} = 0.98$ minutes and $s_{women} = 1.02$ minutes.
i) Is there evidence to support the claim that men and women differ in repeatability for this assembly task? Use $\alpha = 0.02$ and state any necessary assumptions about the underlying distribution of the data.</td><td>CO3</td><td>PO2</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Two types of plastic are suitable for an electronics component manufacturer to use. The breaking strength of this plastic is important. It is known that $\sigma_1 = \sigma_2 = 1.0$ psi. From a random sample of size $n_1 = 10$ and $n_2 = 12$, you obtain $\overline{x_1} = 162.5$ and $\overline{x_2} = 155.0$. The company will not adopt plastic 1 unless its mean breaking strength exceeds that of plastic 2 by at least 10 psi.
i) Based on the sample information, should it use plastic 1? Use $\alpha = 0.05$ in reaching a decision. Find the P-value.</td><td>CO3</td><td>PO2</td><td>10</td></tr>
</table>

			UNIT – V			
	7	a)	Regression methods were used to analyze the data from a study investigating the relationship between roadway surface temperature (x) and pavement deflection (y). Summary quantities were n = 20, Σy_i = 12.75, Σy_1^2 = 8.86, Σx_i = 1478, $\Sigma\ x_i^2$= 143,215.8, and $\Sigma x_i y_i$ = 1083.67. i) Calculate the least squares estimates of the slope and intercept. Graph the regression line. Estimate σ^2. ii) Use the equation of the fitted line to predict what pavement deflection would be observed when the surface temperature is 85°F. iii) What is the mean pavement deflection when the surface temperature is 90°F? iv) What change in mean pavement deflection would be expected for a 1°F change in surface temperature?	CO4	*PO3*	**15**
		b)	Define data analytics. Mention the types of data analytics with its applications	CO1	*PO1*	**05**

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