U.S.N.										

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

Autonomous Institute Affiliated to VTU

September / October 2024 Supplementary Examinations

Programme: B.E.
Branch: Industrial Engineering and Management
Course Code: 22IM4BSSFE
Course: STATISTICS FOR ENGINEERS

Semester: IV
Duration: 3 hrs.
Max Marks: 100

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><td></td><td></td><td>UNIT – I</td><td><i>CO</i></td><td><i>PO</i></td><td>Marks</td></tr>
<tr><td>1</td><td>a)</td><td>Explain briefly the role statistics in engineering for decision making.</td><td><i>CO</i> 1</td><td><i>PO1</i></td><td>6</td></tr>
<tr><td></td><td>b)</td><td>In an attempt to measure the effects of acid rain, researchers measured the pH (7 is neutral and values below 7 are acidic) of water collected from rain in Ingham County, Michigan.
5.47 5.37 5.38 4.63 5.37 3.74 3.71 4.96 4.64
5.11 5.65 5.39 4.16 5.62 4.57 4.64 5.48 4.57
4.57 4.51 4.86 4.56 4.61 4.32 3.98 5.70 4.15
3.98 5.65 3.10 5.04 4.62 4.51 4.34 4.16 4.64
5.12 3.71 4.64 5.59
i) Find the sample mean and sample standard deviation of these measurements.
ii)Find the quartiles and median of the data.
iii) Draw a box plot for the data.</td><td><i>CO</i> 1</td><td><i>PO1</i></td><td>8</td></tr>
<tr><td></td><td>c)</td><td>The following are the distributions of monthly pay of workers of two factories.
<table>
<tr><td>Pay (INR)</td><td>400-600</td><td>600-800</td><td>800-1000</td><td>1000-1200</td><td>1200-1400</td><td>Total</td></tr>
<tr><td>Factory A</td><td>4</td><td>18</td><td>25</td><td>2</td><td>1</td><td>50</td></tr>
<tr><td>Factory B</td><td>10</td><td>20</td><td>42</td><td>18</td><td>10</td><td>100</td></tr>
</table>
In which factory is the salary variation more?</td><td><i>CO</i> 1</td><td><i>PO1</i></td><td>6</td></tr>
</table>

			UNIT – II			
	2	a)	This exercise illustrates that poor quality can affect schedules and costs. A manufacturing process has 100 customer orders to fill. Each order requires one component part that is purchased from a supplier. However, typically, 2% of the components are identified as defective, and the components can be assumed to be independent. i) If the manufacturer stocks 100 components, what is the probability that the 100 orders can be filled without reordering components? ii) If the manufacturer stocks 102 components, what is the probability that the 100 orders can be filled without reordering components? iii) If the manufacturer stocks 105 components, what is the probability that the 100 orders can be filled without reordering components?	***CO*** 1	***PO1***	**6**
		b)	Suppose that a healthcare provider selects 20 patients randomly (without replacement) from among 500 to evaluate adherence to a medication schedule. Suppose that 10% of the 500 patients fail to adhere with the schedule. Determine the following: i) Probability that exactly 10% of the patients in the sample fail to adhere. ii) Probability that fewer than 10% of the patients in the sample fail to adhere. iii) Probability that more than 10% of the patients in the sample fail to adhere. iv) Mean and variance of the number of patients in the sample who fail to adhere.	***CO*** 1	***PO1***	**8**
		c)	The number of surface flaws in plastic panels used in the interior of automobiles has a Poisson distribution with a mean of 0.05 flaw per square foot of plastic panel. Assume that an automobile interior contains 10 square feet of plastic panel. i) What is the probability that there are no surface flaws in an auto’s interior? ii) If 10 cars are sold to a rental company, what is the probability that none of the 10 cars has any surface flaws? iii) If 10 cars are sold to a rental company, what is the probability that at most 1 car has any surface flaws?	***CO*** 1	***PO1***	**6**
			OR			

	3	a)	The volume of a shampoo filled into a container is uniformly distributed between 374 and 380 milliliters. i) What are the mean and standard deviation of the volume of shampoo? ii) What is the probability that the container is filled with less than the advertised target of 375 milliliters? iii) What is the volume of shampoo that is exceeded by 95% of the containers? iv) Every milliliter of shampoo costs the producer INR 0.002. Any shampoo more than 375 milliliters in the container are an extra cost to the producer. What is the mean extra cost?	***CO*** 1	***PO1***	**8**
		b)	The compressive strength of samples of cement can be modeled by a normal distribution with a mean of 6000 kilograms per square centimeter and a standard deviation of 100 kilograms per square centimeter. i) What is the probability that a sample's strength is less than 6250 Kg/cm2? ii) What is the probability that a sample's strength is between 5800 and 5900 Kg/cm2? iii) What strength is exceeded by 95% of the samples?	***CO*** 1	***PO1***	**6**
		c)	Briefly explain Exponential distribution with its probability density function. Mention some of the application for the same	***CO*** 1	***PO1***	**6**
			UNIT - III			
	4	a)	The life in hours of a 75-watt light bulb is known to be normally distributed with $\sigma = 25$ hours. A random sample of 20 bulbs has a mean life of $x = 1014$ hours. i) Construct a 95% two-sided confidence interval on the mean life. ii) Construct a 95% lower-confidence bound on the mean life. Compare the lower bound of this confidence interval with the one in part (i)	***CO*** 1	***PO1***	**6**
		b)	A machine produces metal rods used in an automobile suspension system. A random sample of 15 rods is selected, and the diameter is measured. The resulting data (in millimeters) are as follows: 8.24 8.25 8.20 8.23 8.24 8.21 8.26 8.26 8.20 8.25 8.23 8.23 8.19 8.28 8.24 i) Calculate a 95% two-sided confidence interval on mean rod diameter. ii) Calculate a 95% upper confidence bound on the mean. Compare this bound with the upper bound of the two-sided confidence interval and discuss why they are different.	***CO*** 2	***PO2***	**8**

<table>
<tr><td></td><td></td><td>c)</td><td>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?</td><td><i>CO</i> 2</td><td><i>PO2</i></td><td>6</td></tr>
<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>A 1992 article in the Journal of the American Medical Association (“A Critical Appraisal of 98.6 Degrees F, the Upper Limit of the Normal Body Temperature, and Other Legacies of Carl Reinhold August Wunderlich”) reported body temperature, gender, and heart rate for a number of subjects. The body temperatures for 25 female subjects follow:

97.8, 97.2, 97.4, 97.6, 97.8, 97.9, 98.0, 98.0, 98.0, 98.1, 98.2, 98.3, 98.3, 98.4, 98.4, 98.4, 98.5, 98.6, 98.6, 98.7, 98.8, 98.8, 98.9, 98.9, and 99.0.

i) Test the hypothesis H_0: $\mu = 98.6$ versus H_1: $\mu \neq 98.6$, using $\alpha = 0.05$. Find the P-value.
ii) Explain how the question in part (i) could be answered by constructing a two-sided confidence interval on the mean female body temperature.</td><td><i>CO</i> 2</td><td><i>PO2</i></td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Consider the following frequency table of observations on the random variable X.
<table>
<tr><td>Values</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>Observed frequency</td><td>24</td><td>30</td><td>31</td><td>11</td><td>4</td></tr>
</table>
i) Based on these 100 observations, is a Poisson distribution with a mean of 1.2 an appropriate model? Perform a goodness- of-fit procedure with $\alpha = 0.05$.
ii) Calculate the P-value for this test.</td><td><i>CO</i> 1</td><td><i>PO1</i></td><td>10</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>The deflection temperature under load for two different types of plastic pipe is being investigated. Two random samples of 15 pipe specimens are tested, and the deflection temperatures observed are as follows (in °F):

Type 1: 206, 188, 205, 187, 194, 193, 207, 185, 189, 213, 192, 210, 194, 178, 205
Type 2: 177, 197, 206, 201, 180, 176, 185, 200, 197, 192, 198, 188, 189, 203, 192

i) Do the data support the claim that the deflection temperature under load for type 1 pipe exceeds that of type 2? In reaching your conclusions, use $\alpha = 0.05$. Calculate a P-value.</td><td><i>CO</i> 1</td><td><i>PO1</i></td><td>8</td></tr>
</table>

<table>
<tr><td></td><td></td><td>b)</td><td>Two different types of injection-molding machines are used to form plastic parts. A part is considered defective if it has excessive shrinkage or is discolored. Two random samples, each of size 300, are selected, and 15 defective parts are found in the sample from machine 1, and 8 defective parts are found in the sample from machine 2.
i) Is it reasonable to conclude that both machines produce the same fraction of defective parts, using $\alpha = 0.05$? Find the P-value for this test.
ii) Suppose that $p_1 = 0.05$ and $p_2 = 0.01$. With the sample sizes given here, what is the power of the test for this two sided alternate?</td><td><i>CO</i> 1</td><td><i>PO1</i></td><td>12</td></tr>
<tr><td></td><td></td><td></td><td>UNIT – V</td><td></td><td></td><td></td></tr>
<tr><td></td><td>7</td><td>a)</td><td>An article in the Tappi Journal (March 1986) presented data on green liquor Na_2S concentration (in grams per liter) and paper machine production (in tons per day). The data (read from a graph) follow:
<table>
<tr><td>y</td><td>40</td><td>42</td><td>49</td><td>46</td><td>44</td><td>48</td><td></td></tr>
<tr><td>x</td><td>825</td><td>830</td><td>890</td><td>895</td><td>890</td><td>910</td><td></td></tr>
<tr><td>y</td><td>46</td><td>43</td><td>53</td><td>52</td><td>54</td><td>57</td><td>58</td></tr>
<tr><td>x</td><td>915</td><td>960</td><td>990</td><td>1010</td><td>1012</td><td>1030</td><td>1050</td></tr>
</table>
i) Fit a simple linear regression model with y = green liquor Na_2S concentration and x = production. Find an estimate of σ^2. Draw a scatter diagram of the data and the resulting least squares fitted model.
ii) Find the fitted value of y corresponding to x = 910 and the associated residual.
iii) Find the mean green liquor Na_2S concentration when the production rate is 950 tons per day.</td><td><i>CO</i> 2</td><td><i>PO2</i></td><td>16</td></tr>
<tr><td></td><td></td><td>b)</td><td>Discuss briefly the multi linear regression. With its applications.</td><td><i>CO</i> 1</td><td><i>PO1</i></td><td>4</td></tr>
</table>

****