Progressive Education's Society's **Modern College of Engineering** (An Autonomous Institute Affiliated to Savitribai Phule Pune University)		
F.Y. M.Tech. Computer Engineering (2024 Pattern)		
Question Bank		
Mathematical Foundations in Computer Science (Course Code:CSE01501)		
Q. No	**Questions**	**Unit**
1	What is the significance of the measures of location? Define any three with examples.	1
2	The following are historical data on staff salaries (dollars per pupil) for 30 schools sampled in the eastern part of the United States in the early 1970s. 3.79 2.99 2.77 2.91 3.10 1.84 2.52 3.22 2.45 2.14 2.67 2.52 2.71 2.75 3.57 3.85 3.36 2.05 2.89 2.83 3.13 2.44 2.10 3.71 3.14 3.54 2.37 2.68 3.51 3.37 (a) Compute the sample mean and sample standard deviation. (b) Construct a relative frequency histogram of the data. (c) Construct a stem-and-leaf display of the data.	1
3	The probability that an American industry will locate in Shanghai, China, is 0.7, the probability that it will locate in Beijing, China, is 0.4, and the probability that it will locate in either Shanghai or Beijing or both is 0.8. What is the probability that the industry will locate (a) in both cities? (b) in neither city	1
4	What is the significance of the measures of variability? Define any three with examples.	1
5	According to the journal Chemical Engineering, an important property of a fiber is its water absorbency. A random sample of 20 pieces of cotton fiber was taken and the absorbency on each piece was measured. The following are the absorbency values: 18.71, 21.41, 20.72, 21.81, 19.29, 22.43, 20.17, 23.71, 19.44, 20.50, 18.92, 20.33, 23.00, 22.85, 19.25, 21.77, 22.11, 19.77, 18.04, 21.12 (a) Calculate the sample mean and median for the above sample values. (b) Compute the 10% trimmed mean. (c) Do a dot plot of the absorbency data. (d) Using only the values of the mean, median, and trimmed mean, do you have evidence of outliers in the data?	1
6	For married couples living in a certain suburb, the probability that the husband will vote on a bond referendum is 0.21, the probability that the wife will vote on the referendum is 0.28, and the probability that both the husband and the wife will vote is 0.15. What is the probability that (a) at least one member of a married couple will vote? (b) a wife will vote, given that her husband will vote? (c) a husband will vote, given that his wife will not vote?	1
7	State and prove Bayes' rule. Explain the significance of Bayes' rule in machine learning and AI.	1
8	According to the journal Chemical Engineering, an important property of a fiber is its water absorbency. A random sample of 20 pieces of cotton fiber was taken and the absorbency on each piece was measured. The following are the absorbency values: 18.71, 21.41, 20.72, 21.81, 19.29, 22.43, 20.17, 23.71, 19.44, 20.50, 18.92, 20.33, 23.00, 22.85, 19.25, 21.77, 22.11, 19.77, 18.04, 21.12	1

	(a) Calculate the sample mean and median for the above sample values. (b) Compute the sample variance and standard deviation for the water absorbency data.	
9	The probability that an automobile being filled with gasoline also needs an oil change is 0.25; the probability that it needs a new oil filter is 0.40; and the probability that both the oil and the filter need changing is 0.14. (a) If the oil has to be changed, what is the probability that a new oil filter is needed? (b) If a new oil filter is needed, what is the probability that the oil has to be changed?	1
10	Explain probability density function and cumulative distribution function of a continuous random variable with example.	2
11	In a gambling game, a woman is paid \$3 if she draws a jack or a queen and \$5 if she draws a king or an ace from an ordinary deck of 52 playing cards. If she draws any other card, she loses. How much should she pay to play if the game is fair?	2
12	A dealer's profit, in units of \$5000, on a new automobile is a random variable X having the density function given below: $f(x) = \begin{cases} 2(1-x), & 0 < x < 1, \\ 0, & \text{elsewhere}, \end{cases}$ Find the variance of X.	2
13	Explain probability mass function and cumulative distribution function of a discrete random variable with example.	2
14	The random variable X, representing the number of errors per 100 lines of software code, has the following probability distribution: $\begin{array}{c\|ccccc} x & 2 & 3 & 4 & 5 & 6 \\ \hline f(x) & 0.01 & 0.25 & 0.4 & 0.3 & 0.04 \end{array}$ Find the variance of X.	2
15	A coin is tossed twice. Let Z denote the number of heads on the first toss and W the total number of heads on the 2 tosses. If the coin is unbalanced and a head has a 40% chance of occurring, find (a) the joint probability distribution of W and Z; (b) the marginal distribution of W; (c) the marginal distribution of Z; (d) the probability that at least 1 head occurs.	2
16	Explain joint probability distribution and joint density function of discrete random variables with example.	2
17	From a box containing 4 dimes and 2 nickels, 3 coins are selected at random without replacement. Find the probability distribution for the total T of the 3 coins. Express the probability distribution graphically as a probability histogram.	2
18	From a sack of fruit containing 3 oranges, 2 apples, and 3 bananas, a random sample of 4 pieces of fruit is selected. If X is the number of oranges and Y is the number of apples in the sample, find (a) the joint probability distribution of X and Y ; (b) P[(X, Y) ∈ A], where A is the region that is given by {(x, y) | x + y ≤ 2}.	2
19	Explain state classification and limiting probabilities of discrete-time Markov chains.	3
20	For a cascade of binary communication channels, let P (X0 = 1) = α and P (X0 = 0) = 1 − α, α ≥ 0, and assume that a = b. Compute the probability that a 1 was transmitted, given that a 1 was received after the nth stage; that is, compute: $P(X_0 = 1 \| X_n = 1)$.	3
21	Assume that a computer system is in one of three states: busy, idle, or undergoing repair, respectively denoted by states 0, 1, and 2. Observing its state at 2 P.M. each	3

	day, we believe that the system approximately behaves like a homogeneous Markov chain with the transition probability matrix: $$P = \begin{bmatrix} 0.6 & 0.2 & 0.2 \\ 0.1 & 0.8 & 0.1 \\ 0.6 & 0.0 & 0.4 \end{bmatrix}.$$ Prove that the chain is irreducible, and determine the steady-state probabilities.	
22	Explain discrete-time queuing network representation of multiprocessor memory interference with state diagram.	3
23	Assume that a computer system is in one of three states: busy, idle, or undergoing repair, respectively denoted by states 0, 1, and 2. Observing its state at 2 P.M. each day, we believe that the system approximately behaves like a homogeneous Markov chain with the transition probability matrix: $$P = \begin{bmatrix} 0.6 & 0.2 & 0.2 \\ 0.1 & 0.8 & 0.1 \\ 0.6 & 0.0 & 0.4 \end{bmatrix}.$$ Prove that the chain is irreducible, and determine the steady-state probabilities.	3
24	Draw and explain The M/G/1 queue with Bernoulli feedback.	3
25	What is a Markov Process? Explain Discrete time markov chain in detail.	3
26	Jobs submitted to a university departmental file server can be divided into three classes: <table><tr><th>*Type*</th><th>*Relative frequency*</th><th>*Mean execution time (in seconds)*</th></tr><tr><td>Student jobs</td><td>0.8</td><td>1</td></tr><tr><td>Faculty jobs</td><td>0.1</td><td>20</td></tr><tr><td>Administrative jobs</td><td>0.1</td><td>5</td></tr></table> Assuming that, within a class, execution times are one-stage, two-stage, and three-stage Erlang, respectively, compute the average number of jobs in the server assuming a Poisson overall arrival stream of jobs with average rate of 0.1 jobs per second. Assume that all classes are treated equally by the scheduler.	3
27	For a cascade of binary communication channels, let P (X0 = 1) = α and P (X0 = 0) = 1 − α, α ≥ 0, and assume that a = b. Compute the probability that a 1 was transmitted, given that a 1 was received after the nth stage; that is, compute: $P(X_0 = 1 \mid X_n = 1)$.	3
28	What is a correlation coefficient? Explain with example sample coefficient of determination and population correlation coefficient.	4
29	A study was made on the amount of converted sugar in a certain process at various temperatures. The data were coded and recorded as follows:	4

Temperature, x	Converted Sugar, y
1.0	8.1
1.1	7.8
1.2	8.5
1.3	9.8
1.4	9.5
1.5	8.9
1.6	8.6
1.7	10.2
1.8	9.3
1.9	9.2
2.0	10.5

(a) Estimate the linear regression line.
(b) Estimate the mean amount of converted sugar produced when the coded temperature is 1.75.
(c) Plot the residuals versus temperature.

30 The amounts of a chemical compound y that dissolved in 100 grams of water at various temperatures x were recorded as follows:

4

x (°C)	y (grams)		
0	8	6	8
15	12	10	14
30	25	21	24
45	31	33	28
60	44	39	42
75	48	51	44

(a) evaluate s^2;
(b) construct a 99% confidence interval for β_0;
(c) construct a 99% confidence interval for β_1.

31 Explain Simple regression model with an example and scatter diagram with regression line.

4

32 The amounts of a chemical compound y that dissolved in 100 grams of water at various temperatures x were recorded as follows:

4

x (°C)	y (grams)		
0	8	6	8
15	12	10	14
30	25	21	24
45	31	33	28
60	44	39	42
75	48	51	44

(a) Find the equation of the regression line.
(b) Graph the line on a scatter diagram.
(c) Estimate the amount of chemical that will dissolve in 100 grams of water at 50°C.

33 A professor in the School of Business in a university polled a dozen colleagues about the number of professional meetings they attended in the past five years (x) and the number of papers they submitted
to refereed journals (y) during the same period. The summary data are given as follows:

4

$$n = 12, \quad \bar{x} = 4, \quad \bar{y} = 12,$$

$$\sum_{i=1}^{n} x_i^2 = 232, \quad \sum_{i=1}^{n} x_i y_i = 318.$$

Fit a simple linear regression model between x and y by finding out the estimates of intercept and slope. Comment on whether attending more professional meetings would result in publishing more papers.

34 What is the Coefficient of Determination? Why is it called a measure of Quality of

4

<table>
<tr><td></td><td>Fit? What are the pitfalls of using it?</td><td></td></tr>
<tr><td>35</td><td>The grades of a class of 9 students on a midterm report (x) and on the final examination (y) are as follows
<table>
<tr><td>x</td><td>77</td><td>50</td><td>71</td><td>72</td><td>81</td><td>94</td><td>96</td><td>99</td><td>67</td></tr>
<tr><td>y</td><td>82</td><td>66</td><td>78</td><td>34</td><td>47</td><td>85</td><td>99</td><td>99</td><td>68</td></tr>
</table>
(a) Estimate the linear regression line.
(b) Estimate the final examination grade of a student who received a grade of 85 on the midterm report.</td><td>4</td></tr>
<tr><td>36</td><td>The thrust of an engine (y) is a function of exhaust temperature (x) in◦F when other important variables are held constant. Consider the following data.
<table>
<tr><th>y</th><th>x</th><th>y</th><th>x</th></tr>
<tr><td>4300</td><td>1760</td><td>4010</td><td>1665</td></tr>
<tr><td>4650</td><td>1652</td><td>3810</td><td>1550</td></tr>
<tr><td>3200</td><td>1485</td><td>4500</td><td>1700</td></tr>
<tr><td>3150</td><td>1390</td><td>3008</td><td>1270</td></tr>
<tr><td>4950</td><td>1820</td><td></td><td></td></tr>
</table>
(a) Plot the data.
(b) Fit a simple linear regression to the data and plot the line through the data.</td><td>4</td></tr>
</table>

*** *** ***