B.E. Production Engineering 2nd Year 1st Semester Examination

Ex/PROD/BS/B/T/215/2023

INDUSTRIAL STATISTICS

Time : **Three hours**   Full marks: **100**

Answer Question No. 1 and any four from the rest.

1. The factors that influence the breaking strength of a synthetic fiber are being studied. Four production machines and three operators are chosen and a factorial experiment is run using fiber from the same production run. The results are as follows: (20)

Operator	Machine			
	1	2	3	4
1	109, 110	110, 115	108, 109	110, 108
2	110, 112	110, 111	111, 109	114, 112
3	116, 114	112, 115	114, 119	120, 117

Analyze the data and draw conclusions at 0.05 level of significance. (Given $F_{0.05}$ for (2,12) df = 3.8853, $F_{0.05}$ for (3,12) df = 3.4903, $F_{0.05}$ for (6,12) df = 2.9961)·

2. The following table shows the average temperature and precipitation in a city for the month of March during the years 2010 through 2017. Find the correlation coefficient between the average temperature and precipitation.   (8+6+6)

Year	2010	2011	2012	2013	2014	2015	2016	2017
Temperature ($^{\circ}$F)	78.1	71.8	75.6	72.7	75.3	73.6	75.1	76.0
Precipitation (mm)	6.23	3.64	3.42	2.84	1.83	2.82	4.04	3.50

From the above data, also estimate the average temperature and precipitation for the year 2018.

3.(a) A sample of 48 tools produced by a machine shows the following sequence of good (G) and defective (D) tools: (10)

   G G G G G G D D G G G G G G G G G G G D D D D G G G G G G G D G G G G G G G G G D D G G G
   G G D G G

   Test the randomness of the sequence at 0.01 significance level.

(b) A teacher wishes to test three different teaching methods I, II and III. To do this, the teacher randomly chooses three groups of five students each and teaches each group by a different method. The final examination is then given to all the students and the grades in the following table are obtained. Determine at 0.05 level of significance whether there is a different between the teaching methods. (10) (Given $X^2_{0.05}$ = 5.99 for 2 df)

Method I	78	62	71	58	73
Method II	76	85	77	90	87
Method III	74	79	60	75	78

4.(a) The following table gives the numbers of miles to the gallon obtained by similar automobiles using five different brands of gasoline, Determine whether there is a significant difference between those brands at 0.05 level of significance. (Given $F_{0.05}$ for (4,16) df = 2.3327)   (12)

Brand A	12	15	14	11	15
Brand B	14	12	15		
Brand C	11	12	10	14	
Brand D	15	18	16	17	14
Brand E	10	12	14	12	

(b) A set of observations follows Poisson distribution with mean 4. Determine the corresponding value of coefficient of variation.   (2)

(c) Differentiate between the followings: (3x2)

   (i) Purposive sampling and systematic sampling, (ii) Point estimation and interval estimation, (iii) standard deviation and standard error.

[Turn over

5.(a) A research team investigated whether there was any significant correlation between the severity of a certain disease runoff and the age of the patients. During the study, data for 200 patients were collected and grouped according to the severity of the disease and the age of the patient. The table below shows the results: (10)

		Age		
		Below 40	40-60	Above 60
Runoff	Slight	41	34	9
	Average	24	26	12
	Serious	6	33	15

Test at 0.05 level of significance whether disease runoff and the age of the patients are correlated or not. (Given $X^2_{0.05} = 13.28$ for 4 df)

(b) In a packaging plant, a machine packs cartons with jars. It is supposed that a new machine would pack faster on the average than the machine currently used. To test the hypothesis, the time it takes each machine to pack ten cartons are recorded. The results in seconds are provided as below: (10)

| New machine | 42.1 | 41.0 | 41.3 | 41.8 | 42.4 | 42.8 | 43.2 | 42.3 | 41.8 | 42.7 |
| Old machine | 42.7 | 43.6 | 43.8 | 43.3 | 42.5 | 43.5 | 43.1 | 41.7 | 44.0 | 44.1 |

Does the data provide sufficient evidence to conclude that on the average, the new machine packs faster? Perform the required hypothesis test at 5% level of significance. (Given $t_{18,0.05} = 1.734$ for 4 df)

6.(a) Given that $f(x) = k/3^x$ is a probability distribution for a random variable that can take on the values x = 0, 1, 2, 3 and 4, find k. (6)

(b) With a numerical example, show that the r_s value can be -1. (3)

(c) The following are the weights (in decigrams) of 10 packages of grass seed distributed by a certain company: 46.4, 46.1, 45.8, 47.0, 46.1, 45.9, 45.8, 46.9, 45.2 and 46.0. Find a 95% confidence interval for the variance of all such packages of grass seed distributed by this company. (Given $X^2_{0.025} = 19.023$ and $X^2_{0.975} = 2.700$) (8)

(d) How can the binomial distribution be approximated by Poisson distribution. (3)

7.(a) From a box containing five black balls and three green balls, three balls are drawn in succession, each ball being replaced in the box before the next draw is made. What is the probability that all three balls are the same color? What is the probability that each color is represented? (6)

(b) A heavy machinery manufacturer has 3840 large generators in the field that are under warranty. If the probability is 1/1200 that any one will fail during the given year, find the probabilities that 0, 1 and 2 of the generators will fail during the given year. (6)

(c) In January 2023, you had received 0, 1, 2, 3, 4, 5 and 6 phone calls in your mobile phone for 7, 6, 5, 4, 5, 3 and 1 times (number of days in that month) A historical data show that the average number of phone calls in your mobile in any given month is 2.8. Does the number of calls received by you in January, 2023 follow Poisson distribution? (8)