

**B.E. PRODUCTION ENGINEERING SECOND YEAR SECOND SEMESTER EXAM
(OLD) 2018**

(2nd Year – 1st Semester)

INDUSTRIAL STATISTICS

Time : Three hours

Full marks: 100

Answer any five questions.

1.(a) A number is chosen at random from the set $1, 2, \dots, m$ and another number is chosen at random from the set $1, 2, \dots, n$. What is the expected value of their product? (6)

(b) Let there be an urn with 2 red, 3 white and 4 black balls. Three balls are taken out of the urn at random. If x and y denote respectively the number of red and the number of black balls among them, evaluate (i) the joint distribution, (ii) the marginal distribution of x and y , and (iii) the conditional distributions of x for given y . (8)

(c) A lot of 1000 articles is known to have 15 defectives. If 100 articles are chosen at random from the lot, what will be the probabilities of having (i) no defective and (ii) not more than 3 defectives in the sample? (6)

2.(a) The following are the measurements of the carbon content and the permeability index of 12 sinter mixtures.

Carbon content (%)	4.4	5.5	4.2	3.0	4.5	4.1	4.9	4.7	5.0	4.6	4.9	4.6
Permeability index	12	14	18	35	23	13	19	22	20	16	29	16

From the above data, calculate the correlation coefficient value and comment on it. (10)

(b) The following data pertains to the number of hours jet aircraft engines have been used and the number of hours required for repair.

Number of hours (hundreds)	1	2	3	4	5
Repair time (hours)	10	40	30	80	90

Based on the above data, develop a linear regression model and predict the mean repair time for an aircraft engine with 700 hours of usage. (10)

3. (a) In a certain industrial experiment, a job was performed by 10 workmen according to a particular method (Method I) and by another 10 workmen according to a second method (Method II). The time (in minutes) taken by each workman to complete the job is shown below:

Method I	55	53	57	55	52	51	54	54	53	56
Method II	54	53	56	58	55	56	54	58	57	55

Test whether the performance of the second method is better than that of the first method at 5% significance level. (Given $t_{0.05, 18} = 1.734$) (10)

(b) In the course of an experiment on the breeding of peas, a botanist obtains 556 peas classified as follows:

Round and yellow: 315; Round and green: 108; Angular and yellow: 101; Angular and green: 32

According to a genetic theory, such peas should be obtained in the ratio 9:3:3:1. Are the experimental results compatible with the theory? (Given $\chi^2_{0.05} = 0.470$ at $df = 3$) (10)

4.(a) Corrosion rates (percent) were measured for 4 different metals that were immersed in a highly corrosive solution:

Perform an analysis of variance test to justify the differences due to the metals at 5% significance level. (Given $F_{0.05} = 2.93$ for (3,29) df) (16)

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Aluminum	75	77	76	79	74	77	75	
Stainless steel	74	76	75	78	74	77	75	77
Alloy I	73	74	72	74	70	73	74	71
Alloy II	71	74	74	73	74	73	71	

(b) With a suitable numerical example, prove that it is possible to obtain the Spearman's rank correlation coefficient as -1. (4)

5.(a) In an air-pollution study performed at an experiment station, the following amount of suspended benzene-soluble organic matter (in micrograms per cubic meter) were obtained for eight different samples of air: 2.2, 1.8, 3.1, 2.0, 2.4, 2.0, 2.1, 1.2. Assuming that the population sampled is normal, construct a 95% confidence interval for the corresponding true mean. (Given $t_{0.025,7} = 2.635$) (10)

(b) Two different lighting techniques are compared by measuring the intensity of light at selected locations in areas lighted by the two methods. If 15 measurements in the first area had a standard deviation of 2.7 foot-candles and 21 measurements in the second area had a standard deviation of 4.2 foot-candles, can it be concluded that the lighting in the second area is less uniform? Use a 0.01 level of significance. (Given $F_{0.01} = 3.21$ for (14,20) df) (10)

6.(a) The following are data on the breaking strength (in pounds) of 2 kinds of material:

Material I	144	181	200	187	169	171	186	194	176	182
Material II	175	164	172	194	176	198	154	134	169	164

Use the U test at the 0.05 level of significance to test the claim that the strength of Material II is stochastically larger than that of Material I. (10)

(b) The following are the number of defective pieces turned out by a machine during 15 consecutive shifts: 15, 11, 17, 14, 16, 12, 19, 17, 21, 15, 17, 19, 21, 14 and 22. Test for randomness at the 0.01 level of significance. (10)

7. In a study on gasoline consumption by city buses, four vehicles A, B, C and D were tested. In the first run of the day over a specified course, a particular assignment of drivers a, b, c and d was used. In the next run, the drivers were reassigned to the vehicles and so on for all four runs as shown in the following Latin Square design. (20)

	Vehicle			
	A	B	C	D
Run 1	9.49 (a)	9.83 (b)	9.02 (c)	9.38 (d)
Run 2	9.01 (b)	9.22 (d)	9.39 (a)	8.76 (c)
Run 3	9.06 (d)	9.02 (c)	9.88 (b)	8.88 (a)
Run 4	8.71 (c)	9.02 (a)	9.23 (d)	9.73 (b)

Make an analysis of variance for these data. (Given $F_{0.05} = 4.76$ at (3,6) df)