B.E. PRODUCTION ENGINEERING 2nd Year – 2nd Semester (Old) 2017
INDUSTRIAL STATISTICS

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

Answer any five questions. All questions carry equal marks.

1. (a) Raw material used in the production of a synthetic fiber is stored in a place which has no humidity control. Measurements of the relative humidity in the storage place and the moisture content of a sample of raw material (both in percentages) on 12 days yielded the following data: (10)

Humidity	42	35	50	43	48	62	31	36	44	39	55	48
Moisture content	12	8	14	9	11	16	7	9	12	10	12	11

Fit a straight line by the method of least squares.

(b) Test runs with six models of an experimental engine showed that they operated for 24, 28, 21, 23, 32 and 22 minutes with a gallon of a certain kind of fuel. Test at 0.01 significance level, whether on the average, this kind of engine will operate for at least 29 minutes per gallon with this kind of fuel? (10)

2.(a) As part of an industrial training program, some trainees are instructed by Method A, which is straight teaching-machine instruction, and some are instructed by Method B, which also involves the personal attention of an instructor. If random samples of size 10 are taken from large groups of trainees instructed by each of these two methods, and the scores which they obtained in an appropriate achievement test are (10)

Method A	71	75	65	69	73	66	68	71	74	68
Method B	72	77	84	78	69	70	77	73	65	75

Use 0.05 level of significance to test the claim that Method B is more effective.

(b) In a batch chemical process, two catalysts are being compared for their effect on the output of the process reaction. A sample of 12 batches is prepared using catalyst 1 and a sample of 10 batches was obtained using catalyst 2. The 12 batch for which catalyst 1 was used gave an average yield of 85 with a sample standard deviation of 4, while the average for the second sample gave an average of 81 and a sample standard deviation of 5. Test at 95% significance level whether there is any significance difference between the sample means, assuming the populations are normally distributed with equal variances. (Given $t_{0.05,20} = 1.725$) (10)

3.(a) The following are the numbers of minutes it took 10 mechanics to assemble a piece of machinery in the morning (x) and in the late afternoon (y). Determine the value of correlation coefficient. (10)

x	11.1	10.3	12.0	15.1	13.7	18.5	17.3	14.2	14.8	15.3
y	10.9	14.2	13.8	21.5	13.2	21.1	16.4	19.3	17.4	19.0

(b) To determine whether there really is a relationship between an employee's performance in the company's training program and his/her ultimate success in the job, it takes a sample of 400 cases from its very extensive files and obtains the results shown in the following table: (10)

Success in job	Performance in training program		
	Below average	Average	Above average
Poor	23	60	29
Average	28	79	60
Very good	9	49	63

Use 0.01 level of significance to test the null hypothesis that performance in the training

program and success in the job are independent. (Given X^2 = 13.277 for 4 dof)

4. To study the effectiveness of five different kinds of front-site passenger restraint systems in automobiles A, B, C, D and E, the following Geaeco-Latin square experiment was performed. The rows represent different automotive size classes, the columns represent different barrier impact speeds, and the Greek letters (α, β, γ, δ, ε) represent different impact angles. The experimental results are given in terms of an index of forces at critical points on the test dummy and relates to the probability of a fatal injury. Analyze this experiment. (Given $F_{0.05}$ = for 6.09 for (4,8) dof) (20)

A α 0.50	B β 0.21	C γ 0.43	D δ 0.35	E ε 0.46
B γ 0.51	C δ 0.20	D ε 0.40	E α 0.25	A β 0.39
C ε 0.45	D α 0.07	E β 0.29	A γ 0.20	B δ 0.31
D β 0.39	E γ 0.10	A δ 0.31	B ε 0.24	C α 0.27
E δ 0.43	A ε 0.17	B α 0.31	C β 0.22	D γ 0.32

5.(a) Describe various types of experimental plans. (5)

(b) Mr. Franks, a safety engineer for the Mars Nuclear Power Generating Station, has charted the peak reactor temperature each day for the past year and has prepared the following frequency distribution. (15)

Temp. in ^{0}C	501-510	511-520	521-530	531-540	541-550	551-560	561-570	571-580	581-590	591-600
Frequency	4	7	32	59	82	65	33	28	27	23

Now, compute the values of (i) variance, (ii) MAD, (iii) coefficient of variation, (iv) median, and (v) 30th percentile.

6.(a) 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. ($X^2_{0.025}$ = 19.023 and $X^2_{0.975}$ = 2.700) (10)

(b) A random sample of 12 shearing pins are taken in a study of the Rockwell hardness of the head of the pin. Measurements on the Rockwell hardness were made for each of the 12, yielding an average value of 48.50 with a sample standard deviation of 1.5. Assuming the measurements to be normally distributed, construct a 90% confidence interval for the mean Rockwell hardness. (10)

7. (a) The specifications for a certain kind of ribbon call for a mean breaking strength of 180 pounds. If five pieces of the ribbon (randomly selected from different rolls) have a mean breaking strength of 169.5 pounds with a standard deviation of 5.7 pounds, test the null hypothesis μ = 180 pounds against the alternative hypothesis μ < 180 pounds at 0.01 level of significance. (Given $t_{0.01,4}$= -3.747) (10)

(b) The following table gives the probabilities that a certain computer will malfunction 0,1,2,3,4,5 or 6 times on any one day: (10)

Number of malfunctions	0	1	2	3	4	5	6
Probability	0.17	0.29	0.27	0.16	0.07	0.03	0.01

Now determine the mean and standard deviation of this distribution.