

B.E. Production Engineering 2nd Year 1st Semester Examination, 2019(2nd Year – 1st Semester)

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 batch. The results are as follows: (20)

Operator	Machine			
	1	2	3	4
1	69, 70	70, 75	78, 79	70, 78
2	70, 72	70, 71	71, 79	74, 72
3	76, 74	72, 75	74, 79	80, 77

Analyze the data and draw conclusions at 0.05 level of significance. (Given $F_{0.05}$ for (2,12) df = 19.4, Given $F_{0.05}$ for (3,12) df = 8.74, Given $F_{0.05}$ for (6,12) df = 4.00)

2. 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 ($\alpha, \beta, \gamma, \delta, \epsilon$) 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 6.04 for (4,8) dof) (20)

A α	B β	C γ	D δ	E ϵ
0.60	0.27	0.45	0.38	0.36
B γ	C δ	D ϵ	E α	A β
0.58	0.28	0.42	0.35	0.30
C ϵ	D α	E β	A γ	B δ
0.55	0.17	0.27	0.22	0.30
D β	E γ	A δ	B ϵ	C α
0.36	0.12	0.33	0.27	0.25
E δ	A ϵ	B α	C β	D γ
0.44	0.19	0.31	0.24	0.37

- 3.(a) The following data pertain to the resistance (in ohms) and the failure time (in minutes) of certain overloaded resistors. (7+1)

Resistance	43	29	44	33	33	47	34	31	48	34	46	37
Failure time	32	20	45	35	22	46	28	26	37	33	47	30

Calculate the value of correlation coefficient and comment on it.

- (b) An experiment designed to compare three preventive methods against corrosion yielded the following maximum depths of pits (in thousands of an inch) in pieces of wire subjected to the respective treatments. (12)

Method A	77	54	67	74	71	66
Method B	60	41	59	65	62	64
Method C	49	52	69	47	56	

Use 0.05 level of significance to test the hypothesis that the three samples come from identical populations. (Given $X^2_{(0.05,2)} = 5.991$)

- 4.(a) Given that $f(x) = k/2^x$ 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) The random variable has the probability density function, given by $f(x) = (3/10)(3x - x^2)$ for $0 \leq x \leq 2$; and 0, otherwise. Find the mean and variance of x . (6)

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- (c) 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, the company takes a sample of 400 cases from its very extensive files and obtains the results shown in the following table.

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

Use the 0.01 significance level to test the null hypothesis that performance in the training program and success in job are independent. (Given $X^2_{(0.01,4)} = 7.779$) (8)

- 5.(a) The following are the self-reported times (hours for month) spent on homework, by random samples of juniors in two different majors: (10)

Major 1	63	72	29	58	81	65	79	57	40	76	47	55	60
Major 2	41	32	26	43	78	49	39	56	15	54	8	66	64

Use the U-test at the 0.05 level of significance to test whether or not students from the two groups can be expected to score equally well on the test.

- (b) The followings are the data on the performance of the high-performance radial tires made by a certain manufacturer that are still suitable after having been driven for the given number of miles.

Miles driven (in thousands)	1	2	5	10	20	30	40
% used	98.2	91.7	81.3	64.0	36.4	32.6	17.1

Fit an exponential curve ($y = ab^x$) by applying the method of least squares. (10)

- 6.(a) As part of the investigation of the collapse of the roof of a building, a testing laboratory is given all the available bolts that connected the steel structure at three different positions on the roof. The forces required to shear each of these bolts are as follows:

Position 1	90	82	79	98	83	91	
Position 2	105	89	93	104	89	95	86
Position 3	83	94	80	94			

Perform an ANOVA to test at 0.05 level of significance whether the differences between the sample means at the three positions are significant. (Given $F_{0.05}$ for (2, 14) $df = 19.4$) (10)

- (b) It is claimed that in 60% of the all solar-heated installations, the utility bill is reduced by at least one third. Accordingly, what are the probabilities that the utility bill will be reduced by at least one third in (a) four of five installations, and (b) at least four of five installations. (6)
- (c) How can the binomial distribution be approximated by Poisson distribution. (4)
- 7.(a) A large hotel chain is trying to decide whether to convert more of its rooms to nonsmoking rooms. In a random sample of 400 guests last year, 166 had requested nonsmoking rooms. This year, 205 guests in a sample of 380 preferred the nonsmoking rooms. Would you recommend that the hotel chain convert more rooms to nonsmoking? Support your recommendation by testing the appropriate hypothesis at a 0.01 level of significance. (8)
- (b) Techgene, Inc., is concerned about variability in the number of bacteria produced by different cultures. If the cultures have significantly different variability in the number of bacteria produced, then experiments are messed up and some strange things get produced. The following data have been collected.

	Number of bacteria (in thousands)									
Culture A	91	89	93	101	93	98	144	118	108	125
Culture B	62	76	90	75	88	99	110	140	145	130

Using 0.05 level of significance, test whether these samples have been taken from two populations have equal means and variances. (Given $t_{0.05,18} = 2.101$, $F_{0.05}$ for (9,9) $df = 3.18$) (12)