Ex/Prod/T/216/2017(S)

# B. PROD. E. 2ND YEAR 1ST SEMESTER SUPPLEMENTARY EXAMINATION 2017

## INDUSTRIAL STATISTICS

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

***Answer any five questions. All questions carry equal marks.***

1. (a) 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<br>0.50 | B β<br>0.21 | C γ<br>0.43 | D δ<br>0.35 | E ε<br>0.46 |
| B γ<br>0.51 | C δ<br>0.20 | D ε<br>0.40 | E α<br>0.25 | A β<br>0.39 |
| C ε<br>0.45 | D α<br>0.07 | E β<br>0.29 | A γ<br>0.20 | B δ<br>0.31 |
| D β<br>0.39 | E γ<br>0.10 | A δ<br>0.31 | B ε<br>0.24 | C α<br>0.27 |
| E δ<br>0.43 | A ε<br>0.17 | B α<br>0.31 | C β<br>0.22 | D γ<br>0.32 |

2. (a) Four methods are under development for making discs of a super conducting material. Fifty discs are made by each method and they are checked for superconductivity when cooled with liquid nitrogen. (10)

| | Method A | Method B | Method C | Method D |
|---|---|---|---|---|
| Super conductors | 31 | 42 | 22 | 25 |
| Failures | 19 | 8 | 28 | 25 |

Use 0.05 level of significance to test whether there is a significant difference between the proportions of superconductors produced. Under the stated conditions, the probability of crumbling is the same for the three kinds of materials. (Given $X^2$ = 7.815 for 3 dof)

(b) A study shows that 16 of 200 tractors produced on one assembly line required extensive adjustments before they could be shipped, while the same was true for 14 of 400 tractors produced in another assembly line. At 0.01 level of significance, does this support the claim that the second production line does superior work? (10)

3. (a) A machine is producing metal pieces that are cylindrical in shape. A sample of pieces is taken and the diameters are 1.01, 0.97, 1.03, 1.01, 0.99, 0.98, 0.99, 1.01 and 1.03 centimeters. Find a 99% confidence interval for the mean diameter of pieces from this machine. (Given $t_{0.01}$ = 1.860 for 8 dof) (10)

(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)

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

(b) A laboratory technician measures the breaking strength of each of five kinds of linen threads by means of four different instruments, and obtains the following results (in ounces): (15)

| | Ins. 1 | Ins. 2 | Ins. 3 | Ins. 4 |
|---|---|---|---|---|
| Thread 1 | 20.6 | 20.7 | 20.0 | 21.4 |
| Thread 2 | 24.7 | 26.5 | 27.1 | 24.3 |
| Thread 3 | 25.2 | 23.4 | 21.6 | 23.9 |
| Thread 4 | 24.5 | 21.5 | 23.6 | 25.2 |
| Thread 5 | 19.3 | 21.5 | 22.2 | 20.6 |

Looking upon the threads as treatments and instruments as the blocks, perform an ANOVA at 0.05 level of significance. (Given $F_{0.05}$ = for 5.91 for (4,12) dof and $F_{0.05}$ = for 8.74 for (3,12) dof)

5. (a) The government awarded grants to the agricultural departments of nine universities to test the yield capabilities of two new varieties of wheat. Each variety was planted on plots of equal area at each university and the yields, in kilograms per plot, were recorded as follows: (10)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variety I | 38 | 23 | 35 | 41 | 44 | 29 | 37 | 31 | 38 |
| Variety II | 45 | 25 | 31 | 38 | 50 | 33 | 36 | 40 | 43 |

Find a 95% confidence interval for the mean difference between the yields of the two varieties, assuming the distributions of yields to be approximately normal.

(b) Cost accountants often estimate overhead based on the level of production. At the Standard Knitting Co., they have collected information on overhead expenses and units produced at different plants, and want to estimate a regression equation to predict future overhead. (10)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Overhead | 191 | 170 | 272 | 155 | 280 | 173 | 234 | 116 | 153 | 178 |
| Unit | 40 | 42 | 53 | 35 | 56 | 39 | 48 | 30 | 37 | 40 |

Develop the regression equation for the cost accountants and predict overhead when 50 units are produced.

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

(b) The following are the average weekly losses of worker-hours due to accidents in 10 industrial plants before and after a certain safety program was put into operation:

45 and 36, 73 and 60, 46 and 44, 124 and 119, 33 and 35, 57 and 51, 83 and 77, 34 and 29, 26 and 24, and 17 and 11

Use the 5% significance level to test whether the safety program is effective. (10)