# B.E. Production Engineering 2nd Year 1st Semester Examination (Supplementary)    2023

## INDUSTRIAL STATISTICS

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

1.  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 ($^{o}$F) | 77.1 | 72.8 | 74.6 | 73.7 | 77.3 | 74.6 | 78.1 | 79.0 |
| Precipitation (mm) | 5.23 | 4.64 | 4.42 | 3.84 | 2.83 | 2.92 | 4.84 | 3.30 |

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

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 ($\alpha$, $\beta$, $\gamma$, $\delta$, $\varepsilon$) 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 $\alpha$ 0.60 | B $\beta$ 0.27 | C $\gamma$ 0.45 | D $\delta$ 0.38 | E $\varepsilon$ 0.36 |
|---|---|---|---|---|
| B $\gamma$ 0.58 | C $\delta$ 0.28 | D $\varepsilon$ 0.42 | E $\alpha$ 0.35 | A $\beta$ 0.30 |
| C $\varepsilon$ 0.55 | D $\alpha$ 0.17 | E $\beta$ 0.27 | A $\gamma$ 0.22 | B $\delta$ 0.30 |
| D $\beta$ 0.36 | E $\gamma$ 0.12 | A $\delta$ 0.33 | B $\varepsilon$ 0.27 | C $\alpha$ 0.25 |
| E $\delta$ 0.44 | A $\varepsilon$ 0.19 | B $\alpha$ 0.31 | C $\beta$ 0.24 | D $\gamma$ 0.37 |

3(a) Explain different sampling plans along with their advantages and disadvantages. (10)

(b) 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 shown as below: (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.

4(a) 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 are prepared using catalyst 1 and a sample of 10 batches were 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. Find a 90% confidence interval for the difference between the population means, assuming the populations are normally distributed with equal variances. (Given $t_{0.05,20}$ = 1.725) (10)

(b) The following are the numbers of misprints counted on pages selected at random from three Sunday editions of a newspaper: (10)

| April 11 | 4 | 10 | 2 | 6 | 4 | 12 |
|---|---|---|---|---|---|---|
| April 18 | 8 | 5 | 13 | 8 | 8 | 10 |
| April 25 | 7 | 9 | 11 | 2 | 14 | 7 |

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

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5. In an electrochemical machining process, the effects of electrolyte concentration and inter-electrode gap on the material removal rate (in mg/min) are studied. Both of these input parameters are set at three different levels each. The measured data are provided as follows:

| Inter-electrode gap (mm) | Electrolyte concentration (g/l) | | |
|---|---|---|---|
| | 15 | 30 | 45 |
| 1 | 2.84, 2.89, 3.21 | 3.01, 2.99, 3.41 | 3.04, 3.49, 3.61 |
| 2 | 2.67, 2.79, 2.81 | 2.74, 2.92, 2.97 | 2.65, 2.70, 2.84 |
| 3 | 2.55, 2.69, 2.72 | 2.64, 2.65, 2.71 | 2.52, 2.59, 2.66 |

Analyze the data and draw conclusions. Under what conditions would you operate this machining process? (Given $F_{0.05}$ = 19.4 for (2,18) df, $F_{0.05}$ = 5.84 for (4,18) df) (20)