B. E. PRODUCTION ENGINEERING 2ND YEAR 1st SEMESTER EXAMINATION 2023-24

INDUSTRIAL STATISTICS

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

1. 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)		
	10	20	30
1	2.74, 2.84, 3.11	3.05, 2.89, 3.31	3.06, 3.29, 3.41
2	2.77, 2.89,	4, 2.92, 2.97	2.55, 2.60, 2.89
3	2.65, 2.65, 2.78	2.68, 2.69, 2.78	2.62, 2.69, 2.69

   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)

2.(a) Determine the CV% of first n natural numbers.   (4)

   (b) The probability density function of a random variable X is given by $f(x) = k(x-1)(2-x)$ for $1 \le x \le 2$. Now determine (i) the value of the constant k, (ii) the distribution function F(x), and (iii) $P(5/4 \le x \le 3/2)$.   (6)

   (c) 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)

3.(a) The pressure P of a gas corresponding to various volumes V was recorded as follows:

V (cm^3)	40	50	60	70	80
P (kg/cm^2)	54.7	41.3	30.5	22.9	8.8

   The ideal gas law is given by the equation $PV^\gamma = C$, where γ and C are constants. Find the least squares estimates of γ and C from the given data.   (10)

   (b) The following are the miles per gallon which a test driver got for 10 tankfuls each of three bands of gasoline: (10)

Brand 1	32	29	35	28	32	25	30	29	19	22
Brand 2	19	25	28	29	32	34	27	35	28	20
Brand 3	31	29	26	24	16	28	30	29	18	33

   Use the U test at 0.01 level of significance to test whether there is a difference in the performance of the three brands of gasoline. (Given $X^2_{0.05,2}$ = 5.991)

4.(a) A research company has designed three different systems to clean up oil spills. The following table contains the results, measured by how much surface area (in square meters) is cleaned in one hour. The data were found by testing each method in several trials. Are the three systems equally effective? Use the 0.05 level of significance.   (10)

System A	55	60	63	56	59	55
System B	57	53	64	49	62	
System C	66	52	61	57		

   (Given $F_{0.05}$ = 5.94 for (2,12) dof)

   (b) A dice is tossed 180 times with the following results: (6)

x	1	2	3	4	5	6
f	28	36	36	30	27	23

   Use Kolmogorov-Sirnov test to justify whether the dice is a balanced one.

(c) A heavy machinery manufacturer has 3840 large generators in the field that are under warranty. If the probability is 1/1200 that any one will fail during the given year, find the probabilities that 0, 1 and 2 of the generators will fail during the given year. (4)

5.(a) A taxi company is trying to decide whether the use of radial tires instead of regular belted tires improves fuel economy. Twelve cars were equipped with radial tires and driven over a prescribed test course. Without changing drivers, the same cars were then equipped with the regular belted tires and driven once again over the test course. The gasoline consumption, in kilometers per liter, was recorded as follows: (10)

Radial tires	4.2	4.7	6.6	7.0	6.7	4.5	5.7	6.0	7.4	4.9	6.1	5.2
Belted tires	4.1	4.9	6.2	6.9	6.8	4.4	5.7	5.8	6.9	4.7	6.0	4.9

Can we conclude that cars equipped with radial tires give better fuel economy than those equipped with regular belted tires?

(b) Differentiate between: (i) Estimation and test of hypothesis, (ii) Stratified sampling and multistage sampling (5×2)