

GUJARAT TECHNOLOGICAL UNIVERSITY
M. E. - SEMESTER – I • EXAMINATION – WINTER 2012

Subject code: 714601**Date: 08-01-2013****Subject Name: Statistics For Engineers****Time: 02.30 pm – 05.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Use of Statistical Table is permissible.

- Q.1**
- (a) 1) Define positive and negative correlation with examples. 02
 2) What is the purpose of studying time series? 02
 3) Write the three fundamental concepts on which Taguchi method is based on. 02
 4) Giving an example to illustrate a 2^3 factorial design experiment. 02
- (b) 1) Given that $f(x) = \frac{k}{2^x}$ is a probability distribution for a random variable that can take on the values $x = 0, 1, 2, 3, 4$, find k . 02
 2) What is the value of the finite population corrector factor when $n = 100$ and $N = 5000$? 02
 3) Find the mean and the standard deviation of the following random variable having binomial distribution:
 “The numbers of defectives in a sample of 700 parts made by a machine, when the probability is 0.03 that any one of the parts is defective.”
- Q.2**
- (a) 1) Human error is given as the reason for 75% of all accidents in a plant. Use the binomial distribution to find the probability that human error will be given as the reason for two of the next four accidents. 03
 2) Suppose that the probabilities are 0.4, 0.3, 0.2, and 0.1 that there will be 0, 1, 2 or 3 power failures in a certain city during the month of July. Use the formula which define μ and σ^2 to find mean and variance of this probability distribution. Also find mean and variance by computing formula also. 04
- (b) Prove the following statement
 1) “When n is large and p is small, binomial probabilities are often approximated by means of Poisson distribution with $\lambda = np$.” 05
 2) If 95% of certain high – performance radial tires last at least 30,000 miles, find the mean and the standard deviation of the distribution of the number of these tires, among 20 selected at random, that last at 02

least 30,000 miles, using the special formulas for the mean and the variance of a binomial distribution

OR

- (b) Find the moment generation function of the binomial random variable X and then use it to verify that $\mu = np$ and $\sigma^2 = np(1-p) = npq$. **07**

- Q.3 (a)** 1) In a manufacturing process where glass products are produced, defects or bubbles occur, occasionally rendering the piece undesirable for marketing. It is known that, on average, 1 in every 1000 of these items produced has one or more bubbles. What is the probability that a random sample of 8000 will yield fewer than 7 items possessing bubbles? (Use the Poisson approximation to binomial distribution) **04**

- 2) In the inspection of tin plate produced by a continuous electrolytic process, 0.2 imperfections are spotted per minute, on average. Find the probabilities of spotting **03**

- (a) one imperfection in 3 minutes;
(b) at least two imperfections in 5 minutes;
(c) at most one imperfection in 15 minutes.

- (b) 1) The time required to assemble a piece of machinery is a random variable having approximately a normal distribution with $\mu = 12.9$ minutes and $\sigma = 2.0$ minutes. What are the probabilities that the assembly of piece of machinery of this kind will take (a) at least 11.5 minutes and (b) anywhere from 11.0 to 14.8 minutes? **03**

- 2) The time at the counter for a customer to be served at a post office can be modeled as random variable having mean 176 seconds and variance 256. The sample mean $\bar{X}$ will be obtained from the times for a random sample of 100 customers. What is the probability that $\bar{X}$ will be between 175 and 178 seconds? **04**

OR

- Q.3 (a)** 1) The mean weight loss of $n = 16$ grinding balls after a certain length of time in mill slurry is 3.42 grams with a standard deviation of 0.68 gram. Construct a 99% confidence interval for the true mean weight loss of such grinding balls under the stated conditions. **04**

- 2) If independent random samples of size $n_1 = n_2 = 8$ come from a normal populations having the same variance, what is the probability that either sample variance will be at least 7 times as large as the other? **03**

- (b) 1) Discuss random sampling with the definitions of random sample for finite and infinite population. **04**

- 2) A research worker wants to determine the average time it takes a mechanic to rotate the tires of a car, and she wants to be able to assert with 95% confidence that the mean of her sample is off by at most **03**

0.50 minute. If she can presume from past experience that $\sigma = 1.6$ minutes, how large a sample will she have to take?

- Q.4 (a)** To find best arrangement of instruments on a control panel of an airplane, 3 different arrangements were tested by simulating an emergency condition and observing the reaction time required to correct the condition. The reaction times (in tenths of second) of 28 pilots (randomly assigned to the different arrangements) are as follows:

Arrangement 1	14	13	9	15	11	13	14	11				
Arrangement 2	10	12	9	7	11	8	12	9	10	13	9	10
Arrangement 3	11	5	9	10	6	8	8	7				

- 1) Test at the level of significance $\alpha = 0.01$ whether we can reject the null hypothesis that the differences among the arrangements have no effect. **04**
 - 2) Construct Bonferroni Simultaneous intervals with 94% confidence level for estimating the magnitudes of the differences among the means corresponding to the three arrangements. **04**
- (b)** An experiment was designed to study the performance of 4 detergents for cleaning fuel injectors. The following “cleanliness” reading were obtained for specially designed equipment for 12 tanks of gas distributed over 3 different models of engines:

	Engine 1	Engine 2	Engine 3
Detergent A	45	43	51
Detergent B	47	46	52
Detergent C	48	50	55
Detergent D	42	37	49

- 1) Consider the detergents as treatments and engines as blocking, prepare ANOVA table and perform F test for variances due to the treatments and the blocking. Write your conclusions. Take $\alpha = 0.01$ **04**
- 2) Write the model equation for two way classification with interpretation of each term in the equation. **02**

OR

- Q.4 (a)** It is desired to compare 3 different methods of soldering copper electrical leads along with the effect of two extraneous sources of variability namely, different operators doing the soldering and using different soldering fluxes. If 3 operators and 3 fluxes are to be considered, the two replicates of the experiments were run using the following Latin square arrangements: **07**

Replicate I		Flux		
		1	2	3
Operator 1	A	B	C	
Operator	C	A	B	

Replicate II		Flux		
		1	2	3
Operator 1	C	B	A	
Operator	A	C	B	

Operator 3	2		
	B	C	A

Operator 3	2		
	B	A	C

The results, showing the number of pounds tensile force required to separate the soldered leads, are as follows:

Replicate I		
14.0	16.5	11.0
9.5	17.0	15.0
11.0	12.0	13.5

Replicate II		
10.0	16.5	13.0
12.0	12.0	14.0
13.5	18.0	11.5

Analyze the experiment and test at the 0.01 level of significance level if there are differences in the methods, the operators, the fluxes, or the replicates.

- (b) It is desired to determine the effects of flue temperature and oven width on the time required to make coke. The experimenter is using 3 oven widths (inches), 4, 8, & 12 and 2 temperature levels (degree F), 1600 & 1900. Considering it a two factor 3×2 factorial experiment, three replicates of the experiment are performed to obtain the following results in terms of the time taken by the oven (hours) to make coke. Prepare ANOVA table, Perform required F tests and write your conclusions. Use $\alpha = 0.05$ level of Significance. 07

Factor A Oven width	Factor B Flue temperature	Replicate 1	Replicate 2	Replicate 3
4	1600	3.5	3.0	9.2
4	1900	2.2	2.3	6.9
8	1600	7.1	6.9	21.5
8	1900	5.2	4.6	16.6
12	1600	10.8	10.6	32.4
12	1900	7.6	7.1	22.0

- Q.5 (a) 1) The temperature of a metal strip was measured at various time intervals during heating and the values are given in the table below: 04

Time, t (mins)	1	2	3	4
Temp., T (°C)	70	83	100	124

If the relationship between the temperature T and the time t is of the form $T = b x + a$ where $x = e^{t/4}$. Use least square linear regression and estimate the temperature at t = 6 minutes.

- 2) A psychologist wanted to compare two methods A and B of teaching. He selected a random sample of 22 students. He grouped them into 11 pairs so that the students in a pair have approximately equal scores on an intelligence test. In each pair one student was taught by method A and the other by method B and examined after the course. The ranks obtained by them are tabulated below: 03

Rank A:	6	3	8.5	10	1.5	8.5	5	1.5	7	4	11
Rank B:	1	2	9.5	4	5	3	8	7	9.5	11	6

Find the rank correlation coefficient.

- (b) The table below shows the demand for a particular brand of fax machine in a departmental store in each of the last nine months. **07**

Month	1	2	3	4	5	6	7	8	9
Demand	12	15	19	23	27	30	32	33	37

- Calculate the four monthly moving averages.
- What would be your forecast for the demand in month 10?
- Apply exponential smoothing with a smoothing constant of 0.2 to derive a forecast for the demand in month 10.

OR

- Q.5 (a) Determine the period of the moving average for the following data and calculate the moving average for that period. **07**

Year	1	2	3	4	5	6	7	8
Value	130	127	124	135	140	132	129	127
Year	9	10	11	12	13	14	15	
Value	145	158	153	146	145	164	170	

- (b) 1) The following are the number of minutes it took 10 mechanics to assemble a piece of machinery in the morning x and in the late afternoon y: **04**

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

Calculate Karl Pearson's coefficient r.

- 2) If the correlation among three variables are as follows:

	1-SAT	2-CLEP	3-GPA
1-SAT	1		
2-CLEP	0.87	1	
3-GPA	0.72	0.88	1

Compute partial correlation between the second variable CLEP and the third variable GPA holding the first variable SAT constant.
