

TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**Examination Control Division**  
2078 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE,BME,BAME BIE,BAS	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH 452)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary figures are attached herewith.
- ✓ Assume suitable data if necessary.



1. Two students perform an experiment on acceleration due to gravity and obtained the following observations in m/s<sup>2</sup>. [6]

Student A	9.71	9.6	10.2	9.82	10.0	9.62	9.5	9.62	8.9
Student B	9.90	8.9	10.1	9.5	9.85	9.4	10.1	9.4	9.1

Whose experiment is more uniform?

2. The local government is bidding for two contract A and B, the probability that a company will get contract A is 3/5, the probability that the company will get contract B is 1/3 and the probability that the company will get both the contract is 1/8 What is the probability that
- The company will get contract A or B?
  - The company will get neither contract?
  - The company will get only contract A
- [6]
3. Explain Negative binomial distribution and its properties. [5]
4. The average number of collisions occurs during the summer months at particular intersection is 2 per week. [5]
  - What is the probability of no collisions in any particular week?
  - What is the probability that there will be exactly one collision in a week?
  - What is the probability of exactly two collision in a week?
5. Discuss normal distribution and standard normal distribution and its characteristics. [5]
6. A continuous random variable X has following probability density function [5]
- $$f(x) = \begin{cases} \frac{3}{4}(1+x^2), & 0 \leq x \leq 1 \\ 0, & \text{otherwise} \end{cases}$$
- Find mean and standard deviation of X
  - Find P(-σ < X < σ)
7. Define parameter and sample statistics. from the population of size 5 as: 22, 23, 24, 25 and 26. [5]
  - List out all the samples of size three without replacement.
  - Find the distribution of sample mean.
  - Also find the standard error of sample mean.
8. Suppose that 15% of 1750 students at a school have experienced extreme level of stress during the past month. A research firm decided to ask a random sample of 160 students

if they have experienced extreme levels of stress during the past month. Subsequently they find that 10% of the sample replied "yes" to the question. Assuming true proportion is 15%, what is the approximate probability that more than 10% of the sample would report that they experienced extreme levels of stress during the past month?

[5]

9. Define error of hypothesis testing based on sample. Write down the steps involved in the hypothesis testing of difference of mean when both the samples are large.

[5]

10. The average marks Found to be 51 with standard deviation of 6 marks. does this evidence support that the sample is drawn from the population with average marks 50 at 5% level of significant, assuming that mark obtained normally distributed.

[5]

11. A manager of a sports club keeps information concerning the main sport in which members participate and their ages. To test whether there is a relationship between the age of a member and his or her choice of sport, 499 members of the sports club are randomly selected. Conduct a test for independence at 5% level of significance.

[5]

	Age of sports club member		
Sport	18-25	26-30	31-40
Racquetball	42	58	30
Tennis	58	76	38
Swimming	72	60	65

12. A coin is tossed 200 times and 115 heads obtained. Is there evidence, at the 1% level, that the coin is biased towards heads?

[5]

13. A corporation owns several companies. The strategic planner for the corporation believes money spent on advertising can to some extent be a predictor of total sales. As an aid in long-term planning, she gathers the following sales and advertising information from several of the companies for 2009 (Rs millions).

[5]

Advertising	12.5	3.7	21.6	60.0	37.6	6.1	16.8	41.2
Sales	148	55	338	994	541	89	126	397

- a) Develop the equation of the simple regression line to predict sales from advertising expenditure using these data.  
 b) Also find the standard error of estimate of regression coefficient.

14. Discuss the properties of simple correlation coefficient and  $r^2$

[5]

15. A random sample was taken of the thickness of insulation in transformer windings, and the following thicknesses (in millimeters) were recorded

[8]

18	21	22	29	25	31	37	38	41	39
44	48	54	56	56	57	47	38	35	36
29	37	32	42	43	40	48	36	37	37
36	38	40	41	44	39	38	34	24	32
39	44	42	30	37	30	42	37	34	37
32	24	42	36	49	39	23	34	36	40

- a) Estimate from these data the percentage of all the windings that received, more than 30mm of insulation but less than 50 mm.  
 b) Find the 95% confidence interval for the true mean thickness of insulation.

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 2077 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BME, BAM, BIE, BAS	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH 522)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Z-table, t-table, X<sup>2</sup> table are attached herewith.
- ✓ Assume suitable data if necessary.

1. Define five number summaries of data. Prepare the Box-plot for the following data of daily registration of workers in the construction site. [5+1]

34	42	66	40	59	36	41	35	36	62
43	30	43	32	44	58	53	50	48	38

2. State Baye's theorem. In training, the 70% of persons achieved a rating of satisfactory. Of those as rated as satisfactory, 80% has acceptable scores on the personality test. Of those rated as Unsatisfactory, 35% has acceptable scores. Find the probability that an applicant would be a satisfactory trainee given the acceptable scores on personality test. [1+5]

3. Define Binomial distribution. How does it differ from Hypergeometric distribution? [5]

4. A multiple choice test contains 25 questions, each with four answers. Assume a student just guesses on each question. [5]

- a) What is the probability that the student answers more than 20 questions correctly?  
 b) What is the probability the student answers less than 5 questions correctly?

5. A continuous random variable X has probability density function defined as follows:

$$f(x) = \begin{cases} k(7x^2 + 8x - 13) & \text{for } 2 \leq x \leq 5 \\ 0, & \text{Otherwise} \end{cases}$$

- (i) Find the value of constant k.  
 (ii) Mean and variance of random variable X. [5]

6. The height of a group of women is normally distributed with a mean of 165cm and a standard deviation of 3.5cm. Nischal Basnet is looking for women whose height is between 168cm and 174cm for a film role. What proportion will meet his criteria? What is least height of top 25% taller women in the group? [5]

7. If a population is consist of four elements 1, 2, 3, and 4. List out all possible samples of size two and find sampling distribution of proportion of even no. when sampling is simple random sampling without replacement. Also prove that sample proportion is unbiased estimate. [5]

8. Define population and sample parameter and statistic between parameter and statistical with examples. [5]

9. Five measurement of the tar containing a certain kind of cigarette yielded 14.5, 14.2, 14.4, 14.3 and 14.6 mg per cigarette. Show that the difference between the mean of this sample and average tar claimed by the manufacturer,  $\mu=14.0$ , is significant at  $\alpha=0.05$ . Assume Normality. [5]

10. At what condition, pair test should be used? Write the procedure of testing of pair t-test. [5]

11. Patients in a hospital are classified as surgical or medical. A record is kept of the number of times patients require nursing service during the night and whether or not these patients are on Medicare. The data are presented here:

		Patient Category	
Medicare	Surgical	Medical	
Yes	620	380	
No	550	450	

Test the hypothesis (using  $\alpha=0.01$ ) that calls by surgical medical patients are independent of whether the patients are receiving Medicare.

[5]

12. A builder claim that heat pump are installed in 70 of all homes being constructed today in the city. Would you agree with this claim if a random survey of new homes in this city shows that 8 out of 15 had heat pump installed? Use 5% limit of significance.

[5]

13. What are the two regression coefficients and what do they represent? Write the properties of regression coefficients.

[5]

14. A software company collected data for a sample of 10 computer programmers. A suggestion was made that regression analysis could be used to determine if salary was related to the years of experience and the score on the company's programmer aptitude test. The years of experience and the score on the company's programmer aptitude test. The years of experience, score on the aptitude test and corresponding monthly salary (in 1000s) for a sample of 10 programmers is shown on the following table:

Experience (yrs)	4	7	1	5	8	10	0	1	6	6
Score	78	100	86	82	86	84	75	80	83	91
Salary	24.0	43.0	23.7	34.3	35.8	38.0	22.2	23.1	30.0	33.0

a) Fit best line to represent the data set.

b) Estimate the salary whose score is 96.

[5]

15. An article in the 1993 volume of the Transactions of the American Fisheries Society reports the results of a study to investigate the mercury contamination in largemouth bass. A sample of fish was selected from 53 Florida lakes and mercury concentration in the muscle tissue was measured (ppm). The mercury concentration values are:

1.23	0.49	0.59	0.18	0.49	1.08	0.56	0.27
1.33	1.16	0.34	0.19	0.19	0.98	0.75	0.52
0.04	0.05	0.34	0.04	0.83	0.63	0.86	0.65
0.044	0.15	0.84	0.49	0.81	0.56	0.94	
1.2	0.19	0.5	1.1	0.71	0.41	0.4	
0.27	0.77	0.34	0.16	0.5	0.28	0.43	
0.73	0.17	0.21	0.1	0.27	0.34	0.25	

Find (a) Mean (b) Standard Deviation (c) Standard error of Mean (d) Minimum and Maximum value (e) 95% confidence interval on true value of mean.

[8]

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**2076 Bhadra**

Exam.		Regular	
Level	BE	Full Marks	80
Programme	BCE, BME, BAM, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH 552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. The following table gives the frequency distribution of marks of 800 candidates:

[6]

Marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Freq.	10	40	80	140	170	130	100	70	40	20

- a) Find the median and interpret the result.
- b) If the minimum mark to pass is 35, what percentage of candidate pass the exam?
- c) What is the no. of candidates who get marks between 34 and 79?

2. State Bayes' theorem. In a group of equal number of men and women, 20% of men and 30% of women are unemployed. If a person selected is random,

- a) What is the probability that the selected person is an employed?
- b) What is the probability that the selected person is men employed?

[6]

3. Define Negative Binomial Distribution. How does it differ from Binomial Distribution? [2+3]

4. It is conjectured that an impurity exists in 30% of all drinking wells in a certain rural community. In order to gain some insight into this problem, it is determined that some tests will be made. It is too expensive to test all of the wells in the area so 10 were randomly selected for testing.

[5]

- a) Establish suitable probability distribution function for impurity exists in drinking wells.
- b) What is the probability that exactly three would have the impurity assuming that the conjecture is correct?
- c) What is the probability that at least three wells are impure?

5. The probability density function of a random variable X is given as  $f(x) = Kx^2$  for  $0 < x < 3$ , Find the constant K and also find the mean and variance of random variable x.

[5]

6. Define the cumulative distribution function for continuous random variable and mention its important properties.

[5]

7. Define standard error of sampling distribution of mean. Write the expression for Standard error of Mean, when (a) sample is drawn without replacement from a finite population (b) sample is drawn from infinite population.

[5]

8. State central Limit Theorem. The weights of a population of workers have mean 167 and standard deviation 27. If a sample of 36 workers is chosen, approximate the probability that the sample mean of their weight lies between 163 and 170.

[5]

9. The mean consumption of food grains among 400 sampled middle class consumers is 380 grams per day per person with standard deviation of 120 gram. A similar sample survey of 600 working class consumers gave a mean of 410 grams with standard deviation of 80 grams. Can you justify that the classes consume the same quantity of food grains, using 5% level of significance.

[5]

**OR**

Write down the necessary steps of hypothesis testing of single mean for small samples.

[5]

10. 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 cleared in 1 hour. The data were found by testing each method in several trials. Using ANOVA, test whether the three systems are equally effective. Use the 0.05 level of significance.

[5]

55	60	63	56	59	55
57	53	64	49	62	-
66	52	61	57	-	-

11. Define chi-square distribution. In an experiment on pea breeding, Mendal obtained the following frequencies of seeds: 315 round and yellow, 101 wrinkled and yellow, 108 round and green, 32 wrinkled and green, total 556. Theory predicts that the frequencies should be in the proportion 9:3:3:1 respectively. Set up proper hypothesis and test it at 10% level of significance.

[5]

12. Define confidence interval. From a lot of units produced by Machine A, a sample of 500 is drawn and tested for a quality characteristic. It is found that 16 units are not meeting the specification. Another sample of size 100 is drawn from the lot of similar units produced by machine B and tested. In this case only 3 units are found to be not meeting the specification. Obtain a 95% confidence intervals for the difference of the proportions of defective units produced by the two machines.

[5]

13. A household survey on monthly expenditure on food yield following data:

Monthly expenditure (100 Rs.)	10	15	20	25	30	35	40
Monthly income (1000 Rs.)	2	4	5	7	6	6	5
Size of the family	4	5	7	10	8	11	4

Calculate the coefficient of multiple correlation and coefficient of multiple determination. Also interpret the result.

[5]

**OR**

A regression model is desired relating temperature and the proportion of impurities passing through solid helium. Temperature is listed in degrees centigrade. The data are as follows:

[5]

Temperature (°C)	-260.5	-255.7	-264.6	-265.0	-270.0	-272.0	-272.5	-272.6	-272.8	-272.9
Proportion of impurities	0.425	0.224	0.453	0.475	0.705	0.860	0.935	0.961	0.979	0.990

- a) Fit a linear regression model.  
 b) Does it appear that the proportion of impurities passing through helium increases as the temperature approaches -273 degrees centigrade?

14. Define partial and multiple correlation. What are the similarities and differences between correlation and regression?

[5]

15. The admission staff of a university, concerned with success of students it selects for admission wishes to compare the students' college performance with high school grades and test scores. The high school and college grades-point average (GPA) and student's average test (SAT) scores of 20 sampled students are as follows:

[8]

H.S. GPA (x)	College GPA (y)	SAT Score (z)
3.6	2.5	1100
3.5	3.6	1180
3.4	3.6	1180
2.2	2.8	960
2.6	2.7	940
3.5	3.8	1250
2.9	3.0	1010
3.4	3.4	1170
2.7	2.2	950
2.2	3.5	1040
3.9	4.0	1330
3.6	3.0	1100
3.7	3.2	1160
3.9	3.7	1310
3.2	3.5	1150
2.6	1.9	860
4.0	3.8	1340
4.0	3.9	1330
2.1	2.5	940
2.4	3.2	1070

- Find, for each of the H.S. GPA, college GPA and SAT scores; the mean and standard deviation.
- What is your conclusion about variability and uniformity from the analysis?

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Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, BME, BAME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH 552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary figures are attached herewith.
- ✓ Assume suitable data if necessary.

1. Write short notes on Box and Whisker plot. An analysis of monthly wages paid to workers in two firms A and B belonging to the same industry gives the following results:

	Firm A	Firm B
No. of Workers	500	600
Average monthly wage	186	175
Variance of distribution of wages	81	100

- i) Which firm, A or B, has a larger wage bill?  
 ii) In which firms, A or B, is there greater variability in individual wage?  
 iii) Calculate combined mean and combined variance of the wage of firm A and firm B. [6]

2. State Baye's Theorem. 70% of the light aircraft that disappear while in flight in a certain country are subsequently discovered. Of the aircraft that are discovered, 60% have an emergency locator, whereas 90% of the aircraft not discovered do not have such a locator. Suppose a light aircraft has disappeared.

- a) If it has an emergency locator, what is the probability that it will not be discovered?  
 b) If it does not have an emergency locator, what is the probability that it will be discovered? [1+5]

3. Define hyper geometric distribution with an example. Describe the conditions for the binomial approximation to hyper geometric distribution? [2+3]

4. If chances of passing an examination of probability and statistics of students is 60%. If a randomly selected student had passed examination, what is the probability that it was his fifth attempt? [5]

5. Define standard normal distribution. Give the condition for normal approximation to binomial distribution. [2+3]

6. Throw light on Gamma and Chi-squared distributions. Specify relationship between them. [5]  
 Or,

Find the mean and variance of the probability density function given by

$$f(x) = \begin{cases} 12x^2(1-x) & ; \quad 0 \leq x \leq 1 \\ 0 & ; \quad \text{otherwise} \end{cases}$$

7. What do you mean by sampling distribution of sample proportion with engineering example? [4]

8. Consider a normal population with mean  $\mu = 82$  and standard deviation  $\sigma = 12$   
 a) If a random sample of size 64 is selected, what is the probability that the sample mean will lie between 80.8 and 83.2?  
 b) With a random sample of size 100, what is the probability that the sample mean will lie between 80.8 and 83.2? [6]

9. A water company randomly sampled residential water meters in order to monitor daily water consumption. On a particular day, sample of 35 meters showed a sample mean of 240 gallons and sample standard deviation of 45 gallons. Find a 95% confidence interval for the mean water consumption for the population and interpret it. [4]

10. 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 3 different positions on the roof. The forces required to see 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	89	80	94			

Perform an analysis of variance to test at the 0.05 level of significance whether the differences among the sample means at the three positions are significant.

[6]

11. Suppose it is claimed that in a very large batch of components, about 10% of items contain some form of defect. It is proposed to check whether this proportion has increased, and this will be done by drawing randomly a sample of 150 components. In the sample, 20 are defectives. Does this evidence indicate that the true proportion of defective components is significantly larger than 10%? Test at significance level  $\alpha=0.05$ .

[5]

12. Write the steps for testing hypothesis on difference between two population proportions for the large sample size.

[5]

13. Define partial correlation and multiple correlation with examples. Write down their properties.

[5]

14. Ten steel wires of diameter 0.5mm and length 2.5m were extended in a laboratory by applying vertical forces of varying magnitudes. Results are as follows:

Force (kg)	15	19	25	35	42	48	53	56	62	65
Increase in length in (mm)	1.7	2.1	2.5	3.4	3.9	4.9	5.4	5.7	6.6	7.2

- a) Estimate the parameters of a simple linear regression model with forces as the explanatory variable.  
 b) Find a 90% confidence limits for the slope of regression line.

15. As part of a study monitoring acid rain, measurements of sulfate deposits (kg/hectare) are recorded for different locations on the Eastern Terai of Nepal. The results are listed in the following table for 15 recent and consecutive years:

[8]

Year	Location 1 (x)	Location 2 (y)	Location 3 (z)
1	11.94	13.09	7.96
2	11.28	10.88	12.84
3	10.38	12.19	7.38
4	8.00	10.75	7.26
5	12.12	17.21	10.12
6	10.27	10.26	8.89
7	14.80	15.49	11.60
8	13.52	11.61	9.02
9	10.55	10.53	7.78
10	9.81	12.50	8.70
11	11.27	9.94	10.50
12	12.12	11.21	9.95
13	11.68	9.71	15.59
14	11.77	9.37	10.54
15	17.29	13.87	13.64

- a) Find sample mean, sample standard deviation and coefficient of variation for Sulfate deposits of each location.  
 b) Give your conclusion about variability and uniformity from the analysis.

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Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
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- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. What is box plot and what does it measure? Describe the features that a box plot displays. [3+3]
2. State Baye's theorem. A Geologist classified 2015 Nepal earthquake according to intensity as; light, moderate and high. According to geologist, 90% of earthquakes are of light, 8% of moderate and 2% of high intensity. An Engineer did post earthquake assessment in Sindhupalchok and found that 1% of damages were done by light, 10% by moderate and 80% by high-intensity earthquakes. During assessment an Engineer randomly selected a household. [1+4]
  - a) What is the probability that the house is damaged?
  - b) If the house is damaged, what is the probability that it's due to moderate earthquake?
3. What are the difference and similarities between Binomial and Hypergeometric Probability distribution? [3+2]
4. Multiple-choice test consists of 10 questions and 4 answer to each question. If each question is answered by shuffling 4 tags tabled 1, 2, 3 and 4 drawing one making the alternative whose number is drawn. Find the probability of (i) getting 3 (ii) at least one (iii) at least 7 (iv) at most three of these questions answered correctly. [5]
5. Score of 9000 candidates of IOE entrance examination is normally distributed with average score 50 and standard deviation of 20 [5]
  - a) Find the value of score exceeded by top 900 candidates
  - b) Find the number of candidate who secured at least 90
6. The mean elongation of steel bar under a particular tensile load has been established to be normally distribution with parameters  $\mu = 0.06$  and  $\sigma = 0.008$ . Assuming the same distribution applies to new bar, find the probability that the mean elongation falls [5]
  - i) Above 0.08
  - ii) Between 0.05 and 0.07
  - iii) Either below 0.045 or above 0.065

**OR**

The distribution of amount of the gravel (in ton) sold by particular construction supply company in a given week is continuous random variable X with the probability density function.

$$f(x) = \begin{cases} \left(\frac{3}{2}\right)(x^2 + 1) & \text{for } 0 \leq x \leq 1 \\ 0 & \text{otherwise} \end{cases}$$

- a) Find the cumulative distribution function of sales.
- b) What is the expected value and variance of sales?

7. Define the following terms: [6]
- Parameter
  - Statistics
  - Sampling distribution of statistic
  - Standard error of statistic
8. A population consists of the four numbers 5, 6, 9, 12. [6]
- Write down all possible sample size of two without replacement.
  - Verify that the population mean is equal to the mean of sample mean.
  - Calculate the standard error of the sampling distribution of the sample mean.
9. In 39 soil samples tested for trace elements, the average amount of copper was found to be 22 milligrams, with a standard deviation of 4 milligrams. Find a 90% confidence interval for the true mean copper content in the soils from which these samples were taken. [4]
10. An experiment was conducted to compare three methods of packaging a certain frozen food. The criterion was the ascorbic acid content (mg/100 gm) after a specific period of time. The following data were obtained: [6]

Packaging Method							
A	14.29	19.10	19.09	16.25	15.09	16.61	19.63
B	20.06	20.64	18.00	19.56	19.47	19.07	18.38
C	20.04	26.23	22.74	24.04	23.37	25.02	23.27

Do these data provide sufficient evidence at the 0.01 level of significance to indicate a difference in packaging methods?

11. Describe the types of errors in hypothesis testing. Write the procedure of testing of hypothesis of difference two population proportions. [5]
12. Define chi-square distribution. From the following data can you conclude that there is association between the purchase of brand and geographical region? (Use 5% level of significance) [5]

	Region		
	Central	Eastern	Western
Purchase brand	40	55	45
Do not purchase brand	60	45	55

13. What does a regression coefficient measure? Mention its important properties. [4]
14. Following data give experience (nearest year), performance rating and salary of eight engineers. [4+1]

Experience (year)	16	12	18	4	3	10	5	12
Performance rating	87	88	89	68	78	80	75	83
Salary ('000)	100	125	120	100	120	110	90	125

- a) Find Possible multiple correlation coefficient and interpret the result.

P.T.O.

15. The alternating current (AC) breakdown voltage of an insulating liquid indicates its dielectric strength. The article "Testing Practices for the AC Breakdown Voltage Testing of Insulation Liquids" (IEEE Electrical Insulation Magazine, 1995: 21-26) gave the accompanying sample observation on breakdown voltage (kV) of a particular circuit under certain conditions.

[8]

62	64	46	57
50	62	55	55
53	50	53	53
57	68	54	59
41	54	52	53
53	55	47	52
55	57	47	50
61	50	55	55
59	55	57	60
64	50	48	50
50	56	63	56
53	55	57	58

- Construct a box plot of the data and comment on features.
- Calculate and interpret a 95% CI for true average breakdown voltage  $\mu$ . Does it appear that  $\mu$  has been precisely estimated? Explain.

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Exam.	Back		
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Programme	BCE, BME, BIE, BAM	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
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- ✓ Assume suitable data if necessary.

1. What are the merits and demerits of mean? The expenditure of 1000 families is given as below:

Expenditure	40-59	60-79	80-99	100-119	120-139
No. of families	50	-	500	-	50

If the median of frequency distribution is 87, find the missing frequencies.

[6]

2. Define addition theorem of probability. In a group of equal number of men and women, 20% of men and 30% of women are unemployed. If a person selected in random,
- What is the probability that the selected person is an employed?
  - What is the probability that the selected person is men employed?
- [6]
3. Define Binomial probability distribution with an example. How does the negative binomial distribution differ from binomial distribution? [2+3]
4. In a certain factory turning out optical lenses, there is a small chance, 1/500 for any lens to be defective. The lenses are supplied in packets of 10 each. What is the probability that a packet will contain
- no defective lens
  - at least one defective lenses.
  - at most two defective lenses
- [5]
5. Define the normal distribution. Give the condition for normal approximation of binomial distribution. [2+3]
6. The mean elongation of steel bar under a particular tensile load has been established to be normally distributed with parameters  $\mu = 0.06$  and  $\sigma = 0.008$ . Assuming the same distribution applies to new bar, find the probability that the mean elongation falls
- Above 0.08
  - Between 0.05 and 0.07
  - Either below 0.045 or above 0.065
- [5]

**OR**

The distribution of amount of the gravel (in ton) sold by a particular construction supply company in a given week is continuous random variable X with the probability density function.

$$f(x) = \begin{cases} \left(\frac{3}{2}\right)(x^2 + 1) & \text{for } 0 \leq x \leq 1 \\ 0 & \text{Otherwise} \end{cases}$$

- Find the cumulative distribution function of sales.
- What is the expected value and variance of sales?

[5]

7. Define sampling distribution of proportion with example. [4]
8. A population consists of the four numbers 12, 13, 14, 15. [6]
- Write down all possible sample size of two without replacement.
  - Verify that the population mean is equal to the mean of the sample mean.
  - Calculate the standard error of the sampling distribution of the sample mean.
9. Write down the properties of regression coefficient and correlation coefficient. [5]
10. The following data gives the experience of machine operators in years and their performance as given by the number of good parts turned out per 100 pieces.

Experience (X)	16	12	18	4	3	10	5	12
Performance (Y)	87	88	89	68	78	80	75	83

- Fit the regression equation of performance ratings on experience and estimate the probable performance if an operator has 8 years experience.
- Calculate coefficient of determination and interpret it. [5]

OR

A sample of 10 values of three variables  $X_1$ ,  $X_2$  and  $X_3$  were obtained as

$\sum X_1 = 10$	$\sum X_2 = 20$	$\sum X_3 = 30$
$\sum X_1^2 = 20$	$\sum X_2^2 = 68$	$\sum X_3^2 = 170$
$\sum X_1 X_2 = 10$	$\sum X_1 X_3 = 15$	$\sum X_2 X_3 = 64$

Find (i) Partial correlation between  $X_1$  and  $X_3$  eliminating the effect of  $X_2$ .

- Multiple correlation between  $X_1$ ,  $X_2$  and  $X_3$  assuming  $X_1$  as dependent. [5]

11. A company produces automobile tyres, the manager of the company want to estimate the limits in which expected trend life of his tyres will probably lie. A test sample of 64 tyres was taken and a test run showed the average trend life of 50000 miles. Find the 95% and 99% confidence limits for population mean. Given that population standard deviation is 3000 miles. [4]
12. The following data represents the units of production per day turned out by three different brands of machines used by three mechanists:

Machines	Production			
1	15	14	19	18
2	17	12	20	16
3	16	18	16	17

Using ANOVA test whether the differences in performances of the three brands of machines are significant. Use  $\alpha = 5\%$  [6]

OR

A sample of 15 beams of a grand complex are given below in feet<sup>3</sup>.

12.8	9.8	10.2	10.0	12.0
10.5	8.9	12.2	10.8	9.0
11.2	12.1	10.1	8.8	10.6

A civil engineer claimed that volumes of beams are greater than 10 feet<sup>3</sup>, test whether his claim is right or wrong. (Use  $\alpha = 1\%$ ) [6]

13. Define critical value and critical region. A manufacturer claimed that at least 95% of the pumps supplied to the ABC company confirmed to specifications. However, the production manager at ABC company wasn't satisfied with the claim of the manufacturer. Hence, to test the claim, the manager examined a sample of 250 pumps supplied last month and found that 228 pumps as per the specifications. Can you conclude that the production manager is right to doubt on the claim of the manufacturer? ( $\alpha=0.01$ ) [5]

(P.T.O)

14. Define chi-square distribution. A sample of 500 workers of a factory according to gender and nature of work is as follow: [5]

Nature of work	Gender	
	Male	Female
Technical	200	100
Non-technical	50	150

Test at 5% level of significance whether there exist any relationship between gender and nature of work.

15. The heights of male and female students are given below: [8]

Height	Sex of the person	
	Male	Female
145-150	0	3
150-155	2	8
155-160	6	15
160-165	17	12
165-170	21	4
170-175	10	0
175-180	2	0
180-185	2	0

- Calculate mean height for male and female students
- Calculate sample standard deviation and sample variance for given data.
- Which data for height is consistent?

\*\*\*

04 TRIBHUVAN UNIVERSITY  
 INSTITUTE OF ENGINEERING  
**Examination Control Division**  
 2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BME, BIE, BAM	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. What are the merits and demerits of mean? The expenditure of 1000 families is given as below:

Expenditure	40-59	60-79	80-99	100-119	120-139
No. of families	50	-	500	-	50

If the median of frequency distribution is 87, find the missing frequencies. [6]

2. Define conditional probability. Two sets of candidates are competing for the positions on the Board of Directors of a company. The probability that the first and second sets will win are 0.6 and 0.4 respectively. If the first set wins the probability of introducing a new product is 0.8 and the corresponding probability if the second set wins is 0.3. What is the probability that the product will be introduced? [6]

3. Define hypergeometric distribution with an example. Describe the conditions for the binomial approximation to hypergeometric distribution? [2+3]

4. An office switchboard receives telephone calls at a rate of 3 calls per minute on an average. Find the probability of receiving (i) no calls in one minute interval;  
 (ii) at least 3 calls in an one minute interval;  
 (iii) at most 2 calls in a five minute interval [5]

5. The mean elongation of steel bar under a particular tensile load has been established to be normally distribution with parameters  $\mu = 0.06$  and  $\sigma = 0.008$ . assuming the same distribution applies to new bar, find the probability that the mean elongation falls [5]

- a) Above 0.08
- b) Between 0.05 and 0.07
- c) Either below 0.045 or above 0.065

**OR**

The distribution of amount of the gravel (in ton) sold by a particular construction supply company in a given week is continuous random variable X with the probability density function.

$$f(x) = \begin{cases} \left(\frac{3}{2}\right)(x^2 + 1) & \text{for } 0 \leq x \leq 1 \\ 0 & \text{Otherwise} \end{cases}$$

- a) Find the cumulative distribution function of sales.  
 b) What is the expected value and variance of sales? [5]

6. The amount of distilled water dispensed by a certain machine is normally distributed with mean value 64 oz and standard deviation 0.78 oz. What container size will ensure that overflow occurs only 0.5% of the time? [4]
7. Define parameter and statistic with examples. [4]
8. A population consists of the four numbers 5, 6, 9, 12. [6]

- a) Write down all possible sample size of two without replacement.  
 b) Verify that the population mean is equal to the mean of the sample mean.  
 c) Calculate the standard error of the sampling distribution of the sample mean.
9. Define correlation and regression with examples. Write down the properties of correlation coefficient and regression coefficient. [5]

10. The following data gives the experience of machine operators in years and their performance as given by the number of good parts turned out per 100 pieces.

Experience (X)	16	12	18	4	3	10	5	12
Performance (Y)	87	88	89	68	78	80	75	83

- a) Fit the regression equation of performance ratings on experience and estimate the probable performance if an operator has 8 years experience. [5]
11. Describe the procedure of the test of significance of difference of two means for small sample. [5]
12. Shyam and Co. produces three varieties of products: deluxe, fine and ordinary. A recent market survey is conducted for preference of products. The preference was found as follow:

Product	Production			
	Deluxe	Fine	Ordinary	Total
Deluxe	15	14	19	18
Fine	17	12	20	16
Ordinary	16	18	16	17

- Is there a significant difference in the preference of products using ANOVA test. Use  $\alpha = 5\%$ . [6]
13. Define type I and II error. A manufacturer claimed that at least 95% of the pumps supplied to the ABC Company confirmed to specifications. However, the production manager at ABC Company wasn't satisfied with the claim of the manufacturer. Hence, to test the claim, the manager examined a sample of 250 pumps supplied last month and found that 228 pumps as per the specifications. Can you conclude that the production manager is right to doubt on the claim of the manufacturer? ( $\alpha = 0.01$ ) [5]
14. Define chi-square distribution. From the following data can you conclude that there is association between the purchase of brand and geographical region? (Use 5% level of significance) [5]

15. As part of a study monitoring acid rain, measurements of sulfate deposits (kg/hectare) are recorded for different locations on the Eastern Terai of Nepal. The results are listed in the following table for 15 recent and consecutive years:

[8]

Acid Rain: Sulfate Deposited (kg/hectare)

Year	Location 1 (x)	Location 2 (y)	Location 3 (z)
1	11.94	13.09	7.96
2	11.28	10.88	12.84
3	10.38	12.19	7.38
4	8.00	10.75	7.26
5	12.12	17.21	10.12
6	10.27	10.26	8.89
7	14.80	15.49	11.60
8	13.52	11.61	9.02
9	10.55	10.53	7.78
10	9.81	12.50	8.70
11	11.27	9.94	10.50
12	12.12	11.21	9.95
13	11.68	9.71	15.59
14	11.77	9.37	10.54
15	17.29	13.87	13.64

- Find sample mean, sample standard deviation and coefficient of variation for Sulfate deposits of each location.
- Give your conclusion about variability and uniformity from the analysis.

\*\*\*

**TABLE A-4** Chi-Square ( $\chi^2$ ) Distribution

Degrees of Freedom	Area to the Right of the Critical Value									
	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.005
1	—	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.299
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.042	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.194	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.257	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.954	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

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#### Degrees of Freedom

$n \geq 1$

for confidence intervals or hypothesis tests with a standard deviation or variance

$k - 1$

for multinomial experiments or goodness-of-fit with  $k$  categories

$(r - 1)(c - 1)$

for contingency tables with  $r$  rows and  $c$  columns

$k - 1$

for Kruskal-Wallis test with  $k$  samples

Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. Write the significance difference between measure of central tendency and measure of dispersion.

In a study conducted by the Department of Mechanical Engineering at Virginia Tech, the steel rods supplied by two different companies were compared. Ten sample springs were made out of the steel rods supplied by each company, and a measure of flexibility was recorded for each. The data are as follows:

[3+3]

Company A: 9.3 8.8 6.8 8.7 8.5 6.7 8.0 6.5 9.2 7.0

Company B: 11.0 9.8 9.9 10.2 10.1 9.7 11.0 11.1 10.2 9.6

- (a) Calculate the sample mean and median for the data for the two companies.
- (b) Calculate the Sample standard deviation.
- (c) Which company is more consistence?

2. Define the Bay's rule of probability and its application in engineering?

[6]

If the probabilities are, respectively, 0.09, 0.15, 0.21, and 0.23 that a person

- (a) Verify that  $f(x)$  is a density function.
- (b) Find  $P(0 < X \leq 1)$ .

3. The weekly demand for a drinking-water product, in thousands of liters, from a local chain of efficiency stores is a continuous random variable  $X$  having the probability density

[5]

$$f(x) = \begin{cases} 2(x-1), & 1 < x < 2, \\ 0, & \text{elsewhere.} \end{cases}$$

- Find probability that
- a) demand will between 0.5 to 1.5 liter
  - b) average demand per week

4. Define the Hypergeometric distribution. Discuss the condition of Hypergeometric distribution.

[5]

5. During a laboratory experiment, the average number of radioactive particles passing through a counter in 1 millisecond is 4. What is the probability that 6 particles enter the counter in a given millisecond?

[5]

OR

It is conjectured that an impurity exists in 30% of all drinking wells in a certain rural community. In order to gain some insight into the true extent of the problem, it is determined that some testing is necessary. It is too expensive to test all of the wells in the area, so 10 are randomly selected for testing.

- (a) Using the binomial distribution, what is the probability that exactly 3 wells have the impurity, assuming that the conjecture is correct?
- (b) What is the probability that more than 3 wells are impure?

6. Write three important properties of Normal distribution. A certain type of storage battery lasts, on average, 3.0 years with a standard deviation of 0.5 year. Assuming that battery life is normally distributed, find the probability that a given battery will last less than 2.3 years. [5]
7. write the difference between sample and population. Write three important of central limit theorem. [5]
8. A manufacturer of sports equipment has developed a new synthetic fishing line that the company claims has a mean breaking strength of 8 kilograms with a standard deviation of 0.5 kilogram. Test the hypothesis that  $\mu = 8$  kilograms against the alternative that  $\mu \neq 8$  kilograms if a random sample of 50 lines is tested and found to have a mean breaking strength of 7.8 kilograms. Use a 0.01 level of significance. [5]
9. Distinguish between z-test and t-test of hypothesis for test of single population mean? [5]

OR

Discuss errors of testing of hypothesis. Write the procedure of testing of single mean for small sample.

10. At what condition pair test should be used. Write the procedure of testing of pair test. [5]
11. A random sample of size  $n_1 = 25$ , taken from a normal population with a standard deviation  $\sigma_1 = 5.2$ , has a mean = 81. A second random sample of size  $n_2 = 36$ , taken from a different normal population with a standard deviation  $\sigma_2 = 3.4$ , has a mean = 76. Test the hypothesis that  $\mu_1 = \mu_2$  against the alternative,  $\mu_1 \neq \mu_2$ . Use 5 % level of significance [5]
12. A real estate agent claims that 60% of all private residences being built today are 3-bedroom homes. To test this claim, a large sample of new residences is inspected; the proportion of these homes with 3 bedrooms is recorded and used as the test statistic. State the null and alternative hypotheses to be used in this test and determine the location of the critical region. [5]

OR

Three testing machines are used to determine the breaking load in tension of wire which is believed to be uniform. Nine pieces of wire are cut off, one after another. They are numbered consecutively, and three are assigned to each machine using random numbers. Random numbers are used also to determine the order in which specimens are tested on each machine. The breaking loads (in Newtons) found on each machine are shown in the table below.

Machin 1	1570	1750	1680
Machin 2	1890	1860	2390
Machin 1	1640	1760	2020

Do the data indicate (at the 5% level of significance) that one or two of the machines give higher readings than others? (value of  $F_{2,6} = 5.1433$ )

13. The thrust of an engine (y) is a function of exhaust temperature (x) in F when other important variables are held constant. Consider the following data. [5]

Thrust	4300	4650	3200	3150	4950	4010		3810	4500	3008
Temperature	1760	1652	1445	1390	1820	1665		1550	1700	1270

(a) Plot the data.

(b) Fit a simple linear regression to the data and plot the line through the data.

14. Distinguish between correlation and regression. Write importance of coefficient of determination.

[5]

15. A container of car antifreeze is supposed to hold 3785 mL of the liquid. Realizing that fluctuations are inevitable, the quality-control manager wants to be quite sure that the standard deviation is less than 30 mL. Otherwise, some containers would overflow while others would not have enough of the coolant. She selects a simple random sample, with the results given here. Use these sample results to construct the 99% confidence interval for the true value of s.

[8]

3761	3861	3769	3772	3675	3861	3888	3819	3788	3800	3720	3748
3787	3753	3821	3811	3740	3740	3839	3445	3351	3332	323	3423
3312	3452										

**Using your calculator**

- a) Calculate the sample mean
- b) Calculate the sample standard deviation
- c) Does this confidence interval suggest that the fluctuations are at an acceptable level?
- d) Observing your result draw your conclusion

\*\*\*

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. What are graph and diagrams? What are the importance and limitation of diagrammatic and graphical representation of statistical data? [2+4]
2. Define Axiomatic approach of probability. In a bolt Factory, machine A, B and C manufacture 60%, 25% and 15% respectively. Of the total of their output 1%, 2% and 1% are defective bolts. A bolt is drawn at random from the total production and found to be defective. From which machines the defective bolt is expect to have been manufactured? [6]
3. What are the chief characteristics of Negative Binomial Distribution? How does it differ from Binomial Distribution? [4+1]
4. Define poisson distribution. A survey report shows that the probability 0.001 that a car will have a flat tyre while driving over a certain bridge. What is the probability that among 2000 cars driven over this bridge (i) not more than one will have a flat tyre; (ii) more than three will have a flat tyre; (iii) exactly 4 will have a flat tyre. [5]
5. A random variable X has the probability density function  $f(x)$  as [5]
$$f(x) = \begin{cases} kx e^{-\frac{x^2}{2}}, & \text{for } 0 \leq x < \infty \\ 0 & \text{otherwise} \end{cases}$$
  - i) Find the value of constant k  $f(x)$  is probability density function
  - ii) Find the distribution function  $F(x)$
  - iii) Also find the mean of random variable X
6. Define Normal distribution. Give the condition for normal approximation to Binomial distribution with an example. [5]
7. Define the standard error of mean. Write the expression for standard error of mean when:
  - i) Sample is drawn from large population
  - ii) Sampling is done without replacement form a finite population
[5]
8. A population consists of the four numbers 12,13,14,15. [5]
  - i) Write down all possible sample size two without replacement.
  - ii) Verify that the sample mean is unbiased estimator for population mean.
  - iii) Calculate the standard error of mean.
9. Define the correlation coefficient and mention its important properties. What does the coefficient of determination measure? [5]

10. Past experience shows the following result of productivity per hectare with the respective uses of chemical fertilizers and seeds. Fit the multiple linear regression equation of Y and X<sub>1</sub> and X<sub>2</sub> from the given data.

[5]

Fertilizer kgs (X <sub>1</sub> ):	45	30	70	75	65	80
Seeds kgs (X <sub>2</sub> ):	2	1.8	3	2.5	2	3
Productivity kgs (Y):	2000	2100	1800	1900	2400	2500

*OR*

- A simply supported beam carries a concentrated load X (Kg) at its mid point. The following table gives maximum deflection Y (cm) corresponding to various value of X.

[5]

X:	100	120	140	160	180	200
Y:	0.45	0.55	0.60	0.70	0.80	0.85

Calculate the two regression equations and estimate the value of maximum deflection when X = 170 kg.

11. Describe the procedure of the test of significance for paired t-test.

[5]

12. Three training methods were compared to see if they led to greater productivity after training. The following are productivity measures for individuals trained by each method:

[5]

Method 1	45	40	50	39	52	44
Method 2	59	43	47	51	39	49
Method 3	41	37	43	40	52	39

Perform an Analysis of variance to test at the 0.05 level of significance whether the three training methods lead to different levels of productivity?

13. The results of a survey regarding "radio listeners" preference for different types of music are given in the following table, is there any association between listeners classified by age group and preference of type of music influence by age?

[5]

Types of music	Age Group		
	19-25	26-35	above 36
Folk Music	80	60	9
Modern music	210	325	44
Indifferent	16	45	32

14. From a lot of units produced by machine A, a sample of 500 is drawn and tested for a quality characteristics. It is found that 16 units are not meeting the specification. Another sample of size 100 is drawn from the lot of similar units produced by machine B and tested. In this case, only 3 units are found to be not meeting the specification. Obtain a 99% confidence intervals for the difference of the properties of defective units produced by the two machines.

[5]

15. Following data reveals the sample of 27 pairs of observation (X, Y) drawn from large population.

[8]

X	46	55	49	57	56	46	66	47	51
Y	27	37	24	43	43	50	49	48	29
X	61	56	68	68	48	58	68	45	50
Y	46	43	40	18	39	32	48	18	45
X	59	45	66	62	57	57	57	69	47
Y	32	26	27	29	47	37	37	27	30

Find the

- Sample mean for each variable X and Y
- Which series is more consistent and why?
- Standard error of the difference of mean in the population
- Find the coefficient of Karl Pearson Correlation

\*\*\*

TABLE A-5  $F$  Distribution ( $\alpha = 0.05$  in the right tail)

	Numerator degrees of freedom (df <sub>1</sub> )								
	1	2	3	4	5	6	7	8	9
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54
2	18.513	19.000	19.164	19.247	19.296	19.330	19.353	19.371	19.385
3	10.128	9.5521	9.2766	9.1172	9.0135	8.9406	8.8867	8.8452	8.8123
4	7.7086	6.9445	6.5914	6.3882	6.2561	6.1631	6.0942	6.0410	6.9988
5	6.6079	5.7861	5.4095	5.1922	5.0503	4.9503	4.8759	4.8183	4.7725
6	5.9874	5.1433	4.7571	4.5337	4.3874	4.2839	4.2067	4.1468	4.0990
7	5.5914	4.7374	4.3468	4.1203	3.9715	3.8660	3.7870	3.7257	3.6767
8	5.3177	4.4590	4.0662	3.8379	3.6875	3.5806	3.5005	3.4381	3.3881
9	5.1174	4.2565	3.8625	3.6331	3.4817	3.3738	3.2927	3.2296	3.1789
10	4.9646	4.1028	3.7083	3.4780	3.3258	3.2172	3.1355	3.0717	3.0204
11	4.8443	3.9823	3.5874	3.3567	3.2039	3.0946	3.0123	2.9480	2.8962
12	4.7472	3.8853	3.4903	3.2592	3.1059	2.9961	2.9134	2.8486	2.7964
13	4.6672	3.8056	3.4105	3.1791	3.0254	2.9153	2.8321	2.7669	2.7144
14	4.6001	3.7389	3.3439	3.1122	2.9582	2.8477	2.7642	2.6987	2.6458
15	4.5431	3.6823	3.2874	3.0556	2.9013	2.7905	2.7066	2.6408	2.5876
16	4.4940	3.6337	3.2389	3.0069	2.8524	2.7413	2.6572	2.5911	2.5377
17	4.4513	3.5915	3.1968	2.9647	2.8100	2.6987	2.6143	2.5480	2.4943
18	4.4139	3.5546	3.1599	2.9277	2.7729	2.6613	2.5767	2.5102	2.4563
19	4.3807	3.5219	3.1274	2.8951	2.7401	2.6283	2.5435	2.4768	2.4227
20	4.3512	3.4928	3.0984	2.8661	2.7109	2.5990	2.5140	2.4471	2.3928
21	4.3248	3.4668	3.0725	2.8401	2.6848	2.5727	2.4876	2.4205	2.3660
22	4.3009	3.4434	3.0491	2.8167	2.6613	2.5491	2.4638	2.3965	2.3419
23	4.2793	3.4221	3.0280	2.7955	2.6400	2.5277	2.4422	2.3748	2.3201
24	4.2597	3.4028	3.0088	2.7763	2.6207	2.5082	2.4226	2.3551	2.3002
25	4.2417	3.3852	2.9912	2.7587	2.6030	2.4904	2.4047	2.3371	2.2821
26	4.2252	3.3690	2.9752	2.7426	2.5868	2.4741	2.3883	2.3205	2.2655
27	4.2100	3.3541	2.9604	2.7278	2.5719	2.4591	2.3732	2.3053	2.2501
28	4.1960	3.3404	2.9467	2.7141	2.5581	2.4453	2.3593	2.2913	2.2360
29	4.1830	3.3277	2.9340	2.7014	2.5454	2.4324	2.3463	2.2783	2.2229
30	4.1709	3.3158	2.9223	2.6896	2.5336	2.4205	2.3343	2.2662	2.2107
40	4.0847	3.2317	2.8387	2.6060	2.4495	2.3359	2.2490	2.1802	2.1240
60	4.0012	3.1504	2.7581	2.5252	2.3683	2.2541	2.1665	2.0970	2.0401
120	3.9201	3.0718	2.6802	2.4472	2.2899	2.1750	2.0868	2.0164	1.9588
$\infty$	3.8415	2.9957	2.6049	2.3719	2.0986	2.0096	1.9384	1.8799	

(continued)



Exam.		Regular	
Level	BE	Full Marks	80
Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. Mention and discuss the significance of statistics in engineering. In a moderately asymmetrical distribution the value of mean and median are 20 and 24 respectively. Find the value of mode. [3+3]
2. Define conditional probability. A manufacturing firm produces steel pipes in three plants with daily production volumes of 500, 1000 and 2000 units respectively. According to experience, it is known that the fractions of defective output produced by the three plants are respectively 0.005, 0.008, 0.010. If a pipe is selected from a day's total production and found to be defective, find out the probability that the pipe might have come from plant II and III. [6]
3. What are the characteristics of Hypergeometric probability Distribution? How does it differ from Binomial probability distribution? [3+2]
4. It is found that a Cricketer hit a century in a game is 25%. He declared that he will retire from cricket after 6<sup>th</sup> century from now. By using Negative Binomial distribution find the probability that [5]
  - i) He will lose none of the game
  - ii) He will lose only game
  - iii) He will lose exactly two games
  - iv) He will lose at least two games.
5. Define standard normal distribution and write the condition for normal approximation to the Binomial and Poisson probability distribution. [5]

**OR**

If the probability density function of a random variable is given by

$$f(x) = kx^3, 0 \leq x \leq 1 \\ = 0, \text{ otherwise}$$

Find:

- i) The value of k
- ii)  $P(X > 2/3)$
- iii)  $P(1/4 < X < 3/4)$  and mean of distribution
6. Incomes of a group of 10,000 persons were found to be normally distributed with mean Rs. 1,520 and s.d Rs 160. Find the number of persons whose incomes will be [5]
  - i) Between Rs.1400 and Rs.1520
  - ii) More than Rs. 1600
  - iii) Lowest income of richest 1000 persons

7. What do you mean by Sampling Distribution of a Statistical and Standard Error? [5]
8. From a population of 5 members 3, 6, 9, 12, 15 draw all possible random sample of size 3 without replacement. Obtain the sampling distribution of sample mean and calculate expectation of sample mean. [5]
9. Define partial and multiple correlations with examples. Write down the properties of partial and multiple correlation. [5]
10. The following data gives the experience of machine operators in years and their performance as given by the number of good parts turned out per 100 pieces. [5]

Experience (X)	16	12	18	4	3	10	5	12
Performance (Y)	87	88	89	68	78	80	75	83

- i) Fit the regression equation of performance ratings on experience and estimate the probable performance if an operator has 8 years experience.  
 ii) Calculate 95% confidence interval for the regression coefficient (i.e., slope)

OR

A household survey on monthly expenditure on food yield following data:

Monthly expenditure(100 Rs.)	10	15	20	25	30	35	40
Monthly income(1000 RS.)	2	4	5	7	6	6	5
Size of the family	4	5	7	10	8	11	4

- i) Obtain the multiple correlation coefficient  
 ii) Find coefficient of multiple determination and interpret it.

11. Differentiate between (a) confidence level and significance level (b) Type I and type II errors of hypothesis testing. [5]

OR

Describe the procedure of testing of hypothesis for single men for large sample.

12. The following table represents the sales of three salesmen in four different districts: [5]

Districts	Sales figure		
	A	B	C
A	14	20	16
B	12	23	15
C	10	20	10
D	8	18	12

Perform an Analysis of Variance to test whether there is any significant difference in the sales of different district at the 0.05 level of significance.

13. A study shows that 16 of 200 tractors produced on one assembly line required extensive adjustment before they could be shipped, while the same was true for 14 of 400 tractors produced on another assembly line. At the 0.05 level of significance, does this support the claim that the second production line does superior work? [5]

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14. To determine whether there is really relationship between an employee's performance in the training program and his ultimate success in the job, it takes a sample of 400 cases from its very extensive files and obtains the result shown in the following table:

[5]

Performance in training program

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

Use the 0.05 level of significance to test whether performance in training program and success in the job are independent.

15. A study was done on a diesel powered light duty pickup truck to see if humidity influence emission of nitrous oxide. Emission measurements were taken at different times, with varying experimental conditions. The data are as follows:

[8]

Nitrous oxide	Humidity
0.90	72.4
0.91	41.6
0.96	34.3
0.89	35.1
1.00	10.7
1.10	12.9
1.15	8.3
1.03	20.1
0.77	72.2
1.07	24.0
1.07	23.2
0.94	47.4
1.10	31.5
1.10	10.6
1.10	11.2
0.91	73.3
0.87	75.4
0.78	96.6
0.82	107.4
0.95	54.9

- a) Find the mean and variance of given data.  
 b) Calculate degree of relationship between them  
 c) Calculate coefficient of determination and interpret the given data.

\*\*\*

TABLE A-4

Chi-Square ( $\chi^2$ ) Distribution

Degrees of Freedom	Area to the Right of the Critical Value									
	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.005
1	—	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
5	0.412	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086	16.750
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.194	46.963	49.645
29	13.121	14.257	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

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#### Degrees of Freedom

$n - 1$

for confidence intervals or hypothesis tests with a standard deviation or variance

$k - 1$

for multinomial experiments or goodness-of-fit with  $k$  categories

$(r - 1)(c - 1)$

for contingency tables with  $r$  rows and  $c$  columns

$k - 1$

for Kruskal-Wallis test with  $k$  samples

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**04 TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
Examination Control Division  
2072 Magh**

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions..
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. What are the chief measures of central tendency and measures of dispersion? The mean weight of 100 students in a certain class is 59 kg. The mean weight of boys in the class is 65 kg and that of girls is 50 kg. Find the number of boys and girls in the class. [2+4]
2. A box containing 5000 IC chips, of which 1000 are manufactured by company A and the rest by company B. Ten percentage of chips made by company A and five percentage of the chips by company B are defective. If we select a chip at a random [6]
  - i) What is the probability that the chips chosen is defective?
  - ii) if a randomly chosen chip are found to be defective, what is the probability that it comes from company A
3. Define hypergeometric probability distribution with an example. Describe the conditions for the binomial approximation to hypergeometric distribution? [2+3]
4. In a certain factory turning out optical lenses, there is a small chance, 1/500 for any lens to be defective. The lenses are supplied in packets of 10 each. What is the probability that a packet will contain [5]
  - i) No defective lens
  - ii) At least one defective lenses
  - iii) At most two defective lenses

**OR**

Define mathematical expectation of a discrete random variable. A probability distribution is given

X = x	0	1	2	3	4	5
P(X=x)	0.26	0.25	0.11	0.02	0.25	0.11

Find (a) P(X ≥ 4); (b) P(0 < X < 4); (c) P(X = 4 ∩ X = 5); (d) F(3)

5. Define Gamma Distribution and write the chief characteristics of it. [5]

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6. In a photo graphic process, the developing time of prints may be looked upon as a random variable having the normal distribution with a mean of 16.28 second and a standard deviation of 0.12 second. Find the probability that it will take [5]

- i) Anywhere from 16.00 to 16.50 seconds to develop one of the prints
- ii) At least 16.20 seconds to develop one of the prints
- iii) At most 16.35 seconds to develop one of the prints

**OR**

The distribution of amount of the gravel (in ton) sold by a particular construction supply company in a given week is continuous random variable  $X$  with the probability density function.

$$f(x) = \begin{cases} \left(\frac{3}{2}\right)(x^2 + 1) & \text{for } 0 \leq x \leq 1 \\ 0 & \text{otherwise} \end{cases}$$

- a) Find the cumulative distribution function of sales
  - b) What is the expected value and variance of sales
7. Define sampling distribution of proportion with suitable example. [5]
8. A population consists of the four numbers 2, 3, 4, 5 [5]
- i) Write down all possible sample size of two without replacement
  - ii) verify that the population mean is equal to the mean of the sample mean
  - iii) Calculate the standard error of the sampling distribution of the sample mean
9. 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 sample of size 10 are taken from large group of trainees instructed by each of these two methods and the scores which they obtained in an appropriate achievement test are [5]

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 the 0.05 level of significance to test the claim that method B is more effective.

10. Hotel's manager in Kathmandu wants to know the hotel's average daily registration. The following table presents the numbers of guest registered each of 27 randomly selected days. Calculate the sample mean standard errors of mean and 95% confidence limits of population mean. [5]

61	57	53	60	64	57	54	58	63
61	50	59	50	60	57	58	62	63
60	54	54	61	51	53	62	57	60

**OR**

Shyam and Co. produces three varieties of products: deluxe, fine and ordinary. A recent market survey is conducted for preference of products. The preference was found as follow:

Product	Production			
	Deluxe	Fine	Ordinary	Total
Deluxe	15	14	19	18
Fine	17	12	20	16
Ordinary	16	18	16	17

Is there a significant difference in the preference of products using ANOVA test. Use  $\alpha = 5\%$

04 TRIBHUVAN UNIVERSITY  
 INSTITUTE OF ENGINEERING  
**Examination Control Division**  
 2071 Magh

Exam.	OLD Back (2065 & Earlier Batch)		
Level	BE	Full Marks	80
Programme	BCE, BME	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (EG571SH)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Seven questions selecting Four from Group A and Three from Group B.
- ✓ Necessary tables are attached herewith.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

**Group A**

1. a) Write the differences between diagram and graph. Write the importances of diagrammatic presentation of data [6]
- b) Following is the distribution of monthly wages of employees of two factories. Which factory pays more money to the employees and in which factory the monthly wages is more consistent? [5]
 

Wages (Rs.)	200-400	400-600	600-800	800-1000	1000-1200	1200-1400	1400-1600
Factory A	4	8	11	6	5	3	3
Factory B	7	12	9	4	4	3	1
2. a) Define the terms:( i) Exhaustive event (ii) Favorable event (iii) Mutually exclusive events (iv) Equally likely events and (v) Independent events [6]
   
  
 b) Two third of the students in a class are boys and rest are girls. It is known that the probability of a girl getting first division marks is 0.25 and that of boy getting first division mark is 0.28. Find the probability that a student chosen at random will get first division mark ? [5]
3. a) Differentiate between discrete random variable and continuous random variable with examples. [5]
   
  
 b) In a gambling, a man is paid Rs.5 if he gets all heads or all tails when three coins are tossed and he pays out Rs.3 if either one or two of head shows, what is his expected gain? [6]
4. a) What are the differences and similarities between binomial distribution and negative binomial distribution? [6]
   
  
 b) Assuming the probability of a male birth is  $\frac{1}{2}$ , find in how many of 160 families with 4 children each would you expect to have [5]
  - I. at least one boy
  - II. at least one boy and one girl

5. a) Define normal distribution? Also state its important properties. [6]
- b) The breakdown voltage  $X$  of a randomly chosen diode of a particular type is known to be normally distributed with  $\mu = 40$  volts and  $\sigma = 1.5$  volts [5]
- What is the probability that the break down voltage will be between 39 and 42 volts
  - What is the probability that the break down voltage will be between 40 and 43 volts
6. a) Define joint probability mass function and marginal probability mass function. [6]
- b) The Joint probability distribution of the number  $X$  of car and the number  $Y$  of buses per signal cycle of a proposed left turn lane is displayed in the accompanying joint probability table: [5]

		y		
		0	1	2
x	0	0.025	0.015	0.01
	1	0.05	0.03	0.02
	2	0.125	0.075	0.05
	3	0.15	0.09	0.06
	4	0.1	0.06	0.04
	5	0.05	0.03	0.02

- What is the probability that there is exactly one car and exactly one bus during a cycle?
- What is the probability that there is at most one car and at most one bus during a cycle?
- What is the probability that there is exactly one car during a cycle?

#### Group B

7. a) What are the estimator and estimates? Describe the criteria for a good estimator. [6]
- b) A quality control manager needs to estimate the average hours of life of light bulbs. The population standard deviation is known to be 100 hours. A random sample of 64 light bulbs indicated a sample average life of 350 hours. Set up 95% and 99% confidence interval of true average life of bulbs. [6]
8. a) Describe the types of error that arises in testing of hypothesis. Describe the test procedure of test of significance of mean for large sample. [6]
- b) The sample average unrestrained compressive strength for 45 specimens of particular type of bricks was computed to be 3107 psi and sample standard deviation was 188 psi. The distribution of unrestrained compressive strength may be somewhat skewed. Does the data strongly indicate that the true average unrestrained compressive strength is less than design value of 3200? Test using 1% level of significance. [6]

04 TRIBHUVAN UNIVERSITY  
 INSTITUTE OF ENGINEERING  
**Examination Control Division**  
 2071 Bhadra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. What are the differences between measures of central tendency and measures of dispersion? The mean and standard deviation of 20 items is found to be 10 and 2 respectively. At the time of checking it was found that one item 8 was incorrect. Calculate the mean and standard deviation if : (a) the wrong item is omitted (b) it is replaced by 12. [2+4]
2. Differentiate between equally likely events and mutually exclusive events with suitable example. A consulting firm rents cars from three agencies, 20% from agency D, 20% from agency E, and 60% from agency F. If 10% of the cars from D, 12% of the cars from E, and 4% of the cars from F have bad tires, what is the probability that the firm will get a car with bad tires? [6]
3. Define Negative Binomial Distribution. Write the conditions for Negative Binomial Distribution. [2+3]
4. A shipment of 20 digital voice recorders contains 5 that are defective. If 10 of them are randomly chosen for inspection, what is the probability that 2 of the 10 will be defective? Also, find the mean and variance of the distribution. [5]
5. Define Standard Normal Distribution. Write the normal approximation to the (a) Binomial Distribution and (b) Poission Distribution. [4]

**OR**

A college professor never finishes his lecture before the bell rings to end the period, and always finishes his lectures within one minute after the bell rings. Let  $X$  = the time which elapses between the bell and the end of the lecture. Suppose that the p.d.f. of  $X$  is

[4]

$$f(x) = kx^2, 0 \leq x \leq 1$$

$$= 0, \text{ otherwise}$$

- a) Find the value of  $k$
- b) What is the probability that the lecture ends within  $\frac{1}{2}$  minute of the bell ringing?
- c) What is the probability that the lecture continues beyond the bell for between 15 and 30 seconds?
- d) What is the probability that the lecture continuous for at least 40 seconds beyond the bell? [6]
6. Suppose that the pH of soil samples taken from a certain geographic region is normally distributed with mean pH 6.00 and standard deviation 0.10. If the pH of a randomly selected soil sample from this region is determined.
  - a) What is the probability that the resulting pH is between 5.90 and 6.15?
  - b) What is the probability that the resulting pH exceeds 6.10?
  - c) What is the probability that the resulting pH is at most 5.95?
7. What is sampling distribution? Construct frequency distribution table of sample mean in population 2, 4, 6, 8, 10 with sample size two. Also prove that sample mean is unbiased estimate of population mean. [4]

8. Define Central Limit Theorem. An auditor for a large credit card company, knows that, on average, the monthly balance of any given customer is \$112, and the standard deviation is \$56. If the auditor audits 50 randomly selected accounts, what is the probability that the sample average monthly balance is (a) below \$100 (b) between \$100 and \$130?

[2+4]

9. An article in the Tappi Journal (March, 1986) presented data on green liquor  $\text{Na}_2\text{S}$  concentration (in grams per liter) and paper machine production (in tons per day). The data (read from a graph) are shown as follows:

[6]

y	40	42	49	46	44	48	46
x	825	830	890	895	890	910	915
y	43	53	52	54	57	58	
x	960	990	1010	1030	1030	1050	

- a) Fit a simple linear regression model with  $y$  = green liquor  $\text{Na}_2\text{S}$  concentration and  $x$  = production.  
b) Find the fitted value of  $y$  corresponding to  $x = 910$  tons.

OR

The following show the improvement (gain in reading speed) of eight students in a speed-reading program, and the number of weeks they have been in program.

No. of weeks	3	5	2	8	6	9	3	4
Speed gain (word/minute)	86	118	49	193	164	232	73	109

Estimate the parameters of a simple linear regression model with No. of weeks as independent variable.

10. Define the correlation coefficient and mention its important properties. What does the coefficient of determination measure?

[4]

11. Describe the procedure of the test of significance of two means for small sample.

[4]

12. 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 (coded values) are as follows:

[6]

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

Perform an Analysis of Variance to test at the 0.05 level of significance whether the differences among the sample means at the three positions are significant.

13. Define point estimate. Write down the properties of good estimator with examples.

[5]

14. In 40 tosses of a coin, 24 heads were obtained. Find 95% and 99% confidence limit for proportion of heads.

[5]

15. The following table shows the number of hours 45 hospital patients slept following the administration of a certain anesthetic.

[8]

7	10	12	4	8	7	3	8	5
12	11	3	8	1	1	13	10	4
4	5	5	8	7	7	3	2	3
8	13	1	7	17	3	4	5	5
3	1	17	10	4	7	7	11	8

- a) Find sample mean, sample variance and sample standard deviation.  
b) Compute a value that measures the amount of variability relative to the value of mean.

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Exam.		Regular / Back	
Level	BE	Full Marks	80
Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject: - Probability and Statistics (SH552)**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. What are the differences between measures of central tendency and measures of dispersion? The mean and standard deviation of 20 items is found to be 10 and 2 respectively. At the time of checking it was found that one item 8 was incorrect. Calculate the mean and standard deviation if : (a) the wrong item is omitted (b) it is replaced by 12. [2+4]

2. Differentiate between equally likely events and mutually exclusive events with suitable example. A consulting firm rents cars from three agencies, 20% from agency D, 20% from agency E, and 60% from agency F. If 10% of the cars from D, 12% of the cars from E, and 4% of the cars from F have bad tires, what is the probability that the firm will get a car with bad tires? [6]

3. Define Negative Binomial Distribution. Write the conditions for Negative Binomial Distribution. [2+3]

4. A shipment of 20 digital voice recorders contains 5 that are defective. If 10 of them are randomly chosen for inspection, what is the probability that 2 of the 10 will be defective? Also, find the mean and variance of the distribution. [5]

5. Define Standard Normal Distribution. Write the normal approximation to the (a) Binomial Distribution and (b) Poission Distribution. [4]

**OR**

A college professor never finishes his lecture before the bell rings to end the period, and always finishes his lectures within one minute after the bell rings. Let X = the time which elapses between the bell and the end of the lecture. Suppose that the p.d.f. of X is [4]

$$f(x) = kx^2, 0 \leq x \leq 1$$

$$= 0, \text{ otherwise}$$

- Find the value of k
  - What is the probability that the lecture ends within  $\frac{1}{2}$  minute of the bell ringing?
  - What is the probability that the lecture continues beyond the bell for between 15 and 30 seconds?
  - What is the probability that the lecture continuous for at least 40 seconds beyond the bell?
6. Suppose that the pH of soil samples taken from a certain geographic region is normally distributed with mean pH 6.00 and standard deviation 0.10. If the pH of a randomly selected soil sample from this region is determined. [6]

- What is the probability that the resulting pH is between 5.90 and 6.15?
- What is the probability that the resulting pH exceeds 6.10?
- What is the probability that the resulting pH is at most 5.95?

7. What is sampling distribution? Construct frequency distribution table of sample mean in population 2, 4, 6, 8, 10 with sample size two. Also prove that sample mean is unbiased estimate of population mean. [4]

8. Define Central Limit Theorem. An auditor for a large credit card company, knows that, on average, the monthly balance of any given customer is \$112, and the standard deviation is \$56. If the auditor audits 50 randomly selected accounts, what is the probability that the sample average monthly balance is (a) below \$100 (b) between \$100 and \$130?

[2+4]

9. An article in the Tappi Journal (March, 1986) presented data on green liquor  $\text{Na}_2\text{S}$  concentration (in grams per liter) and paper machine production (in tons per day). The data (read from a graph) are shown as follows:

[6]

y	40	42	49	46	44	48	46
x	825	830	890	895	890	910	915
y	43	53	52	54	57	58	
x	960	990	1010	1030	1030	1050	

- a) Fit a simple linear regression model with  $y$  = green liquor  $\text{Na}_2\text{S}$  concentration and  $x$  = production.  
b) Find the fitted value of  $y$  corresponding to  $x = 910$  tons.

*OR*

The following show the improvement (gain in reading speed) of eight students in a speed-reading program, and the number of weeks they have been in program.

No. of weeks	3	5	2	8	6	9	3	4
Speed gain (word/minute)	86	118	49	193	164	232	73	109

Estimate the parameters of a simple linear regression model with No. of weeks as independent variable.

10. Define the correlation coefficient and mention its important properties. What does the coefficient of determination measure?

[4]

11. Describe the procedure of the test of significance of two means for small sample.

[4]

12. 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 (coded values) are as follows:

[6]

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

Perform an Analysis of Variance to test at the 0.05 level of significance whether the differences among the sample means at the three positions are significant.

13. Define point estimate. Write down the properties of good estimator with examples.

[5]

14. In 40 tosses of a coin, 24 heads were obtained. Find 95% and 99% confidence limit for proportion of heads.

[5]

15. The following table shows the number of hours 45 hospital patients slept following the administration of a certain anesthetic.

[8]

7	10	12	4	8	7	3	8	5
12	11	3	8	1	1	13	10	4
4	5	5	8	7	7	3	2	3
8	13	1	7	17	3	4	5	5
3	1	17	10	4	7	7	11	8

- a) Find sample mean, sample variance and sample standard deviation.  
b) Compute a value that measures the amount of variability relative to the value of mean.

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02 TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**Examination Control Division**  
2071 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. What are the chief measures of central tendency? Also describe the techniques to measure the consistency. [6]
2. Five coins are tossed 320 times. If coins are unbiased construct the probability distribution table of the result. Also find mean and variance of the given probability distribution. [6]
3. Define binomial probability distribution with its important characteristics. [5]
4. It has been claimed that in 60% of all solar-heat installations the utility bill will be 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 (b) at least four of five installations? [5]
5. Define continuous random variable and probability density function. The probability density function of a random variable is  $f(x) = \begin{cases} \frac{3}{4}x & 0 \leq x \leq 2 \\ 0 & \text{otherwise} \end{cases}$ . Find mean and variance of the variable x. [4]
6. The time for a super glue to set can be treated as a random variable having a normal distribution with mean 30 seconds. Find its standard deviation if the probability is 0.20 that it will take on a value greater than 39.2 seconds. [6]

**OR**

The daily consumption of water in a certain place follow a gamma-distribution with parameters  $\alpha = 2$  and  $\beta = 3$ . If the daily capacity of this city is 9 million gallon of water, what is the probability that on any given day the water supply is inadequate?

7. Define sampling distribution. Write the difference between population and sample. A population consists of 3, 7, 11, 15. Consider all possible samples of size two which can be drawn without replacement from this population. Find population mean and population standard deviation [4]
8. State central limit theorem. If a 1-gallon can of paint covers on the average 513.3 sq.ft. with a standard deviation of 31.5 sq.ft., what is the probability that the sample mean area covered by a sample of 40 of these 1-gallon cans be anywhere from 510 to 520 sq.ft.? [6]
9. Define Pearsonian's correlation coefficient. Write down two differences between correlation and regression coefficient. [4]

10. The following are the measurements of the air velocity and evaporation coefficient of burning fuel droplets in an impulse engine.

[6]

Air velocity cm/sec (x)	20	60	100	140	180	220	260	300	340	380
Evaporation coefficient mm <sup>2</sup> /sec (y)	0.18	0.37	0.35	0.78	0.56	0.75	1.18	1.36	1.17	1.65

Fit the straight line by method of least square and find the value of evaporation coefficient when air velocity is 200 cm/sec.

11. Write down the steps for testing hypothesis on difference between two population means for the large sample size.

[4]

12. An examination was given to 50 students at college A and 60 students at college B. At A mean grade was 75 with standard deviation of 9. At B mean grade was 79 with a standard deviation of 7. Is there significant difference between the performance of students at A and those at B, given that  $\alpha = 0.05$ ?

[6]

**OR**

Three randomly selected groups of chickens are fed on three different diets. Each group consists of five chickens. Their weight gains during a specified period of time are as follows:

Diet I	4	4	7	7	8
Diet II	3	4	5	6	7
Diet III	6	7	7	7	8

Test the hypothesis that mean gains of weight due to the three diets are equal.

13. Write the properties of good estimators with examples.

[5]

14. In random sample of 400 industrial accidents, it was found that 231 were due to at least partially to unsafe working conditions. Construct 99% and 95% confidence intervals for the corresponding true proportion.

[5]

15. An article in computer and industrial engineering describes the time-failure data (in hours) for jet engines. Some of the data observed are presented below.

[8]

Engine	Failure Time	Engine	Failure Time
1	150	13	213
2	291	14	271
3	93	15	197
4	53	16	200
5	2	17	262
6	65	18	255
7	183	19	286
8	144	20	206
9	223	21	179
10	197	22	232
11	187	23	165
12	197	24	155
		25	203

- a) Find sample mean, sample variance and sample standard deviation.
- b) Exclude the lowest six data and compute (a) again.
- c) Analyze the result (a) and (b). Draw your conclusion.

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Exam.				OLD Back (2065 & Earlier Batch)			
Level	BE	Full Marks	80	Programme	BCE, BME	Pass Marks	32
Year / Part	II / II	Time	3 hrs.				

**Subject:** - Probability and Statistics (EG571SH)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Seven questions selecting Four from Group A and Three from Group B.
- ✓ Necessary tables are attached herewith.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

#### Group A

1. a) Write the differences between diagram and graph. Write the importances of diagrammatic presentation of data [6]
- b) Following is the distribution of monthly wages of employees of two factories. Which factory pays more money to the employees and in which factory the monthly wages is more consistent? [5]
 

Wages (Rs.)	200-400	400-600	600-800	800-1000	1000-1200	1200-1400	1400-1600
Factory A	4	8	11	6	5	3	3
Factory B	7	12	9	4	4	3	1
2. a) Define the terms: (i) Exhaustive event (ii) Favorable event (iii) Mutually exclusive events (iv) Equally likely events and (v) Independent events [6]
   
 b) Two third of the students in a class are boys and rest are girls. It is known that the probability of a girl getting first division marks is 0.25 and that of boy getting first division mark is 0.28. Find the probability that a student chosen at random will get first division mark? [5]
3. a) Differentiate between discrete random variable and continuous random variable with examples. [5]
   
 b) In a gambling, a man is paid Rs.5 if he gets all heads or all tails when three coins are tossed and he pays out Rs.3 if either one or two of head shows, what is his expected gain? [6]
4. a) What are the differences and similarities between binomial distribution and negative binomial distribution? [6]
   
 b) Assuming the probability of a male birth is  $\frac{1}{2}$ , find in how many of 160 families with 4 children each would you expect to have
  - I. at least one boy
  - II. at least one boy and one girl

5. a) Define normal distribution? Also state its important properties. [6]
- b) The breakdown voltage  $X$  of a randomly chosen diode of a particular type is known to be normally distributed with  $\mu = 40$  volts and  $\sigma = 1.5$  volts [5]
- What is the probability that the break down voltage will be between 39 and 42 volts
  - What is the probability that the break down voltage will be between 40 and 43 volts
6. a) Define joint probability mass function and marginal probability mass function. [6]
- b) The Joint probability distribution of the number  $X$  of car and the number  $Y$  of buses per signal cycle of a proposed left turn lane is displayed in the accompanying joint probability table: [5]

		y		
		0	1	2
x	0	0.025	0.015	0.01
	1	0.05	0.03	0.02
	2	0.125	0.075	0.05
	3	0.15	0.09	0.06
	4	0.1	0.06	0.04
	5	0.05	0.03	0.02

- What is the probability that there is exactly one car and exactly one bus during a cycle?
- What is the probability that there is at most one car and at most one bus during a cycle?
- What is the probability that there is exactly one car during a cycle?

#### Group B

7. a) What are the estimator and estimates? Describe the criteria for a good estimator. [6]
- b) A quality control manager needs to estimate the average hours of life of light bulbs. The population standard deviation is known to be 100 hours. A random sample of 64 light bulbs indicated a sample average life of 350 hours. Set up 95% and 99% confidence interval of true average life of bulbs. [6]
8. a) Describe the types of error that arises in testing of hypothesis. Describe the test procedure of test of significance of mean for large sample. [6]
- b) The sample average unrestrained compressive strength for 45 specimens of particular type of bricks was computed to be 3107 psi and sample standard deviation was 188 psi. The distribution of unrestrained compressive strength may be somewhat skewed. Does the data strongly indicate that the true average unrestrained compressive strength is less than design value of 3200? Test using 1% level of significance. [6]

04 TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**Examination Control Division**  
2070 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. What are the merits and demerits of positional average median? Calculate mean, median and mode from the following data of rainfall. [6]

Rainfall (in mm)	20-30	30-40	40-50	50-60	60-70
No. of days	15	16	20	24	15

2. Define addition theorem of probability. In a group of equal number of men and women, 20% of men and 30% of women are unemployed. If a person selected is random. [6]

- a) What is the probability that the selected person is an employed?  
b) What is the probability that the selected person is men employed?

3. Write down the differences between a binomial and a negative binomial distribution with an example. [5]

4. In a certain factory turning out optical lenses, there is a small chance, 1/500 for any lens to be defective. The lenses are supplied in packets of 10 each. What is the probability that a packet will contain [5]

- a) no defective lens      b) at least one defective lenses      c) at most two defective lenses

5. Define the normal distribution. Give the condition for normal approximation of binomial distribution. [2+3]

6. The mean weight of products is 68.22 grams with variance of 10.8 grams. How many products in a batch of 1000 would you expect (a) to be over 72 grams (b) between 70 and 72 grams (c) below 65 grams? [5]

**OR**

A college professor never finishes his lecture before the bell rings to end of the period, and always finishes his lecture within one minute after the bell rings. Let X be the time that elapse between the bell and the end of the lecture, and suppose the probability density function of X is

$$\begin{cases} kx^2 & 0 \leq x \leq 1 \\ 0 & \text{Otherwise} \end{cases}$$

- a) Find the value of k.  
b) What is the probability that the lecture ends within 20 seconds of bell rings?  
c) What is the probability that the lecture continue beyond the bell for between 20 to 40 seconds?  
7. Define sampling distribution of proportion with example. [4]  
8. State the central limit theorem. Write two applications of it. [6]  
9. Write down the properties of regression coefficient and correlation coefficient. [5]  
10. The following data gives the experience of machine operators in years and their performance as given by the number of good parts turned out per 100 pieces. [5]

Experience (X)	16	12	18	4	3	10	5	12
Performance (Y)	87	88	89	68	78	80	75	83

- a) Fit the regression equation of performance ratings on experience and estimate the probable performance if an operator has 8 years experience.  
b) Calculate coefficient of determination and interpret it.

***OR***

A sample of 10 values of three variables  $X_1$ ,  $X_2$  and  $X_3$  were obtained as

$\Sigma X_1 = 10$	$\Sigma X_2 = 20$	$\Sigma X_3 = 30$
$\Sigma X_1^2 = 20$	$\Sigma X_2^2 = 68$	$\Sigma X_3^2 = 170$
$\Sigma X_1 X_2 = 10$	$\Sigma X_1 X_3 = 15$	$\Sigma X_2 X_3 = 64$

Find:

- a) Partial correlation between  $X_1$  and  $X_3$  eliminating the effect of  $X_2$ .
- b) Multiple correlation between  $X_1$ ,  $X_2$  and  $X_3$  assuming  $X_1$  as dependent.

11. A company produces automobile tyres, the manager of the company want to estimate the limits in which expected trend life of his tyres will probably lie. A test sample of 64 tyres was taken and a test run showed the average trend life of 50000 miles. Find the 95% and 99% confidence limits for population mean. Given that population standard deviation is 3000 miles. [4]

12. The following data represents the units of production per day turned out by three different brands of machines used by three mechanists: [6]

Machines	Production			
	1	15	14	19
2	17	12	20	16
3	16	18	16	17

Using ANOVA test whether the differences in performances of the three brands of machines are significant. Use  $\alpha = 5\%$ .

***OR***

The average hourly wage of sample of 150 workers in a plant 'A' was Rs. 2.56 with a standard deviation of Rs. 1.08. The average wage of a sample of 200 workers in plant 'B' was Rs. 2.87 with a standard deviation of Rs. 1.28. Can an applicant safely assume that the hourly wages paid by plant 'B' are higher than those paid by plant 'A'? Use  $\alpha = 0.05$ .

13. Define critical value and critical region. A manufacturer claimed that at least 95% of the pumps supplied to the ABC company confirmed to specifications. However, the production manager at ABC company wasn't satisfied with the claim of the manufacturer. Hence, to test the claim, the manager examined a sample of 250 pumps supplied last month and found that 228 pumps as per the specifications. Can you conclude that the production manager is right to doubt on the claim of the manufacturer? ( $\alpha = 0.01$ ) [5]

14. Define chi-square distribution. A sample of 500 workers of a factory according to gender and nature of work is follow: [5]

Nature of work	Gender	
	Male	Female
Technical	200	100
Non-technical	50	150

Test at 5% level of significance whether there exist any relationship between gender and nature of work.

15. The heights of male and female students are given below. [8]

Height	Sex of the person	
	Male	Female
145-150	0	3
150-155	2	8
155-160	6	15
160-165	17	12
165-170	21	4
170-175	10	0
175-180	2	0
180-185	2	0

- a) Calculate mean height for male and female students.
- b) Calculate sample standard deviation and sample variance for given data.
- c) Which data for height is consistent?

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<b>Exam.</b>	Regular (2066 & Later Batch)		
<b>Level</b>	BE	<b>Full Marks</b>	80
<b>Programme</b>	BCE, BME, BIE	<b>Pass Marks</b>	32
<b>Year / Part</b>	II / II	<b>Time</b>	3 hrs.

**Subject:** - Probability and Statistics (SH552)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. A civil engineer tested six samples of each of three types of brick for use in a particular construction project. The following data are the compressive strength of bricks in psi.

Type I	2900	3105	2950	2859	3155	3132
Type II	2805	2985	3067	3204	3250	3119
Type III	3207	2825	2836	3222	3121	3218

- i) Calculate the average compressive strength and the standard deviation for each type.  
 ii) Which type of brick is best and why? [2x3=6]

2. State 'Bayes' theorem for conditional probability. A company produces certain type of sophisticated items by three machines. The respective daily production figures are: Machine A 300 units, Machine B 450 units and Machine C 250 units. Past experience shows that the percentages of defective in the three machines are 0.1, 0.2 and 0.7 respectively for the machines A, B and C. An item is drawn at random from a day's production and is found to be defective. What is the probability that it is not produced by machine C ? [1+5]

3. Define hypergeometric distribution. Write down the differences between hypergeometric and binomial distribution. [2+2]

4. Write any two conditions that a function is a probability mass function. If 6 of 18 new buildings in a city violate the building code, what is the probability that a building inspector, who randomly selects 4 of the new buildings for inspection, will catch  
 a) none of the buildings that violate the building code.  
 b) at least 3 of the new buildings that violate the building code. [2+2+2]

OR

Define Poisson probability distribution with the condition for poisson distribution.

A local booth of Nepal Telecom receives on an average 2 calls per minute. Find the probability of (i) no phone call (ii) exactly 4 calls (iii) at least three calls.

5. Define standard normal distribution with area property. [4]

6. The length of life of 600 dry battery cells are normally distributed with mean 12 hours and standard deviation 2.5 hours . Find the number of battery cells that are expected to have life i) more than 15 hours; ii) between 10 and 14 hours iii) less than 6 hours. [6]

OR

If X has a probability density function:

$$f(x)=k(1-x^2) \quad \text{for } -1 < x < 1$$

Otherwise

Find (i) k (ii)  $P(0.5 < x < 1)$  (iii) The distribution function of random variable x.

7. Define population, sample, parameter and statistic with examples. [2 + 4]
8. The lifetime of a certain brand of an electric bulb may be considered a random variable with mean 1200 hours and standard deviation 150 hours. Using the *Central Limit Theorem*, find the probability that the sample mean, of the lifetime with a sample of size 36, is between 1100 hours and 1300 hours. [4]
- OR*
- From a population of 3 members 1, 3, 5 draw all possible simple random samples of size 3 without replacement. Obtain the sampling distributions of sample mean and from it calculate expectation of sample mean. [4]
9. The simple correlation coefficient between fertilizer (X<sub>1</sub>), seeds (X<sub>2</sub>) and productivity (X<sub>3</sub>) are  $r_{12}=0.69$ ,  $r_{13}=0.64$  and  $r_{23}=0.85$ . Calculate the partial correlation coefficient  $r_{12,3}$  and multiple correlation  $R_{1,2,3}$ . [4]
10. Ten Steel wires of diameter 0.5 mm and length 2.5m were extended in a laboratory by applying vertical forces of varying magnitudes. Results are as follows:

Force(kg)	15	19	25	35	42	48	53	56	62	65
Increase in length (mm)	1.7	2.1	2.5	3.4	3.9	4.9	5.4	5.7	6.6	7.2

Determine correlation coefficient and coefficient of determination between force and increase in length and interpret the result using coefficient of determination.

[6]

*OR*

Suppose a statistics professor is interested in predicting final exam score (Y) from SAT mathematics score (X), using the following data student.

SAT score X	440	465	282	521	535	552	572	590	607
Final Score Y	40	47	43	54	64	52	59	68	44

- (i) Determine the regression equation for predicting scores on the final (Y) from SAT score (X).  
(ii) From a SAT score of 500, predict the score on the final.

11. The following are the lifetimes of three types of tires in miles.

[6]

Tire	Life times(000) miles			
I	28	27.4	26	27
II	26.9	25.6	24.9	27.7
III	27	28.4	26.6	25

Construct ANOVA table and test for equality of the mean life times.

OR

Define critical value and test statistic value. A moped manufacturer hypothesized that the mean miles per gallon for its moped is 115.2. It takes the samples of 49 moped and find the sample mean to be 117.4 per gallon. If the population standard deviation is known to 8.4, test the hypothesis that the true mean miles per gallon is significantly greater than 115.2 using 0.05 significance level.

12. Describe the procedure of test of significance between two population proportions.  
13. The distribution of number of error page was given below as.

[4]

[5]

No. of error	0	1	2	3	4	5
No. of pages	275	138	75	7	4	1

Using Chi-square test of goodness of fit, verify whether the distribution of error follow a poisson distribution.

14. In a factory, 2% steel rods were found defective in a lot of 2000 and in another factory, 2.5% steel rods were found defective in a lot of 3000 rods. Do you find that the rods in the second factory are significantly inferior compared to the rods in the first factory? (Use  $\alpha=1\%$ ) [5]

15. An article in computer and industrial engineering describes the time-to-failure data (in hours) for jet engines. Some of the data observed are presented below: [3+3+2]

Engine	Failure Time	Engine	Failure time
1	150	13	213
2	291	14	271
3	93	15	197
4	53	16	200
5	2	17	262
6	65	18	255
7	183	19	286
8	144	20	206
9	223	21	179
10	197	22	232
11	187	23	165
12	198	24	203

- Find sample mean, sample variance and sample standard deviation.
- Exclude the lowest six data and compute (a) again.
- Analyze the results (a) and (b). Draw your conclusion.

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Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, BME	Pass Marks	32
Year / Part	II / II	Time	3 hrs

**Subject:** - Probability and Statistics

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Seven questions selecting Four from Group A and Three from Group B.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

**Group A**

[(6+5)×4]

1. a) What do you mean by measures of central tendency? Describe briefly the requisites of a good measure of central tendency.
- b) Two automatic filling machines A and B are used to fill tea in 500gms cartons. A random sample of 100 cartons on each machine showed the following:

Tea Contents: (In gms)	485-490	490-495	495-500	500-505	505-510	510-515
No. of Cartons filled by	Machine A	12	18	20	22	24
	Machine B	10	15	24	20	18

Find:

- i) Which machine is better?  
ii) Which machine has a consistent performance?
2. a) Define the following terms with a suitable example:
  - i) Mutually exclusive events
  - ii) Independent events
  - iii) Exhaustive cases
 b) Suppose that in a particular city, airport A handles 50% of all airline traffic; and airports B and C handle 30% and 20% respectively. The detection rates for a passenger for carrying weapons at the three airports are 0.9, 0.5 and 0.4 respectively. If a passenger at any one of the airports is selected at random, what is the probability that he or she carrying a weapon? If he or she is found carrying a weapon through the boarding gate, what is the probability that passenger is using airport A?
3. a) Differentiate discrete and continuous random variables with suitable examples.  
b) A box contains 8 good bulbs and 5 defective bulbs. Three bulbs are drawn at random. Find the probability distribution of the number of defective bulbs drawn. Also calculate mean and variance of the distribution.
4. a) Define negative binomial distribution. Through a suitable example, indicate the difference that it has with binomial distribution.  
b) On an average 1 house in 1000 in a certain district has a fire during a year. If there are 2000 houses in that district, indicate the probability that:
  - i) Exactly 5 houses will have a fire during the year.
  - ii) No houses will have a fire during the year.
  - iii) At least one house will have a fire during the year.
  - iv) At the most 2 houses will have a fire during the year.

5. a) Define normal distribution. State the area properties of a normal curve.
- b) 1000 candidates appeared in a test. The average score in the test is 14 and standard deviation is 2.5. Assuming the normality of the distribution, find:
- The probability that a candidate selected at random will score above 15.
  - How many candidates score between 12 and 15?
  - How many score below 8?
6. a) Define joint probability mass function and marginal probability density function. Give two examples in which the case of joint distribution arise.
- b) If two random variables X and Y have the joint density

$$f(x, y) = \begin{cases} \frac{6}{5}(x + y^2) & \text{for } 0 < x < 1, 0 < y < 1 \\ 0 & \text{elsewhere,} \end{cases}$$

Find:

- Marginal density function for X
- Marginal cumulative distribution function for Y.

### Group B

$[(6+6) \times 3]$

7. a) Explain the concept of point estimation and interval estimation.
- b) A random sample of 900 members has mean 3.4cm and standard deviation 2.61cm. If the population is normal, find 95% and 98% confidence limits for population mean.
8. a) Explain with illustrations, the types of error that arise in testing hypothesis.
- b) In a random sample of 400 men, it is found that 200 men consume brand 'X' of a commodity. On the other hand, in a random sample of 600 women, it is found that 325 consume the same commodity. Test the hypothesis that the data shows a significant difference between men and women so far as the proportion of the commodity consumer is concerned. [Use 5% level of significance].
9. a) Differentiate between z-test and t-test of hypothesis. Also state the conditions underlying t-test.
- b) The means of two random samples of size 9 and 7 are 196.42 and 198.82 respectively. The sum of squares of the deviations from the mean are 26.94 and 18.73 respectively. Can the samples be considered to have drawn from the same normal population? Test the hypothesis at 5% level of significance.
10. a) Define correlation between two variables. Also explain the significance of the study of correlation in statistical analysis?
- b) The following table gives the aptitude test scores and productivity indices of 10 workers selected at random:

Aptitude Scores (X)	60	62	65	70	72	48	53	73	65	82
Productivity index (Y)	68	60	62	80	45	40	52	62	60	81

Find the regression equation of Y on X and estimate the productivity index of a worker whose test score is 92.

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Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. Describe the methods of construction of pie diagram. Compute the coefficient of variation from the data given below. [3+3]

X	10	11	12	13	14
Frequency	3	12	18	12	3

**OR**

Write the importance and application of statistics in the field of engineering. Following are duration in minutes that a person had to wait for a bus go to work on 15 working days:

10, 1, 13, 9, 5, 9, 2, 10, 3, 8, 6, 17, 2, 10 and 15.

Find the mean and variance.

2. Define mutually exclusive and independent events. A manufacturing firm produces steel pipes in three plants with daily production volumes of 500, 1000 and 2000 units respectively. According to past experience, it is known that the fraction of defective output produced by the three plants are respectively 0.005, 0.008, 0.010. If a pipe is selected from a day's total production and found to be defective. Find out the probability that the pipe might have come from plant II. [3+3]

3. Define Binomial distribution. Write the condition for Binomial distribution. [2+3]

4. Suppose that we are investigating the safety of a dangerous intersection of a road. Past police records indicate a mean of 5 accidents per month at this intersection. Suppose the number of accidents is distributed according to a Poisson distribution. Calculate the probability in any month of exactly 0 and between 2 to 4 accidents. [5]

5. Define Continuous Probability distribution function. Write down the properties of continuous probability distribution function.

The proportion of people who respond to a certain mail-order solicitation is a continuous random variable X has the probability density function. [2+3]

$$f(x) = \begin{cases} \frac{2(x+2)}{5}, & 0 < x < 1 \\ 0 & \text{elsewhere} \end{cases}$$

- Show that  $P(0 < x < 1) = 1$
- Find the probability that more than  $1/4$  but fewer than  $1/2$  of the people contacted will respond to this type of solicitation.

**OR**

The average diameter of a certain type of pipe is 2.5 inches and standard deviation is 0.75. Assuming that the diameter of pipes is normally distributed, find the probability of pipes with diameters

- a) greater than 2 inches
  - b) less than 2.75 inches
  - c) between 2.4 and 2.7 inches
6. Define normal distribution and standard normal distribution. Write down area properties of normal distribution. [2+3]
7. Define the following terms with suitable examples. [4]
- a) Statistics
  - b) Parameter
8. A population consists of 3, 7, 11, 15. Consider all possible samples of size two which can be drawn without replacement from this population. Find [2x3]
- a) Population mean
  - b) Mean of sampling distribution of mean
  - c) Standard error of sampling distribution of mean
9. Past experience shows the following result of productivity per hectare with the respective uses of chemical fertilizers and seeds. Fit the multiple linear regression equation of Y on X<sub>1</sub> and X<sub>2</sub> from the given data: [6]

Fertilizer (X <sub>1</sub> ), kgs	45	30	70	75	65	80
Seeds (X <sub>2</sub> ), kgs	2	1.8	3	2.5	2	3
Productivity kgs (Y)	2000	2100	1800	1900	2400	2500

10. Define regression coefficient. Mention the properties of regression coefficient. [4]
11. Explain in brief the properties of good estimator. [4]
12. Suppose that three drying formula for curing glue are studied and the following times are observed. [6]

Formula	Time					
A	13	10	8	11	8	-
B	13	11	14	14	-	-
C	4	1	3	4	2	4

Construct ANOVA table and test for the equality of the mean curing times.

**OR**

A consumer group selected independent random samples of supermarkets located throughout a country for the purpose of comparing the retail prices per pound of coffee of brands A and B. The results of the investigation are summarized in table below. Does this evidence indicate that the mean retail price per pound of brand A coffee is significantly higher than the mean retail price per pound of brand B coffee? Use significance level 0.1.

	Brand A	Brand B
Sample size	75	64
Mean	\$3.00	\$2.95
Standard deviation	\$0.11	\$0.09

13. The table given below shows the data obtained during outbreak of small-pox in a locality. [5]

	Attacked	Not Attacked
Vaccinated	31	469
Not Vaccinated	185	1315

Test the effectiveness of vaccination in preventing the attack from small pox at significance level  $\alpha = 0.05$ .

**OR**

Two bonding agents, A and B are available for making a laminated beam. Out of 50 beams made with Agent A, 11 failed a stress test, whereas 19 of the 50 beams made with Agent B failed. At the 0.05 level, can we conclude that Agent A is better than Agent B?

14. Write down the steps for testing hypothesis of population proportion for a large sample size. [5]

15. An article in computer and industrial engineering (in 2001) describes the time-to-failure data (in hours) for jet engines. Some of the data observed are presented below: [3+3+2]

Engine	Failure Time	Engine	Failure Time
1	150	13	213
2	291	14	271
3	93	15	197
4	53	16	200
5	2	17	262
6	65	18	255
7	183	19	286
8	144	20	206
9	223	21	179
10	197	22	232
11	187	23	165
12	197	24	155
		25	203

- a) Find Sample mean, sample variance and sample standard deviation.
- b) Exclude the lowest six data and compute (a) again.
- c) Analysis the results (a) and (b). Draw your conclusion.

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Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE, BME, BIE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. An engineer tested nine samples of each of three designs of a certain bearing a new electrical winch. The following data are the number of hours it took for each bearing to fail when the winch motor was run continuously at maximum output, with a load on the winch equivalent 1.9 times the intended capacity. [2x3]

A	16	16	53	21	17	25	30	21	45
B	18	27	34	34	32	19	34	17	43
C	21	17	23	32	21	18	21	28	19

- i) Calculate the mean and the median for each group
- ii) Calculate the standard deviation for each group
- iii) Which design is best and why?

2. Define mutually exclusive and independent events with examples. A manufacturing firm produces steel pipes in three plants with daily production volumes of 500, 1000 and 2000 units respectively. According to past experience, it is known that the fraction of defective output produced by the three plants are respectively 0.005, 0.008, 0.010. If a pipe is selected from a day's total production and found to be defective, find out the probability that the pipe might have come from plant II and III. [6]
3. Define Poisson probability distribution with the condition for Poisson distribution. A shipment of 20 digital voice recorders contains 5 that are defective. If 10 of them are randomly chosen for inspection, what is the probability that 2 of the 10 will be defective? [4+6]

**OR**

Which probability distribution is most likely the appropriate one to use for following variables: Binomial, Poisson?

- a) The number of auto passing through a tollbooth.
  - b) The number of defective radios in a lot of 100.
  - c) A box contains 8 good bulbs and 4 defective bulbs, 3 bulbs are drawn at random. Let  $X$  be the random variable denoting the number of defective bulbs drawn. Find the probability distribution of  $X$ . What are the mean and variance of it?
4. Write down the four important properties of normal distribution. [4]

**OR**

Define gamma-distribution. Write its two applications.

5. If  $X$  has a probability density function: [6]

$$f(x) = ke^{-3x} \quad \text{for } X > 0$$

$$0 \quad \text{Otherwise}$$

Find: (i)  $k$  (ii)  $p(0.5 \leq x \leq 1)$  (iii) The distribution function of random variable  $x$ .

**OR**

The burning time of an experimental rocket is a random variable having a normal distribution with mean 4.76 sec and standard deviation 0.04 sec. What is the probability that this kind of rocket will burn (i) less than 4.66 sec (ii) More than 4.8 sec (iii) Between 4.7 to 4.8 sec

6. What do you mean by the sampling distribution of sample mean? [4]
7. A population consists of 3, 7, 11, 15. Consider all possible samples of size two which can be drawn without replacement from this population. Find: [2x3]
- Population mean and population standard deviation.
  - Mean of sampling distribution of mean.
  - Standard error of sampling distribution of mean.
8. Ten steel wires of diameter 0.5mm and length 2.5m were extended in a laboratory by applying vertical forces of varying magnitudes. Results are as follows: [5]

Force (kg)	15	19	25	35	42	48	53	56	62	65
Increase in length (mm)	1.7	2.1	2.5	3.4	3.9	4.9	5.4	5.7	6.6	7.2

- Estimate the parameters of a simple linear regression model with force as the explanatory variable.
- Find 95% confidence limits for the slope of line.

*OR*

The following concentration of pollutants were recorded at eight stations of the monitoring system for pollution control located in the downtown area of Milan, Italy:

NO <sub>2</sub> ( $\mu\text{g}/\text{m}^3$ )	130	130	115	120	135	142	90	116
CO ( $\text{mg}/\text{m}^3$ )	2.9	4.4	3.6	4.1	3.3	5.7	4.8	7.3

Determine correlation coefficient and coefficient of determination between the pollutants and interpret the result using coefficient of determination.

- Distinguish between correlation and regression. Write down the important properties of correlation coefficient and regression coefficients. [3]
- Discuss on type I error and type II error of test of hypothesis. The mean of two large samples of size 1000 and 2000 are 67.5 and 68 respectively. Test the equality of means of two population mean with standard deviation 2.5 at 0.01 level of significance. [6]
- The output of three varieties of wheat each grown on 4 plots of land is given below. Analyze the data and setup an ANOVA table. State if the variety differences are significant at  $\alpha = 0.05$  level. [6]

Varieties of wheat	Yield tones/ hectre			
	A	B	C	
A	6	7	3	8
B	5	5	3	7
C	5	4	3	4

- Write down the steps for testing hypothesis of population for the large sample size. [4]
- A random sample of 700 units from a large consignment showed that 200 were damaged. Find 95% and 99% confidence limits for the proportion of damaged unit in the consignment. [4]
- The following measurements were taken of the horizontal legs x and vertical legs y of numerous welding joints for steel buildings. The main objective was to make the legs equal to 6mm. A part of the results is listed below in millimeters. [2x4]

x =	5.5	5.0	5.0	6.0	7.0	5.2	5.5	5.5	6.0	6.0
	4.5	6.0	5.5	7.7	7.5	6.0	5.6	5.0	5.5	5.5
	6.0	6.5	5.5	5.0	5.5	5.5	6.5	6.5	7.0	5.5
y =	6.5	6.5	5.5	7.5	6.0	7.0	5.0	8.0	6.7	7.8
	5.7	6.5	5.5	8.0	8.0	6.3	6.0	6.0	6.0	5.5
	6.5	6.0	6.0	6.0	6.0	6.5	6.5	6.0	6.0	6.5

Find: (i)  $\sum X$ ,  $\sum X^2$ , mean of leg X (ii)  $\sum Y$ ,  $\sum Y^2$ , mean of leg Y (iii)  $\sigma_n$ ,  $\sigma_{n-1}$  for leg X and leg Y (iv) Which leg is consistent?

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**Examination Control Division**

2067 Mangsir

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE, BME	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject:** - Probability and Statistics

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Seven questions selecting Four from Group A and Three from Group B.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary charts are attached herewith.
- ✓ Assume suitable data if necessary.

**Group A**

1. a) Discuss the importance and limitation of statistical chart. Write the procedure of construction of pie chart. [5]

- b) The following are the annual maximum flows in m<sup>3</sup>/s in the Colorado river at black canyon for the 11 year period from 1990 to 2000: [6]

1980 1130 3120 2120 1700 2550 8500 3260 3960 2270 1700

- i) Compute mean maximum flow of the 11 years  
ii) Compute the variation of flow

2. a) State Baye's theorem and write the suitable example. [5]

- b) Orders for a computer are summarized by the optional features that are requested as follows: [6]

Proportion of orders

no optional features	0.3
one optional feature	0.5
more than one optional feature	0.2

- i) What is the probability that an order requests at least one optional feature?  
ii) What is the probability that an order does not request more than one optional feature?

3. a) Distinguish between probability mass function and probability density function with one example each. [5]

- b) In computing work, I must get on a bus near my house and then transfer to second bus. If the waiting time (in minute) at each bus stop has uniform distribution  $A = 0$  and  $B = 5$ . Then it can be shown that my total waiting time  $Y$  has probability density function. [6]

$$f(x) = (1/25)y \text{ for } 0 < y < 5 \\ = (2/5) - (1-25)y \text{ for } 5 < y < 10$$

- i) What is the probability that waiting time is at most three minutes?  
ii) What is the probability that total waiting time is at most 8 minutes?

4. a) Define the Poisson distribution with suitable example. Discuss the limiting case of Poisson distribution as Binomial distribution. [5]

- b) Suppose that we are investigating the safety of a dangerous intersection. Past police records indicate a mean of 5 accidents per month at this intersection. Suppose the number of accidents is distributed according to a Poisson distribution. Calculate the probability in any month of exactly (i) Zero (ii) More than 1 (iii)  $P(2 \leq x \leq 3)$ . [6]

5. a) Explain the area property of normal distribution and give the conditions for Binomial distribution tends to normal distribution. [5]

- b) An industrial engineer has found that the standard household light bulbs produced by a certain manufacturer have a useful life that is normally distributed with a mean of 250 hours and a variance of 400. [5]
- What is the probability that a randomly selected bulb from this production process will have a useful life in excess of 300 hours?
  - What is the probability that a randomly selected bulb from this production process will have a useful life between 190 and 270 hours?
  - What is the probability that a randomly selected bulb from this production process will have a useful life of not exceeding 260 hours?
6. a) Define joint marginal probability mass function and joint marginal probability density function for random variables X and Y. [6]
- b) If two random variables X and Y have the joint density
- $$f(x, y) = \begin{cases} 2 - x - y; & 0 \leq X \leq 1, \quad 0 \leq Y \leq 1 \\ 0 & \text{otherwise} \end{cases}$$

Find the

- marginal probability density function for X.
- mean  $E(X, Y)$  for X and Y

### Group B

7. a) What are the criteria for the best estimator? Find the maximum likelihood estimator for the function  $f(x) = \lambda e^{-\lambda x}$ . [6]
- b) The breaking strength of yarn used in manufacturing drapery material is required to be at least 100 psi. Past experience has indicated that breaking strength is normally distributed and that  $\sigma = 2$  psi. A random sample of nine specimens is tested, and the average breaking strength is found to be 98 psi. Find a 95% two-sided confidence interval for the true mean breaking strength and infer the result. [6]
8. a) Explain the following terms in connection with testing of hypothesis: [6]
- null hypothesis
  - alternate hypothesis
  - critical region
- b) A sample of heights of 6,400 Englishmen has a mean of 67.85 inches and standard deviation of 2.56 inches, while sample heights of 1600 Austrians has a mean of 68.55 inches and standard deviation of 2.52 inches. Do the data indicate that Austrians are on an average taller than Englishmen? Test the hypothesis at 5% level of significance. [6]
9. a) Describe briefly the procedure of t-test for the difference of means. [6]
- b) A study shows that 12 workers using Design A have a mean assembly time of 300 seconds with standard deviation of 12 seconds and that 15 workers using Design B have mean and standard deviation of 335 and 15 seconds respectively. Test whether assembly time for Design A is less than that for Design B at 5% level of significance. [6]
10. a) What is the linear regression analysis? Write the application of regression analysis in engineering field, supporting your logic with one suitable example. [6]
- b) An article in the Journal of Environmental Engineering (Vol. 115, No. 3, 1989, pp. 608-619) reported the results of a study on the occurrence of sodium and chloride in surface streams in central Rhode Island. The following data are chloride concentration y (in milligrams per liter) and roadway area in the watershed x (in percentage). [6]

X	4.4	6.6	9.7	10.6	10.8	10.9	11.8	12.1
Y	0.19	0.15	0.57	0.70	0.67	0.63	0.47	0.70

Find the correlation coefficient and coefficient of determination of given data and draw your conclusion.

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Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE, BME	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Probability and Statistics

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Seven questions selecting Four from Group A and Three from Group B.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Necessary tables are attached herewith.
- ✓ Assume suitable data if necessary.

Group A

1. a) Discuss the significant differences between mean, median and mode. In a set of 10 data, one of them is very high, which central measure is suitable and why? [6]
- b) The means of two samples of size 50 and 100 respectively are 54.1 and 50.3 and the standard deviations are 8 and 7. Obtain the standard deviation of the sample size 150 obtained by combining the two samples. [5]
2. a) State and prove Baye's theorem.
- b) A husband and wife appear in an interview for the two vacancies in the same post. The probability of husband's selection is  $1/7$  and that of wife's selection is  $1/5$ . What is the probability that
  - none of them will be selected
  - only one of them will be selected
  - both of them will be selected
3. a) Define probability mass function for a random variable X. A random variable X has the following probability function: [6]

X	0	1	2	3	4	5	6	7
P(X)	K	K	$2K$	$2K$	$3K$	$K^2$	$2K^2$	$7K^2$

Find: i) K ii)  $P(X \geq 1)$  iii)  $P(3 \leq X < 6)$

- b) If the probability density of a random variable X is given by

$$f(x) = \begin{cases} x & \text{for } 0 < x < 1 \\ 2-x & \text{for } 1 \leq x < 2 \\ 0 & \text{otherwise;} \end{cases}$$

Obtain the corresponding cumulative distribution function and compute

$$\text{i) } P(0.6 < X < 1.2) \quad \text{ii) } P(X > 0.5)$$

4. a) Write similarities and dissimilarities between Binomial distribution and Negative Binomial distribution.

- b) Suppose that 70% of the first-class mail from New York to California is delivered within 4 days after being mailed. If 20 pieces of first-class mail are mailed from New York to California.

- Find the probability that at least 15 pieces of mail arrive within 4 days of the mailing date.
- Find the probability that 10 or fewer pieces of mail arrive later than 4 days after the mailing date.

5. a) Define the Normal distribution and standard Normal distribution. Write the properties of Normal distribution. [6]

6. a) A restaurant serves three fixed price dinners costing \$7, \$9 and \$10. For a randomly selected couple dining at this restaurant, let  $X$  = the cost of the man's dinner,  $Y$  = the cost of woman's dinner. The joint p.m.f. of  $X$  and  $Y$  is given in the following table:

[5]

P(x,y)		y		
		7	9	10
x	7	0.05	0.05	0.10
	9	0.05	0.01	0.35
	10	0.00	0.20	0.10

- i) Compute the marginal probability mass functions of  $X$  and  $Y$ .  
ii) What is the expected total cost of the dinner for the two people?  
iii) Are  $X$  and  $Y$  independent?
- b) Each front tire on a particular type of automobile is supposed to be filled to a pressure of  $26\text{Psi}$ . Suppose the actual air pressure in each tire is a random variable  $X$  for the right tire and  $Y$  for the left tire with joint p.d.f.

[6]

$$f(x, y) = \begin{cases} K(x^2 + y^2), & 20 \leq x \leq 30, 20 \leq y \leq 30 \\ 0, & \text{otherwise} \end{cases}$$

- i) What is the value of  $K$ ?  
ii) What is the probability that both tires are under-filled?  
iii) What is the probability that the difference in air pressure between the two tires is at most 2 p.s.i.?

### Group B

7. a) Explain the terms : (i) the standard error of estimate and the sample size (ii) point estimation and interval estimation (iii) confidence level and significance level.

[6]

- b) Find the maximum likelihood estimator for  $\mu$  and  $\sigma^2$  from a normal distribution

$$f(x; \mu, \sigma^2) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}; -\infty < x < \infty$$

[6]

8. a) What is a statistical hypothesis? Discuss the steps involved in testing a hypothesis.

[6]

- b) A television manufacturer claims that at most 250 microamperes of current are needed to attain a certain brightness level with a particular type of set. A sample of 20 sets yields a sample average  $\bar{X} = 257.3$ . Let  $\mu$  denote the true average current necessary to achieve the desired brightness with sets of this type and assume that  $\mu$  is the mean of normal population with  $\sigma^2 = 15$ .

[6]

- i) Test at level  $\alpha = 0.05$  the null hypothesis that  $\mu$  is at most 250 against the appropriate alternative.  
ii) If  $\mu = 260$ , what is the probability of type II error?

9. a) Distinguish between large sample and small sample tests of significance. Also list the assumptions made for large sample tests.

[6]

- b) A study was conducted to investigate the effect of two diets on the weight gain of a 14-year old children suffering from malnutrition. Ten children were subject to diet X and nine to diet Y. The gain in weight over a nine month period are shown in the table below:

[6]

Diet X	14.0	11.2	12.5	15.0	10.2	22.0	9.8	13.0	10.5	9.6
Diet Y	14.4	11.6	18.2	12.8	19.5	13.1	21.2	11.3	15.3	

Use the data to determine if there is evidence to indicate a difference between the mean gain in weight for children fed on two diets. (use  $\alpha = 0.05$ )

10. a) Write down the properties of correlation coefficient  $r$  and discuss the application of it in engineering field.

[6]

- b) The following table shows the ages  $x$  and systolic B.P.  $y$  of 12 women. Determine the least squares regression line of  $y$  on  $x$ . Estimate the B.P. of a woman whose age is 45 year.

[6]

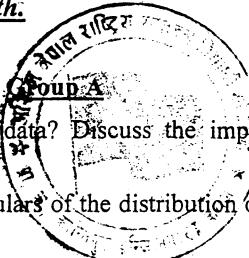
Age (x)	56	42	72	36	63	47	55	49	38	42	68	60
BP (y)	147	125	160	118	149	128	150	145	115	140	152	155

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Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, BME	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

**Subject: - Probability and Statistics**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Seven questions selecting Four from Group A and Three from Group B.
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1. a) What are the sources of statistical data? Discuss the importance of diagrammatical and graphical representation of these data. [5]
- b) The following are some of the particulars of the distribution of weights of boys and girls in a class: [6]

	Boys	Girls
No. of Students	100	50
Mean weight	60 kg	45 kg
Variance	9	4

- i) Find the mean and standard deviation of combined data.  
ii) Which of the two distributions is more variable?
2. a) State the axioms of probability. Define with examples the conditional probabilities and independent events. [5]
- b) State Baye's theorem. A test shows that 99% of time if one has plague virus and shows positive 10% of time it has no virus. Assume that only 1% of the population has virus. [6]
  - i) What is the probability that the test will show positive?  
ii) If a randomly selected person is tested and the result is positive, what is the probability that the person has the virus?
3. a) Define the discrete and continuous random variables and their corresponding probabilities distributions with examples. [5]
- b) A computer store has purchased 3 computers of a certain type at \$500 apiece to sell at \$1000 apiece. The manufacturer has agreed to repurchase any unsold computers at the end of two-month period at \$200 apiece. Let  $X$  = the number of computers sold and has the p.m.f. as follows: [6]

x	0	1	2	3
p(x)	0.1	0.2	0.3	0.4

Compute: (i) mean sell (ii) variance of the sell (iii) the expected profit.

4. a) Define the binomial experiment and the binomial probability distribution of a discrete random variable  $X$ . State the basic differences of this distribution with the hyper geometric and negative binomial distribution. [5]
- b) Let a continuous random variable  $X$  be defined by  $f(x) = \begin{cases} 2(1-x) & , 0 \leq x \leq 1 \\ 0 & , \text{otherwise} \end{cases}$  [6]

Show that  $f(x)$  is the probability distribution function of  $x$ .

Also compute: (i) the density function  $f(x)$  (ii)  $P(0.25 \leq x \leq 0.5)$  (iii) the mean  $\mu$

5. a) Define the normal distribution. Describe in brief its characteristics and applications. [5]
- b) Suppose that the pH of soil samples taken from a certain geographic region is normally distributed with mean pH 6.0 and standard deviation 0.10. If the pH of a randomly selected soil sample from this region is determined [6]
  - i) What is the probability that the resulting pH is between 5.90 and 6.15?
  - ii) What is the probability that the resulting pH exceeds 6.10?
  - iii) What is the probability that the resulting pH is at most 5.95?

6. a) A restaurant serves three fixed price dinners costing \$7, \$9 and \$10. For a randomly selected couple dining at this restaurant, let  $X$  = the cost of the man's dinner,  $Y$  = the cost of woman's dinner. The joint p.m.f. of  $X$  and  $Y$  is given in the following table:

[5]

P(x,y)		y		
		7	9	10
x	7	0.05	0.05	0.10
	9	0.05	0.01	0.35
	10	0.00	0.20	0.10

- i) Compute the marginal probability mass functions of  $X$  and  $Y$ .  
ii) What is the expected total cost of the dinner for the two people?  
iii) Are  $X$  and  $Y$  independent?
- b) Each front tire on a particular type of automobile is supposed to be filled to a pressure of  $26\text{Psi}$ . Suppose the actual air pressure in each tire is a random variable  $X$  for the right tire and  $Y$  for the left tire with joint p.d.f.

[6]

$$f(x,y) = \begin{cases} K(x^2 + y^2), & 20 \leq x \leq 30, 20 \leq y \leq 30 \\ 0, & \text{otherwise} \end{cases}$$

- i) What is the value of  $K$ ?  
ii) What is the probability that both tires are under-filled?  
iii) What is the probability that the difference in air pressure between the two tires is at most 2 p.s.i.?

#### Group B

7. a) Explain the terms : (i) the standard error of estimate and the sample size (ii) point estimation and interval estimation (iii) confidence level and significance level.

[6]

- b) Find the maximum likelihood estimator for  $\mu$  and  $\sigma^2$  from a normal distribution

$$f(x; \mu, \sigma^2) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}; -\infty < x < \infty$$

[6]

8. a) What is a statistical hypothesis? Discuss the steps involved in testing a hypothesis.

[6]

- b) A television manufacturer claims that at most 250 microamperes of current are needed to attain a certain brightness level with a particular type of set. A sample of 20 sets yeilds a sample average  $\bar{X} = 257.3$ . Let  $\mu$  denote the true average current necessary to achieve the desired brightness with sets of this type and assume that  $\mu$  is the mean of normal population with  $\sigma^2 = 15$ .

[6]

- i) Test at level  $\alpha = 0.05$  the null hypothesis that  $\mu$  is at most 250 against the appropriate alternative.

- ii) If  $\mu = 260$ , what is the probability of type II error?

9. a) Distinguish between large sample and small sample tests of significance. Also list the assumptions made for large sample tests.

[6]

- b) A study was conducted to investigate the effect of two diets on the weight gain of a 14-year old children suffering from malnutrition. Ten children were subject to diet X and nine to diet Y. The gain in weight over a nine month period are shown in the table below:

[6]

Diet X	14.0	11.2	12.5	15.0	10.2	22.0	9.8	13.0	10.5	9.6
Diet Y	14.4	11.6	18.2	12.8	19.5	13.1	21.2	11.3	15.3	

Use the data to determine if there is evidence to indicate a difference between the mean gain in weight for children fed on two diets. (use  $\alpha = 0.05$ )

10. a) Write down the properties of correlation coefficient  $r$  and discuss the application of it in engineering field.

[6]

- b) The following table shows the ages  $x$  and systolic B.P.  $y$  of 12 women. Determine the least squares regression line of  $y$  on  $x$ . Estimate the BP of a woman whose age is 45 year.

[6]

Age (x)	56	42	72	36	63	47	55	49	38	42	68	60
BP (y)	147	125	160	118	149	128	150	145	115	140	152	155

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**Group A**

1. a) Point out limitations of statistics. Explain how statistics is liable to be misused and how can the wrong uses of statistics be avoided? [5]
- b) Samples of polythene bags from two manufactures, A and B are tested by a prospective buyer for bursting pre-structure and the results are as follows: [6]

Bursting Pressure (lb)	5-9	10-14	15-19	20-24	25-29	30-34
Number of bags	A	2	9	29	54	11
	B	9	11	18	32	27
						13

Which set of bags has uniform pressure? If prices are same which manufacture's bags would be preferred by the buyers?

2. a) State and prove Baye's theorem of probability. [5]
- b) A university has to select an examiner from a list of 50 persons: 20 of them are women and 30 men; 10 of them know Nepali and 40 not; 15 of them are teachers and 35 not. What is the probability that a Nepali knowing woman teacher is selected by the university? [6]
3. a) Differentiate discrete and continuous random variables with relevant examples. [5]
- b) What do you mean by probability distribution of a discrete random variable? Three defective items are mixed with seven good ones. Three items are drawn at random. Find the probability distribution of number of defective items. Also, find the mean and variance of the distribution. [6]
4. a) Define negative binomial distribution and state condition of applicability for it. How does negative binomial distribution differ from binomial distribution? [5]
- b) The probability that an individual suffers from a bad reaction from a particular injection is 0.001. Find the probability that out of 1500 individuals (i) exactly two (ii) none (iii) at least one (iv) at most two will suffer from a bad reaction. [6]
5. a) Define normal distribution for a continuous random variable. Discuss the area property and importance of the normal curve. [5]
- b) A corporation installs 10000 electric lamps in the street of a city. If these lamps have an average life of 1850 burning hours with a standard deviation of 200 hours, what number of lamps may be expected to burn for (i) more than 2000 hours (ii) less than 1600 hours (ii) between 1540 and 1800 hours? [6]

5. a) The number of a group of 10,000 persons was found to be normally distributed with mean Rs. 750/- per month and standard deviation Rs. 50/-. Find (i) the number of persons with income less than Rs. 700/- per month (ii) the number of persons with income between Rs. 700/- and Rs. 800/- per month.
- b) At a certain examination, 10% of the students who appeared for the paper in statistics get less than 30 marks and 97% of the students got less than 62 marks. Assuming the distribution to be normal, find the mean and standard deviation of the distribution.
6. a) Find K so that  $f(x,y) = k xy$ ,  $1 \leq x \leq y \leq 2$  will be a probability density function.
- b) If two random variable X and Y have for  $X = x$  and  $Y = y$ , then joint probability density function.  $f(x,y) = \frac{1}{2x^2y}$ ; for  $1 \leq x < \alpha$  and  $1/x < y < x$

Derive marginal distribution of X and Y. Further obtain the conditional distribution of Y for  $X = x$  and also that of X given  $Y = y$ .

#### Group B

7. a) Define point estimate and interval estimate with suitable examples.
- b) It has been estimated by cable companies that 60% of all Nepalese households are wired to receive cable T.V. You would like to test this claim within 5% error and 99% level of confidence. How large a sample would you require?
8. a) An education claims that the average I.Q. of a city college students is at most 110 and that in a study made to test this claim 150 college students, selected at random, had an average I.Q. of 111.2 with a standard deviation of 7.2. Use a level of significance of 0.01 to test the claim of education.
- b) In random sample of 1000 persons from town A, 40% were found to be consumer of rice. In another random sample of 1000 persons from town B, 50% were found to be consumers of rice. Do these data reveal a significant difference in the proportion of rice consumers in these two towns?
9. a) Two types of batteries are tested for their length of life and the following data are obtained.

	No. of samples	Mean life in hrs.	Variance
Type A	9	600	121
Type B	8	640	144

Is there a significant difference in the two means?

- b) In a manufacturing company the new modern manager is in a belief that music enhances the productivity of the workers. He made observation on six workers for a week and recorded the production before and after the music was installed from the data below, can you conclude that the productivity has indeed changed due to music.

Employee	1	2	3	4	5	6
Week without music	219	205	226	198	209	216
Week with music	235	186	240	203	221	205

10. a) Define regression lines. Write about the properties of regression coefficients.
- b) The production supervisor of a Brigham Container Company is convinced of the need to assign strenuous jobs - according to age. He randomly selected 10 workers and measure the amount of time they were able to maintain a strenuous loading capacity.

Strenuous minutes	2	7	5	9	10	4	4	8	6	5
Age in yrs	42	27	36	25	22	39	19	19	33	30

- i) Develop the equation which describes the best relationship between age and physical stamina.
- ii) How long might a 30 years old man be expected to maintain strenuous physical activity.

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Group A

1. a) An analysis of the monthly wages paid to workers in two firms A and B belonging to the same industry gives the following result.

	Firm A	Firm B
No. of workers	160	150
Average wage	260	275
Variance of wage distributor	100	121

Calculate the mean and variance of all the workers taken together.

- b) The lives of two models of refrigerators in a recent survey are

Life (No. of yrs)	0-2	2-4	4-6	6-8	8-10	10-12
Model X	5	16	13	7	5	4
Model Y	2	7	12	19	9	1

2. a) State and proof Bayes' theorem. *(A) which model has longer average life*

- b) A factory produces a certain type of output by three machines respecting. Daily production figures are Machine X : 1500 units; Machine Y : 3000 units; Machine Z : 4500 units. Past experiences show that 1.5% of the output produced by Machine X, 2% of the output produced by Machine Y and 2.2% produced by Machine Z are defective. An item is drawn at random, what is the probability that it comes from the output of Machine Y.

3. a) A die is thrown 6 times. If getting an odd number is a success. What is the probability of getting (i) 5 successes (ii) at least 5 successes (iii) at most 5 successes?

- b) A manufacture finds that the average demand per day for the mechanics to repair his new product is 1.5 over a period of one year and demand per day is distributed as Poisson variate. He employs two mechanics. In how many days in one year (i) both the mechanics would be free (ii) some demand is refused.

4. a) A continuous random variable X has the probability density function  $f(x) = A + Bx$ ;  $0 \leq x \leq 1$ . If the mean of the distribution is  $\frac{1}{2}$ ; find A and B.

- b) A continuous distribution of a variable X is defined by

$$\begin{aligned} f(x) &= \frac{1}{16}(3+x)^2; \quad -3 \leq x \leq -1 \\ &= \frac{1}{16}(6-2x^2); \quad -1 \leq x \leq 1 \\ &= \frac{1}{16}(3-x)^2; \quad 1 \leq x \leq 3 \end{aligned}$$

- i) Verify that the area under the curve is unity.

- ii) Find the mean and variance of the above distribution.

- Z a) Define the joint probability mass function and marginal probability function for a bivariate distribution. [5]
- b) Let X denote the reaction time in seconds, to a certain stimulant and Y denote the temperature ( $^{\circ}\text{F}$ ) at which a certain reaction starts to take place. Suppose that two random variable X and Y have the joint density. [6]

$$f(x, y) = \begin{cases} 4x, & 0 < x < 1; 0 < y < 1 \\ 0, & \text{Elsewhere} \end{cases}$$

3 Find i)  $P(0 \leq X \leq \frac{1}{2} \text{ and } \frac{1}{4} \leq Y \leq \frac{1}{2})$   $\frac{1}{2}$   
ii)  $P(X < Y)$

### Group B

- a Explain, with illustrations, the concept of (i) Point estimation and (ii) Interval estimation. [6]
- b) In 39 soil samples tested for trace elements, the average amount of copper was found to be 22 milligrams, with a standard deviation of 4 milligrams. Find a 90%, 95% and 99% confidence interval for the true mean copper content in the soils from which these samples were taken. [6]
8. a) Explain the following terms:  $(23.0536, 20.946)$ ,  $(23.255, 20.744)$  [6]
- i) Statistic and parameter  $(23.649, 20.350)$   
ii) Level of significance  
iii) Critical region
- b) A machine shop is interested in determining a measure of the current year's sales revenue in order to compare it with known results from last year. From the 9682 sales invoices for the current year to date, the management randomly selected invoices and from each recorded  $x$ , the sales revenue per invoice. Using the following data summary, test the hypothesis that the mean revenue per invoice is \$6.35, the same as last year, versus the alternative hypothesis that the mean revenue per invoice is different from \$6.35, with  $n = 400$ ,  $\alpha = 0.05$ . [6]

Data Summary:

$$n = 400 \quad \sum_{i=1}^{400} x_i = \$2464.40 \quad \sum_{i=1}^{400} x_i^2 = 16,156.728$$

- 5 a) Explain the assumption of t test, distinguish clearly between large sample and small sample test of significance. [6]
- b) To investigate a possible "built-in" sex bias in a graduate school entrance examination, 50 male and 50 female graduate students who were rated as above average graduate students by their professors were selected to participate in the study by actually taking this test. Their test results on this examination are summarized in the following table. [6]

$$\mu_A - \mu_B > 0$$

	Males	Females
$\bar{x}$	720	693
$s^2$	104	85
n	50	50

$$Z_M = 1.383$$

$$Z_F = 1.645$$

Do these data indicate that males will, on the average, score higher than females of the same ability on this exam? Use  $\alpha = 0.05$ .

10. a) Prove that the Karl Pearson's coefficient of correlation cannot exceed the limits  $-1 < \gamma \leq 1$ . [6]
- b) The Report "refuse derived fuel evaluation in an Industrial Spreader - Stoker Boiler" reported the accompanying data on  $x = \% \text{ refuse derived fuel (RDF) heat input}$  and  $Y = \% \text{ efficiency}$  for certain boiler. [6]

RDF	X:	37	30	48	29	27	16	0	20
	Y:	78.0	77.2	74.4	77.7	76.9	79.0	82.1	76.5

n Obtain the equation of the estimated regression line. Estimate the true % efficiency when % RDF heat input is 25.

$$77.343$$

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