TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2080 Bhadra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL,BEX,BCT BAG, BCH | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

***Subject:*** - Probability and Statistics *(SH 602)*

- ✓ 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 difference between mean, median and mode with suitable examples. The arithmetic mean and standard deviation of 100 items was 40 and 5. Later on, it was found that an item 53 was misread as 83. Find the correct mean and standard deviation. [3+3]
2. State Baye's Theorem. If there are three machines producing chips, first machine produce 2000, second machine produce 3000 and third machine produce 5000 chips per day. Past experience showed that they produce 95%, 97% and 99% non-defective chips. If a randomly chosen chips is found to be non-defective, what is the probability that it comes from [6]
   (i) First Machine
   (ii) Second machine
   (iii) Third machine
3. Define and compare Binomial and Negative Binomial distribution with similarity and differences. [5]
4. For the case of the thin copper wire, suppose that the number of flaws follows a Poisson distribution with a mean of 2.3 flaws per millimeter. Determine the probability of (i) Exactly 2 flaws in 1 millimeter of wire;(ii) At least 2 flaws in 1 millimeter of wire; (iii) At most 2 flaws in 1 millimeter of wire. [5]
5. A continuous random variable X has probability density function defined as follows. [5]

$$f(x) = \begin{cases} k\, e^{-\frac{9}{2}x} \text{ for } 0 \le x < \infty \\ 0, \text{Otherwise} \end{cases}$$

   (i) Find the value of constant k.

   (ii)Mean and the distribution function of X.
6. 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 variance of 2500. What is the probability that a randomly selected bulb from this production process will have a useful life (i) In excess of 300 hours (ii) Between 190 and 270 hours (iii) Not exceeding 260 hours? [5]
7. A population consists of four numbers 5, 9, 13, 17. [5]
   a) Write down all possible sample of size two without replacement.
   b) Verify that the sample mean is unbiased estimator of population mean.
   c) Calculate the standard error of sample mean.
8. If the resistance of resistors provided by a supplier follow Normal distribution with mean 23 Ohm and standard deviation of 5 Ohm. In a random sample of 40 such resistors, find the probability that the mean resistance of these sample is [5]

   (i) More than 26 Ohm

   (ii) Between 23.8 to 25.6 Ohm

   (ii) Less than 23.4 Ohm

9. A random sample of 12 records gives the average of 163.99 minutes with standard deviation of 3.043 minutes. Find the 95% confidence limits for population mean if population consists of 100 units. [5]

10. The following data are coded observations on the yield of a chemical process using 3 batches of raw material selected randomly:

| Batch: | Yield | | | | | |
|---|---|---|---|---|---|---|
| I | 9.7 | 5.6 | 8.4 | 7.9 | 8.2 | 7.7 |
| II | 10.4 | 9.6 | 7.3 | 6.8 | 8.8 | 9.2 |
| III | 15.9 | 14.4 | 8.3 | 12.8 | 7.9 | 11.6 |

Construct ANOVA table and test for the equality of the average yields of three batches of raw materials at a = 5%. [5]

11. In an experiment to study the dependence of hypertension on smoking habits, the following data were taken on 180 individuals:

| | Nonsmokers | Moderate smokers | Heavy smokers |
|---|---|---|---|
| Hypertension | 21 | 36 | 30 |
| No hypertension | 48 | 26 | 19 |

Test the hypothesis that the presence or absence of hypertension is independent of smoking habits. Use a 0.05 level of significance. [5]

12. Write down the fundamental steps of test of significance of difference of proportion of success for large samples. [5]

13. A study was done on a diesel-powered-light-duty pickup truck to see it humidity. Measurements were taken at different times with varying experimental conditions. The data are as follows: [5]

| Nitrous oxide (Y) | 0.90 | 0.91 | 0.96 | 0.89 | 1.00 | 1.10 | 1.15 | 1.03 | 0.77 | 1.07 |
|---|---|---|---|---|---|---|---|---|---|---|
| Humidity (X) | 72.4 | 41.6 | 34.3 | 35.1 | 10.7 | 12.9 | 8.3 | 20.1 | 72.2 | 24.0 |

a) Fit a straight line to the given data by the method of least squares and use it to predict the estimated amount of nitrous oxide for 50% humidity.

b) Find 95% confidence interval for slope of line β.

14. Define Karl Pearson Correlation coefficient and write down the basic properties of it. Also define and interprete the coefficient of determination. [5]

15. From the following records of randomly chosen day of a departmental store in millions of rupees. Use scientific calculator to compute the required sums. Also compute following measures by using the suitable statistical formulae. [8]

| Sales | 75 | 96 | 80 | 72 | 93 | 71 | 86 | 72 | 79 |
|---|---|---|---|---|---|---|---|---|---|
| | 98 | 77 | 84 | 70 | 96 | 85 | 84 | 94 | 71 |
| | 89 | 92 | 76 | 88 | 78 | 83 | 96 | 87 | 71 |
| | 66 | 97 | 76 | 64 | 77 | 89 | 73 | 75 | 85 |
| | 82 | 81 | 85 | 90 | 87 | 59 | 93 | 67 | 64 |
| | 94 | 77 | 66 | 62 | 92 | 56 | 58 | 82 | 75 |

(i) Sample mean and sample standard deviation.

(ii) Test the consistency of the sales.

(iii) Also find the 95% confidence limit of sales.

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## *Subject:* - Probability and Statistics *(SH 602)*

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1. What are the merits and demerits of arithmetic mean? Compute the five numbers summary of the following information and prepare the Box and Whisker diagram: 34,42,66,40,59,36,41,35,36,62,43,30,43,32,44,58,53,50,48 and 38. [2+4]
2. Describe addition and multiplication law of probability. A problem in statistics is given to three students A, B and C whose chance of solving it are 1/3,1/4 and 1/5 respectively. Find the probability that [3+3]
   (i) The problem will be solved.
   (ii) Only one of them can solve the problem.
   (iii) None of them will solve the problem.
3. Define Poisson distribution with example. Discuss the properties of Poisson distribution. [3+2]
4. From the past record, there is small chance of 1 in 500 will die due to certain disease? If 200 patients were admitted in a certain Hospital. Use suitable probability distribution to calculate the probability that [5]
   (i) No one will die from the disease.
   (ii) Exactly one patient will die.
   (iii) At least two of them will die.
5. In a certain city the daily consumption of water (in millions of gallons) follows approximately a gamma distribution with $\alpha = 2$ and $\beta = 3$. If the daily capacity of this city is 9 million gallons of water, show that the probability that on any given day the water supply is inadequate is 4. [5]
6. The breakdown voltage x of randomly chosen diode of a particular type is known to be normally distributed with mean 40 and standard deviation 1.5 volts. What is the probability that the breakdown voltage will be [5]
   (i) Between 39 and 42 voltage.
   (ii) At most 43 volts.
   (iii) At least 39 volts.
7. From the population of size 5 as:22, 23, 24, 25 and 26. [5]
   a) List out all the samples of size three without replacement.
   b) Find the sample proportion of even number.
   c) Prove that, sample proportion is unbiased estimator proportion of even number. $E(p) = P$.
   d) Also find the standard error of sample proportion of even number.
8. The time at the counter for a customer to be served at a post office can be modeled as a random variable having mean 176 seconds and variance 256. The sample mean will be obtained from the times for a random sample of 100 customers. What is the probability that sample mean will be (i) Less than 177 seconds; (ii) Between 175 and 178 seconds? (iii) More than 178 seconds. [5]
9. Describe the procedure of test of significance between two means for small samples. [5]

10. Four salesmen were posted in different areas by a company. The numbers of units of computer hard disk sold by them are as follows. [5]

| Salesmen | Sales units | | | | | |
|---|---|---|---|---|---|---|
| A | 20 | 23 | 28 | 29 | - | - |
| B | 25 | 32 | 30 | 21 | 29 | - |
| C | 23 | 28 | 35 | 18 | 26 | 28 |
| D | 15 | 21 | 19 | 25 | 32 | 30 |

Is there a significance difference in the performance of salesmen?

11. 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 samples 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. Test at 1% level of significance, whether there are in any significant difference of the proportions of defective units produced by the two machines. [5]

12. In a recent survey 1,072 Engineers were classified according to their intelligence (GPA in Bachelor) and economic conditions after graduation. Test whether there is any association between intelligence and economic condition. [5]

| Economic condition after graduation | Intelligence in BE | | | |
|---|---|---|---|---|
| | Excellent | Good | Mediocre | Dull |
| Good | 48 | 199 | 181 | 82 |
| Not good | 81 | 185 | 190 | 106 |

13. A sample of 10 values of three variance $X_1$,$X_2$ and $X_3$ were obtained as [5]

| $\Sigma X_1=10$ | $\Sigma X_1=20$ | $\Sigma X_1=30$ | $\Sigma X_1^2=20$ | $\Sigma X_2^2=20$ | $\Sigma X_3^2=20$ |
|---|---|---|---|---|---|
| N=6 | $\Sigma X_1\Sigma X_2=10$ | $\Sigma X_1\Sigma X_3=15$ | $\Sigma X_1\Sigma X_3=64$ | - | - |

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

(ii) Multiple correction between $X_1$, $X_2$ and $X_3$ assuming $X_1$ as dependent.

14. Compute the regression Line dependent variable Y on the independent variable X. Also estimate the probable value of Y if the given value of X is equal to 26. [5]

| X | 18 | 10 | 9 | 10 | 21 | 12 | 21 | 9 |
|---|---|---|---|---|---|---|---|---|
| Y | 38 | 34 | 29 | 48 | 24 | 29 | 28 | 49 |

15. A study was done on a diesel powered light duty pickup truck to see if temperature influences emission of nitrous oxide. Emission measurement were taken at different times, with varying experimental conditions. The data are as follows: [8]

| Temperature X | Nitrous oxideY |
|---|---|
| 76.3 | 0.90 |
| 70.3 | 0.91 |
| 77.1 | 0.96 |
| 68.0 | 0.89 |
| 79.0 | 1.00 |
| 67.4 | 1.10 |
| 66.8 | 1.15 |
| 76.9 | 1.03 |
| 77.7 | 0.77 |
| 67.7 | 1.07 |
| 76.8 | 1.07 |
| 86.6 | 0.94 |
| 76.9 | 1.10 |
| 86.3 | 1.10 |
| 86.0 | 1.10 |
| 76.3 | 0.91 |
| 77.9 | 0.87 |
| 78.7 | 0.78 |
| 86.6 | 0.82 |
| 70.9 | 0.95 |

(i) Find the mean and variance of the given data.
(ii) Find the degree of relationship between them.
(iii) Calculate the coefficient of the determination and interpret the given data.

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1. Compute the Five Number summary of the following information and prepare the Box and Whisker diagram: 34, 42, 66, 40, 59, 36, 41, 35, 36, 62, 43,30,43, 32, 44, 58, 53, 50, 48 and 38. Interpret the diagram. [6]

2. Define mutually exclusive and independent events. In a bolt factory, machines A, B and C manufacture respectively 25%, 35% and 40% of the total production, Among their total output, 95%, 94% and 92% are found to be of good quality bolts. A bolt is draws from the total product and is found to be good quality. What is the probability that (i) it was manufactured by A? (ii) it was manufactured by B? [6]

3. What are the difference and similarities between Binomial and Hyper-geometric probability distribution? [5]

4. During a laboratory experiment , the average number of radio active particles passing through a counter in milliseconds is 4. What is the probability that [5]

   a) 6 particles enter the counter.

   b) What is the probability that more than 2 particles enter the counter in given milliseconds.

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

$$f(x) = \begin{cases} k\sqrt{x} & \text{for } 0 < x < 1 \\ 0, & \text{Otherwise} \end{cases}$$

   a) Find the value of constant k.
   b) Mean and the distribution function of X.

6. The breakdown voltage X of a randomly chosen diode of a particular type is known to be normally distributed with mean 40 volts and standard deviation of 1.5 volts. [5]

   a) What is the probability that the break down voltage will be between 40 and 42 volts?

   b) What is the probability that the break down voltage will be less than 43 volts?

7. Write the difference between statistic and parameter. Define central limit theorem and discuss its importance in engineering field. [5]

8. Define parameter and sample statistics. From the population of size 5 as: 22,23,24,25 and 26.

   a) List out all the samples of size three without replacement.

   b) Find the average of each sample.

   c) Prove that the average of sample mean is equal to the population mean.

   d) Also find the standard error of sample mean. [5]

9. The following were obtained in experiment designed to check whether there is a systematic difference in the weights obtained with two different scales. Test at the 5% level of significance whether the difference of the means of the weights obtained with the two scales is significant. [5]

| Rock specimen | | I | II | III | IV | V | VI | VII | VIII | IX | X |
|---|---|---|---|---|---|---|---|---|---|---|---|
| wt.(gram) | Scale-I | 11.23 | 14.36 | 8.33 | 10.50 | 23.42 | 9.15 | 13.47 | 6.47 | 12.40 | 19.38 |
| | Scale-II | 11.27 | 14.41 | 8.35 | 10.52 | 23.41 | 9.17 | 13.52 | 6.46 | 12.45 | 19.35 |

10. The following table shows the lives in hours of four batches of electric lamps. [5]

| Batches | Lives of electric lamps | | | | |
|---|---|---|---|---|---|
| 1 | 1600 | 1610 | 1650 | 1680 | 1700 |
| 2 | 1580 | 1640 | 1640 | 1700 | 1750 |
| 3 | 1460 | 1550 | 1600 | 1620 | 1640 |

Perform the suitable inferential statistics to test whether the different batches of light bulbs have same mean or not at 5% level of significant.

11. Bricks made in four kilns have been graded as high quality, average quality and poor quality. The production of bricks (000 unit) in a particular period was as follows. Test whether Kiln and quality of bricks are independent or not at 1% level of significance. [5]

| Kiln | Quality of brick | | |
|---|---|---|---|
| | High | average | poor |
| A | 24 | 43 | 13 |
| B | 47 | 123 | 34 |
| C | 58 | 98 | 64 |

12. Describing the types of errors in hypothesis testing. Write down the steps for testing hypothesis of population proportion for a large sample size. [5]

13. A family income (Rs'0000) and expenditure (RS'000) survey result the following data.

| Expenditure on food | 5 | 7 | 8 | 9 | 11 |
|---|---|---|---|---|---|
| Annul income | 25 | 40 | 30 | 50 | 25 |
| Family Size | 3 | 2 | 4 | 5 | 1 |

a) Develop a regression model to estimate the expenditure on food based on the annual income of family and the family size.

b) Estimate the expenditure on food of a family with annual income Rs 50,000 and having 4 family members. [5]

14. The level of pollution because of vehicular emissions in Pokhara City is not regulated. Measurements by the local government of the change in flow of vehicles and the change in the level of air pollution (both in percentages) on 12 days yielded the following results:

| Change in flow of vehicles (x) | 28 | 36 | 15 | 19 | 24 | 18 | 25 | 40 | 63 | 12 | 16 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Change in level of air pollution (y) | 22 | 26 | 15 | 18 | 21 | 17 | 21 | 31 | 52 | 8 | 17 | 20 |

a) Make a scatter plot for the given result.

b) Fit a straight line by the method of least squares.

c) Find the change in the level of air pollution when the change in the flow of vehicles is 30%. [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 12 recent and consecutive years. [8]

Acid Rain: Sulfate Deposited (kg/Hectare)

| Year | Location I (P) | Location II (Q) | Location III (R) |
|---|---|---|---|
| 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 | 13.52 | 11.61 | 9.02 |
| 7 | 10.55 | 10.53 | 7.78 |
| 8 | 9.81 | 12.50 | 8.70 |
| 9 | 11.27 | 9.94 | 10.50 |
| 10 | 11.68 | 9.71 | 15.59 |
| 11 | 11.77 | 9.37 | 10.54 |
| 12 | 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.

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1. Define five number summaries of data. Prepare the box-plot for the following data of daily registration of workers in the construction site. 34, 42, 66, 40, 59, 36, 41, 35, 36, 62, 43, 30, 43, 32, 44, 58, 53, 50, 48 and 38. [6]

2. State Bayes' Theorem. In a bolt factory, machines A, B and C manufacture respectively 25%, 35% and 40% of the total population. Among their total output, 5%, 4% and 2% are found to be defective bolts. If a bolt drawn from the total product is found to be defective,
   a) What is the probability that it was manufactured by A?
   b) What is the probability that it was manufactured by B?
   c) What is the probability that it was manufactured by C?
   d) Which machine seems most likely to produce the defective bolts? [6]

3. Discuss the poisson distribution as limit care of binomial distribution. In a certain factory turning out razor blades there is a small chance 1/500 for any blade to be defective. The blades are supplied in packets of 50. Use suitable probability distribution to calculate the approximate number of packets containing in of 10,000 packets. [5]
   a) no defective b) One defective and c) Two defective

4. What are the parameters used in Poisson distribution? A manufacturer of pins knows that on the average 3 on 100 of its production is defective. He sells pins in boxes of 100 and guarantees that not more than 2 pins will be defective. What is the probability that a box selected at random (i) will meet the guaranteed quality? (ii) will not meet the guaranteed quality? [5]

5. Define the normal distribution and standard normal distribution. Under what condition binomial distribution follows normal distribution. [5]

6. Describe the conditions for the probability density function. The length of time (in minutes) that a certain lady speaks on the telephone is found to be random phenomenon, with a probability function specified by the probability density function f(x) as

$$f(x) = \begin{cases} Ae^{-x/5} & \text{for } x \geq 0 \\ 0 & \text{elsewhere} \end{cases}$$

   Find value of A. What is the probability that the number of minutes that she will take over the phone is
   a) more than 10 minutes b) less than 5 minutes and
   c) between 5 and 10 minutes. [5]

7. A population of the four numbers 5, 6, 9, 12.
   a) Write down all possible sample size of two without replacement.
   b) Verify population mean is equal to the mean of sample mean.
   c) Calculate the standard error of the sample distribution of sample mean. [5]

8. State Central Limit Theorem and write any two applications of it. The lifetime of a certain brand of an electric bulb may be considered a random variable with mean 1200 hours and standard deviation 250 hours. find the probability that average lifetime of 60 bulbs
   a) exceed 1400 hours b) is between 1100 hours and 1300 hours
   c) is less than 1100 hours [5]

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

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Before | 45 | 73 | 46 | 124 | 33 | 57 | 83 | 34 | 26 | 17 |
| After | 36 | 60 | 44 | 119 | 35 | 51 | 77 | 29 | 24 | 11 |

Use $\alpha = 0.05$ to test whether the safety program is effective. [5]

10. From a random sample of 60 buses, Montreal's mass-transit office has calculated the mean number of passengers per km to be 4.1. From previous studies, the population standard deviation is known to be 1.2 passengers per km.
    a) Find the standard error of the mean. (Assume that the bus fleet is very large.) [5]
    b) Construct a 95 percent confidence interval for the mean number of passengers per Km for the population.

11. The information obtained during rapid assessment after earthquake about damage grade with respect to structure of building. Test whether there exist any association between damage grade with structure of building at 10% level of significant. [$\chi^2$ value of 6 d.f = 12.592]

| Damage Grade | Structure of Building | | |
|---|---|---|---|
| | Frame | Masonry | Mixed |
| D1 | 303 | 345 | 11 |
| D2 | 37 | 389 | 22 |
| D3 | 14 | 875 | 310 |
| D4 | 5 | 1083 | 13 |

Write down the steps involved in the hypothesis testing of difference of mean when both the sample are small. [5]

12. Rick Douglas, the new manager of food Barn, is interested in the percentage of customers who are totally satisfied with the store. The previous manager had 86 percent of the customers totally satisfied and Rick claims the same is true today. Rick sampled 187 customers and found 157 were totally satisfied. At the 5 percent significance level, is there evidence that Rick's claim is valid? [5]

13. The study was done to study the ambient temperature on the electric power consumed by a chemical plant. Following table represent the data which are collected from an experimental pilot plant.

| Temperature (F) | 27 | 45 | 72 | 58 | 31 | 60 | 34 | 74 |
|---|---|---|---|---|---|---|---|---|
| Electric power (BTU) | 250 | 285 | 320 | 295 | 265 | 298 | 267 | 321 |

Fit a simple regression line, assuming that the relationship between them is linear. Also, predict the power consumption for an ambient temperature of 65°F. [5]

14. Define Karl Pearson Correlation coefficient and its coefficient of determination and write down the basic properties of it. [5]

15. Following data revels the 27 sample of paired data (X, Y) measured in the suitable units. Use scientific calculator to compute the required sums. Also compute following measures by using the suitable statistical formulae. [8]

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| X | 75 | 96 | 80 | 72 | 93 | 71 | 86 | 72 | 79 |
| | 98 | 77 | 84 | 70 | 96 | 85 | 84 | 94 | 71 |
| | 89 | 92 | 76 | 88 | 78 | 83 | 96 | 87 | 71 |
| Y | 166 | 197 | 176 | 164 | 177 | 189 | 173 | 175 | 185 |
| | 182 | 181 | 185 | 190 | 187 | 159 | 193 | 167 | 164 |
| | 194 | 177 | 166 | 162 | 192 | 156 | 158 | 182 | 175 |

a) Sample Average of both variables X and Y.
b) Sample standard deviation of both the variables X and Y
c) Which series is more uniformity as regard to the variability of the data?

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1. What is disparsion? Explain what do you understand by absolute and relative measures of dipersion. The marks distribution of 100 students of a college is as follows: [6]

| Marks | 10-20 | 20-40 | 40-70 | 70-90 | 90-100 |
|---|---|---|---|---|---|
| No of students | 15 | 20 | 30 | 20 | 15 |

Find the mean, median and standard deviation on of given distribution.

2. By examining the chest x-ray, the probability that T.B is detected when a person is actually suffering from it is 0.99. The probability that the doctor diagnoses incorrectly that a person has TB, on the basis of the x-ray is 0.001. In a certain city, 1 in 10000 persons suffer from TB. A person selected at random is diagnosed to have TB. What is the probability that person has actually TB? [6]
3. Define hypergeometric distribution with an example. Describe the conditions for the binomial approximation to hypergeometric distribution. [2+3]
4. An instructor of a statistics class is planning to interview a sample of n = 10 students who are randomly selected from the class. The class has a total 30 students, consisting of 20 male and female students. [5]
   i) Determine the probability mass function of the number of female students in the sample.
   ii) Find the probability that at least students is in sample.
   iii) Find mean and variance for female students.
5. Define standard normal distribution. Give the condition for normal approximation to binomial distribution. [2+3]
6. Time taken to boot a computer is a continuous random variable x having pdf: [5]

$$f(x) = k\,x(1-x), 0 < x 1$$
$$= 0, \text{otherwise}$$

Find i) E(x)
ii) $P(0.25 < x < 0.5)$

7. Define parameter and statistic with examples. Explain the central limit theorem. [5]
8. A population consists of the four numbers 5, 6, 9, 12. [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. What assumptions are of paired t-test? Write the process of paired t-test. [5]

10. Four brands of flashlight batteries are to be compared by testing each brand in five flashlights. Twenty flashlights are randomly selected and divided randomly into four groups of five flashlights each. Then each group of flashlights uses a different brand of battery. The lifetimes of the batteries, to the nearest hour, are as follows; [5]

| Brand A | Brand B | Brand C |
|---|---|---|
| 42 | 36 | 28 |
| 28 | 36 | 38 |
| 24 | 32 | 28 |
| 20 | 39 | 32 |
| 30 | 31 | 28 |

At the 5% significance level, does there appear to be a significance difference in mean lifetime among the four brands of batteries.

11. 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]

12. Describe the hypothesis testing procedure of Chi-square test of independent for 2×2 table. [5]

13. A computer operator is interested to know data rate of internet users dependents upon the band width, the following result were gathered by the operator: [5]

| Band Width | 17 | 35 | 41 | 19 | 25 | 20 | 10 | 15 |
|---|---|---|---|---|---|---|---|---|
| Data rate | 47 | 64 | 68 | 50 | 60 | 55 | 30 | 33 |

i) Is there any association between band width and data rate?
ii) Fit the regression model to describe the given data and also interpret the estimated regression coefficient.
iii) Compute the band width when data rate is 62.

14. Define correlation and regression with examples. Write down the properties of correlation coefficient. [5]

15. Randomly sampled 60 TU graduated BEs, half of whom majored in civil Engineering and half in Computer Engineering. From each, the highest salary offer (including benefits) is stated in following table:

| Salary of Civil Engineering | | Salary of Computer Engineering Graduates | |
|---|---|---|---|
| 61,228 | 86,792 | 68,421 | 73,361 |
| 51,836 | 75,155 | 56,276 | 36,956 |
| 20,620 | 65,948 | 47,510 | 63,627 |
| 73,356 | 29,392 | 58,925 | 71,069 |
| 84,186 | 96,382 | 78,704 | 40,203 |
| 79,782 | 80,644 | 62,553 | 97,097 |
| 29,523 | 51,389 | 81,931 | 49,442 |
| 80,645 | 61,955 | 30,867 | 75,188 |
| 76,125 | 63,573 | 49,091 | 59,854 |
| 62,531 | 56,276 | 48,843 | 79,816 |
| 77,073 | 47,510 | 79,782 | 51,943 |
| 86,705 | 58,925 | 29,523 | 35,272 |
| 70,286 | 78,704 | 80,645 | 60,631 |
| 63,196 | 62,553 | 76,125 | 63,567 |
| 64,358 | 36,956 | 62,531 | 69,423 |

i) Which of these groups shows consistency on the basis of salary offer?
ii) Find standard deviation of difference of average salaries of two groups. [8]

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

**2078 Bhadra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, BAG | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

2078/06/22

## *Subject:* - Probability and Statistics *(SH 602)*

- ✓ 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 number of minutes that a person had to wait for the bus to work on 13 working days are: 1, 10, 13, 12, 8, 2, 6, 9, 17, 30, 5, 4 and 15
   a) Find the values constituting the 5 – number summary. [6]
   b) Construct a box plot.
2. Worldlink, an internet service provider of Nepal buys, signal routers from three countries. It buys 22% of routers from America, 38% from India and 40% from China. It is found that 3% of routers from America, 4% of routers from India and 5% of routers from China are defective. If a customer buys one of these routers, what is the probability that
   a) It is defective [6]
   b) If the router is defective, it is from China. [5]
3. Compare Binomial and Negative Binomial Distributions.
4. In a busy road of Kathmandu there were 500 vehicles passing from 8 AM to 6 PM. It was found that 2 in 1000 vehicle wrongly entered in a one way. Find the probability that at a particular day from 8 AM to 6 PM, there will be [5]
   a) No vehicle enter in one way
   b) One vehicle enter in one way
   c) At least one vehicle enter in one way
   d) At most 2 vehicle enter in one way
5. Define continuous random variable. Write the importance of Normal distribution with its area property. [5]
6. A random variable X has the probability density function f(x) as

$$f(x) = \begin{cases} kx\ e^{-\frac{x^2}{12}}, x \geq 0 \\ 0, \text{ otherwise} \end{cases}$$

   a) Find the value of k if f(x) is a probability density function. [5]
   b) Find the mean and variance of random variable X.
7. Explain the following terms with suitable example
   a) Parameters
   b) Statistics [5]
   c) Standard error of statistics
8. To illustrate that the mean of a random sample is an unbiased estimate of the mean of the population, consider five slips of paper numbered 3, 6, 9, 12, 15.
   a) List all possible samples of size 3 that can be taken without replacement from this finite population.
   b) Calculate the mean of each of the samples listed in
   c) Verify that the sample mean is an unbiased estimate of the population mean [5]

9. The response time in milliseconds was determined for three different types of circuits in an electronic calculator. The results are shown in the following table.

| Circuit Type | Response | | | | |
|---|---|---|---|---|---|
| A | 19 | 22 | 20 | 18 | 25 |
| B | 20 | 21 | 33 | 27 | 40 |
| C | 16 | 15 | 18 | 26 | 17 |

Using $\alpha = 0.01$, test the hypothesis that the three circuit types have the same response time. ($F_{0.01, 2, 12} = 6.93$ $F_{0.01, 3, 12} = 6.70$) [5]

10. Define Hypothesis and Write down the steps involve in the test of significance of difference of mean of large population. [5]

11. Four hundred employees of Nepal Telecom are classified according to their level and decisions. Do you agree with the statement that decisions vary according to level of employee? Test at 5% level of significance. [5]

| Decisions | Sr. Officer | Officer | Jr. Officer | Total |
|---|---|---|---|---|
| Quick | 60 | 80 | 70 | 210 |
| Slow | 40 | 60 | 90 | 190 |
| Total | 100 | 140 | 160 | 400 |

12. Consider the case of Pharmaceutical Manufacturing Company testing two new compounds intended to reduce blood-pressure level. The compounds are administered two different sets of laboratory animals. In groups A, 71 out of 100 animal tested response to drug first with lower blood-pressure levels. In group B, 58 out of 90 animals tested respond to drug second with lower blood pressure level. The company wants to test at 0.05 levels whether there is a difference between the efficiencies of these two drugs. [5]

13. A sample of 10 values of the variables X1, X2 and X3 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 Partial correlation between X2 and X3 eliminating the effect of X1 also interpret coefficient of partial determination. [5]

14. Fires and Acres Burned. Find the best predicted value of number of acres burned given that there were 80 fires [5]

| Fires | 73 | 69 | 58 | 48 | 84 | 62 | 57 | 45 |
|---|---|---|---|---|---|---|---|---|
| Acres burned | 6.2 | 7.2 | 1.9 | 2.7 | 5.0 | 1.6 | 3.0 | 1.6 |

15. A semiconductor manufacturer produces devices used as central processing units in personal computers. The speed of the device (in megahertz) is important because it determines the price that the manufacturer can charge for the devices. The following table contains measurements on 48 devices. [8]

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 717 | 727 | 653 | 637 | 660 | 693 | 679 | 682 | 724 | 642 | 704 | 695 |
| 704 | 652 | 664 | 702 | 661 | 720 | 695 | 670 | 656 | 718 | 660 | 648 |
| 683 | 723 | 710 | 680 | 684 | 705 | 681 | 748 | 697 | 703 | 660 | 722 |
| 662 | 709 | 683 | 705 | 678 | 674 | 656 | 667 | 683 | 691 | 750 | 685 |

Find the

a) Sample mean of the distribution.
b) Sample standard deviation and coefficient of variation.
c) Standard error of sample mean.
d) What percentage of the devices has a speed exceeding 700 megahertz?

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

**2078 Kartik**

| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, BAG | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

## *Subject:* - Probability and Statistics *(SH 602)*

- ✓ 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 investor buys Rs. 12000 worth of shares in a company each month. During the 1st five months he bought the shares at a price of Rs.100, 120, 150, 200, 240 per share. After five months, what is average price paid for the shares by him? [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 win is 0.3. What is the probability that the product will be introduced? [6]
3. What is the difference between Binomial distribution and Poisson distribution? Explain under what condition Poisson distribution approximate to binomial distribution. [5]
4. An office switchboard receives telephone calls at a rate of 3 calls per minute on an average. Find the probability of receiving (a) no calls in one minute interval;
   (b) at least 3 calls in a one minute interval;
   (c) at most 2 calls in a five minute interval [5]
5. A continuous random variable X has following probability density function

$$f(x) = \begin{cases} \frac{3}{4}(1+x^2), & 0 \le x \le 1 \\ 0, & \text{otherwise} \end{cases}$$

   a) Find mean and standard deviation of X
   b) Find $P(-\sigma < X < \sigma)$ [5]
6. Define Normal distribution. Highlight the important properties of Normal Distribution. [5]
7. A population consists of five numbers: 2, 4, 6, 8 and 10. [5]
   a) Write down all possible samples of size two with SWOR.
   b) Calculate mean and the variance of population.
   c) Prove that sample mean is unbiased estimator of population mean.
8. The heights of hilly people of Nepal are normally distributed with a mean of 64 inches and a standard deviation of 2 inches, what is the probability that the mean height of a random sample of 100 hilly people is greater than 66 inches? [5]
9. The mean of a 200 samples of observations from a normal population with a standard deviation 5 cm is 25 cm.
   a) Estimate the population mean with 95% confidence
   b) Estimate the population mean with 95% confidence, changing the population standard deviation to 2.5 cm. [5]

10. 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 | Preference | | | |
|---|---|---|---|---|
| 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? Use ANOVA test, and $\alpha = 5\%$. [5]

11. 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 |

12. Define confidence level. The developer has claimed that at least 98% of the software which he supplied to a company conformed to specifications an examination of samples of 500 software revealed that 30 were defective. Test the claim at a significance level of 0.01. [5]

13. Describe about the correlation coefficients and their properties. Define coefficient of determination and state its use in analysis of data. [5]

14. 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.
b) Calculate the coefficient of determination and interpret it. [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 |

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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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2076 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, BAG | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

## *Subject:* - Probability and Statistics *(SH602)*

- ✓ 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 professor of statistics, in his class with 20 students, had conducted a survey about time spent by students on social media, during college hours, and found average time of 20 minutes and standard deviation of 5 minutes. In subsequent verification, it was found that observation 30 was entered as 13. Then find corrected mean and standard deviation of time spent by the students on social media during college hours. [6]
2. Define mutually exclusive and independent events. An insurance company insured 2000 Civil engineers, 4000 Electrical engineers and 6000 Mechanical engineers. The probability of an accident involving Civil engineer, Electrical engineer and Mechanical engineer during their jobs is 0.01, 0.03 and 0.15 respectively. One of the insured engineers meets with an accident. What is the probability that he is civil Engineer? [6]
3. What are the characteristics of Binomial Distribution and how does it differ from Hypergeometric Distribution? [5]
4. If the probability that an individual suffers a bad reaction from a certain injection is 0.001, determine the probability that out of 2000 individuals
   a) Exactly 3, individuals will suffer bad reaction
   b) More than 2, individuals will suffer bad reaction [5]
5. If inner diameter of a rod follow Normal Distribution. If 7% of the rod has inner diameter less than 35 mm and 89% of rod has inner diameter fewer than 63 mm. Find the mean and the standard deviation of diameter of rods. [5]
6. Find the mean and variance of the probability density function given by

$$f(x)=\begin{cases}12x^2(1-x); & 0\le x\le 1\\ 0\ ; & \text{otherwise}\end{cases}$$ [5]

7. Define Standard error and explain its importance in inferential statistics and write down the formula of standard error of sample mean and sample proportion. [5]
8. A population consists of live numbers 4, 8, 12, 16 and 20. If a random sample of size 2 is drawn without replacement. [5]
   a) Find the population mean and population standard deviation.
   b) List the all possible sample and find their sample mean.
   c) Show the mean of sample mean is equal to the population mean.
   d) Find the standard error of sample mean.
9. Write the process of test of significance of difference of two means for large samples. [5]
10. The sales figure of an item in six shops before and after and advertisement is given as:

| | | | | | | |
|---|---|---|---|---|---|---|
| Before | 53 | 28 | 31 | 48 | 50 | 52 |
| After | 58 | 29 | 30 | 55 | 56 | 45 |

Test whether the advertisement was effective at 5% level of significance? [5]
(t-value for 5 degree of freedom = 2.571)

11. Dyson Company in Berlin plans to produce a new hair product known as Dyson Supersonic. The suppliers for the company are company A and Company B found that 1% and 2% defective of 200 and 300 items respectively. Arrange appropriate hypothesis testing to investigate whether Company B is better by using a 0.05 level of significance. [5]

12. In a recent survey 1650 Engineers were classified according to their intelligence (GPA in Bachelor) and economic conditions after graduation. Test whether there is any association between intelligence and economic condition. [$\chi^2$ value for 9 degree of freedom=16.919] [5]

| Economic Condition after graduation | Intelligence in BE | | | |
|---|---|---|---|---|
| | Excellent | Good | Mediocre | Dull |
| Good | 48 | 199 | 181 | 82 |
| Average | 80 | 73 | 65 | 89 |
| Below average | 86 | 51 | 51 | 84 |
| Not good | 81 | 185 | 190 | 105 |

13. What are the two regression coefficients and what do they present? Write the properties of regression coefficients. [5]

14. Listed below are circumference (in feet) and height (in feet) of trees in Marshall. Minnesota (base on data from "Tree Measurement" by Stenley Rice, American Biology Teacher Vol 61. No 9) [5]

| X( circ) | 1.8 | 1.9 | 1.8 | 2.4 | 5.1 | 3.1 | 5.5 | 5.1 | 8.3 |
|---|---|---|---|---|---|---|---|---|---|
| Y (ht) | 21.0 | 33.5 | 24.6 | 40.7 | 73.2 | 24.4 | 40.4 | 45.3 | 53.5 |

a) Is there a correlation exist?
b) Explain this correlation.

15. The scores of randomly selected 32 students of two groups on Probability and Statistics are;

| Group 'A' | | | | Group 'B' | | | |
|---|---|---|---|---|---|---|---|
| 50 | 37 | 13 | 37 | 56 | 74 | 50 | 43 |
| 45 | 9 | 11 | 34 | 39 | 24 | 55 | 35 |
| 24 | 6 | 13 | 24 | 72 | 32 | 45 | 59 |
| 32 | 32 | 24 | 40 | 47 | 36 | 34 | 32 |
| 33 | 45 | 37 | 38 | 40 | 53 | 55 | 18 |
| 33 | 32 | 46 | 32 | 32 | 42 | 49 | 32 |
| 46 | 21 | 32 | 4 | 41 | 33 | 14 | 60 |
| 45 | 16 | 43 | 32 | 60 | 34 | 38 | 48 |

a) Which group is best?
b) Which group is more consistent?
c) Find standard error of difference of their means. [3+3+2]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
2076 Ashwin

| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, BAG | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

## *Subject:* - Probability and Statistics *(SH 602)*

- ✓ 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 strong and weak points of various measures of Central tendency. From the following frequency distribution find the range of income of middle 70% of the employees and the median income. Also find mean deviation from mean. [6]

| Income in Rs. | 500-600 | 600-700 | 700-800 | 800-900 | 900-1000 |
|---|---|---|---|---|---|
| No. of employees | 150 | 300 | 500 | 200 | 50 |

2. Distinguish between absolute and relative measures of dispersion. The running capacity of two horses is given below, state which is more consistent and why? [5]

| Horse A | 250 | 255 | 280 | 290 | 295 | 300 |
|---|---|---|---|---|---|---|
| Horse B | 280 | 282 | 290 | 295 | 298 | 295 |

3. If we the following probability density function.

$$f(x) = \begin{cases} k(5+2x), 2 \le x \le 4 \\ 0, \quad \text{otherwise} \end{cases}$$ [5]

Find the value of K and mean and variance of random variable X.

4. A random variable X has following probability function.

| X | -2 | -1 | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| P(X) | K | 0.1 | 0.2 | 2k | 3k | 0.1 |

[6]

i) Find the value of K.
ii) Find Mean and Variance.

5. During one stage in the manufacture of integrated circuit chips, a coating must be applied. If 70% of chips receive a thick enough coating, find the probability that among 15 chips (i) at least 12 will have thick enough coatings; (ii) at most 3 will have thick enough coatings; (iii) exactly 10 will have thick enough coatings. [5]

6. In a normal distribution 31% of the items are under 45 and 8% are over 64. Find the mean and standard deviation of distribution. (Given, $Z_{0.42}=1.4$, $Z_{0.19}=0.5$) [5]

7. Describe the advantages of sample surveys over complete enumeration? [6]

Nepal Electricity Authority wishes to estimate the average electric bills for the month of October for single family homes in Kathmandu. Based on similar studies in other cities the standard deviation is assumed to be Rs. 150. The NEA wants to estimate the average bill for October such that error will not deviate by Rs. 15 with 90% confidence. What sample size is needed?

8. What are the assumptions for the t-test? Describe the procedure of test of significance between two means for small sample. [5]

9. 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 one hour. The data were found by testing each method in several trials. Are the three systems equally effective? Use the 0.05 level of significance. [5]

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

10. Test of the fidelity and selectivity of 190 digital radio receivers produced the results shown in the following table.

| | | Fidelity | | |
|---|---|---|---|---|
| | | Low | Average | High |
| Selectivity | Low | 6 | 12 | 32 |
| | Average | 33 | 61 | 18 |
| | High | 13 | 15 | 0 |

Use $\alpha$=0.05and $x^2 = 5.991$ to test whether there is relationship between fidelity and selectivity. [6]

11. Define Hypothesis, and write down the steps involve in the test of significance of difference of proportion. [5]

12. In 1990, 5.8% job applicants who were tested for drugs failed the test. At the 0.05 significant level, the test claim that the failure rate is now lower if a simple random sample of 1520 current job applicants results in 58 failure. Does the result suggest that fewer job applicants now use drugs? [5]

13. Fit the regression line of yield of crop ('000 tones) on amount of rainfall (mm) and amount of fertilizers used (kg). Also estimate the yield of crop for the year in which rainfall is 13 mm and fertilizer used is 9 kg. [5]

| | | | | | | |
|---|---|---|---|---|---|---|
| Yield | 4 | 6 | 7 | 9 | 13 | 15 |
| Rainfall | 3 | 4 | 6 | 8 | 12 | 15 |
| Fertilizer | 4 | 10 | 14 | 20 | 24 | 30 |

14. 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 rating on experience and estimate the probable performance of an operator had 8 years experience.
b) Determine coefficient of determination and interpret it. [5]

15. List Five Number summary and prepare the box plot for numbers of guest registered each of 60 randomly selected days. [6]

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 108 | 94 | 188 | 116 | 165 | 181 | 106 | 133 | 176 | 110 |
| 169 | 134 | 129 | 109 | 85 | 124 | 119 | 165 | 153 | 135 |
| 105 | 180 | 105 | 91 | 117 | 148 | 83 | 96 | 101 | 123 |
| 128 | 143 | 136 | 99 | 169 | 133 | 89 | 90 | 174 | 144 |
| 151 | 168 | 103 | 116 | 106 | 107 | 179 | 113 | 172 | 120 |
| 179 | 183 | 99 | 94 | 87 | 120 | 154 | 159 | 103 | 139 |

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12 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
# Examination Control Division
2075 Ashwin

| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B.Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

## *Subject:* - Probability and Statistics *(SH602)*

- ✓ 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. Define measures of central tendency and measures of variance. Following data gives the distribution of marks of 50 students in statistics.

| Marks more than | 10 | 20 | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|---|---|
| No. of students | 50 | 45 | 35 | 20 | 10 | 4 | 1 |

Compute median marks. Also compute minimum marks obtained by a pass candidate if 60% student pass in the test. [6]

2. A problem in statistics is given to three students A, B and C whose chances of solving are ½, ¾ and ¼ respectively. If all of them try independently, what is the probability that
   a) at least one of them will solve it
   b) none of them can solve it [6]
   c) exactly two of them can solve it [2+2]
3. Define binomial distribution and explain the condition for Binomial distribution.
4. If the probability that an individual suffers a bad reaction from a certain injection is 0.001, among 2000 individual
   a) obtain probability distribution function for suffering bad reaction
   b) determine the probability that
   (i) exactly 3 individuals will suffer bad reaction [6]
   (ii) more than 2, individuals will suffer bad reaction
5. The breakdown voltage x of randomly chosen diode of a particular type is known to be normally distributed with mean 40 and standard deviation 1.5 volts. What is the probability that the breakdown voltage. Will be
   a) Between 39 and 42 Volts
   b) At most 43 Volts [6]
   c) At least 39 Volts

*OR*

The distribution function for a random variable x is

$$f(x) = 1 - e^{-2x} \text{ for } x \geq 0$$
$$= 0 \text{ for } x < 0$$

a) Find $p(x > 2)$
b) Find mean and variance of the variable x.

6. Define discrete and continuous random variable. Also describe the procedure to compute mean and variance for both variables. [4]

7. Define standard normal distribution. Write down its properties and importance of this distribution. [4]

8. A population consists of four number 2, 8, 14, 20,

   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. [6]

9. What are difference between point estimation and Interval estimation? Also discuss differences between estimation and Hypothesis testing. [3+3]

10. Define critical value. A manufacturer claimed that at least 95% of the water pumps supplied to the ABC Company confirmed to specification. However, the product 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 water pumps supplied last month and found that 228 water pumps 45 per the specification. Can you conclude that the production manager is right to doubt on the claim of the manufactures ($\alpha = 0.01$) [6]

11. Three varieties of coal were analyzed by four chemists and the ash-content in the varieties were found as follows:

| Varieties | Chemists | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| A | 8 | 5 | 5 | 7 |
| B | 7 | 6 | 4 | 4 |
| C | 3 | 6 | 5 | 4 |

Test whether the varieties differ significantly in their ash-content? Test at 5% level of significance.
[$F_{(2,9)} = 19.4$, $F_{(3,9)} = 8.81$]. [6]

12. Write the procedure of testing of Hypothesis for single proportion. [4]

13. The following data gives the number of twists required to break a certain kind of forged alloy bar and percentage of alloying element A present in the metal

| Number of twists | 41 | 49 | 69 | 65 | 40 | 50 | 58 | 57 | 31 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|
| Percentage of elements A | 10 | 12 | 14 | 15 | 13 | 12 | 13 | 14 | 13 | 12 |

   a) Fit the regression equation of number of twists on percentage of element A. Determine the predicted number of twists required break an alloy when percentage of element is 20

   b) Find 99% confidence interval for the regression coefficient. [4]

14. The simple correlation coefficient between fertilizer ($x_1$) seeds ($x_2$) and productivity ($x_3$) are $r_{12} = 0.59$, $r_{13} = 0.46$ are $r_{23} = 0.77$ calculate the partial correlation coefficient $r_{12.3}$ and multiple correlation $R_{1.23}$ [4]

15. The samples of length of life of bulbs from two companies are given below. [8]

| Length of life (hours) | Company | |
|---|---|---|
| | A | B |
| 500-600 | 10 | 3 |
| 600-700 | 21 | 8 |
| 700-800 | 6 | 15 |
| 800-900 | 8 | 12 |
| 900-1000 | 21 | 4 |
| 1000-1100 | 10 | 5 |
| 1100-1200 | 2 | 15 |
| 1200-1300 | 12 | 13 |
| 1300-1400 | 19 | 7 |
| 1400-1500 | 9 | 7 |
| 1500-1600 | 3 | 4 |
| 1600-1700 | 7 | 6 |
| 1700-1800 | 5 | 3 |
| 1800-1900 | 4 | 2 |
| 1900-2000 | 1 | 3 |

a) Calculate mean length of life of bulbs fro company A and company B
b) Calculate sample standard deviation and sample variance for given data
c) Which company is bulbs are more uniform?

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2075 Chaitra**

| Exam. | Regular / Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, BAG | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

## *Subject:* - Probability and Statistics *(SH 602)*

- ✓ 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 down the significance of statistics in engineering. An experiment shows the height of 51 plants given below. If average heights of all the 51 plants are 40 cm find the missing frequencies corresponding to the height 30 and 50cm. [6]

| Height (cm) | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| No. of plant | 2 | 3 | - | 21 | - | 5 |

2. What do you mean by mutually exclusive, exhaustive and complementary events? Explain with examples. In a particular city, airport A handles 50% of all airlines traffic, airport B handles 30% and airport C handles 20%. The detection rates for weapons at the three airports are 0.9, 0.5 and 0.4 respectively. A passenger is randomly selected at one of the airports. Then (i) what is the probability that he/she carrying a weapon? (ii) If he/she is found to be carrying a weapon, what is the probability that airport A is being used? [5]

3. Define probability density function? A continuous probability distribution of a variable x is defined as $f(x)=KX(1-X)$ for all $0 \le X \le 1$. Compute (i) $P(X \ge 0.4)$ (ii) $P(¼ \le X \le ¾)$ [5]

   Or,

   A fair dice was rolled until one gets a Six; find the expected number of toss required?

4. Define Negative Binomial distribution and explain characteristics. How does it differ from binomial distribution? [6]

5. A typist made 2.6 mistakes per page on average, find the probability that in the page typed by him, i) there is no mistake ii) at least two mistakes iii) at most 3 mistakes. [5]

6. Define Gamma distribution, chief characteristics and write its applications. [5]

   Or,

   The breakdown voltage X of randomly chosen diode of a particular type is known to be normally distributed with mean 40 and s.d. 1.5 volts. What is the probability that the breakdown voltage will be (a) between 39 and 42 volts; (b) at most 43 volts; (c) at least 39 volts.

7. Define estimation? Write characteristics of a good estimator? A sample of 400 students taking Entrance for BE revealed an average score of 56. Construct a 95% as well as 99% confidence interval for population mean score if standard deviation of score of all students in known to be10. [6]

8. A whole sale dealer wanted to buy a large quantity of light bulbs from two brands label A and B. He bought 100 bulbs from each bulbs brand and found by testing that brand A had mean life time 1120 hours and standard deviation 75 hours and brand B had mean life

time 1062 hours and standard deviation 82 hours. Find the 95% and 99% confidence limits for the difference in the average life of bulbs from the two brands. [5]

9. The following are the breaking strength of three different brands of cables.

| Brand | Breaking Strength | | | | | |
|---|---|---|---|---|---|---|
| A | 40 | 30 | 50 | 60 | 30 | - |
| B | 60 | 40 | 55 | 65 | - | - |
| C | 60 | 50 | 70 | 65 | 75 | 40 |

Construct ANOVA table and test for the equality of the average breaking strength of cables at $\alpha$=5%. [5]

10. In a recent survey 1,072 Engineers were classified according to their intelligence (GPA in Bachelor) and economic conditions after graduation. Test whether there is any association between intelligence and economic condition. [6]

| Economic Condition after graduation | Intelligence in BE | | | |
|---|---|---|---|---|
| | Excellent | Good | Mediocre | Dull |
| Good | 48 | 199 | 181 | 82 |
| Not good | 81 | 185 | 190 | 106 |

$x^2$ value for 2 d.f.=5.991

11. What is testing of hypothesis? Explain the procedure followed in testing of Significance difference between two population proportion large sample? [5]

12. A simple random sample of Household with TV set in use. Show that 1024 of them were tuned to 60 minute while 3836 were tuned to some other show. Use 0.05 significant level to test the claim of CBS executive that "60 minute get more than a 20 shave", which mean that more than 20% of set in use are tuned to 60 minute. [5]

13. A sample of 10 values of three variables X1, X2 and X3 were obtained as

| | | |
|---|---|---|
| $\Sigma X_1=10$ | $\Sigma X_2=20$ | $\Sigma X_3=30$ |
| $\Sigma X_1^2=20$ | $\Sigma X_2^2=68$ | $\Sigma X_3^2=170$ |
| $\Sigma X_1X_2=10$ | $\Sigma X_1X_3=15$ | $\Sigma X_2X_3=64$ |

Find (i) Partial correlation between $X_1$ and $X_2$ eliminating the effect of $X_3$ (ii) Multiple correlation between $X_1$, $X_2$ and $X_3$ assuming $X_1$ as dependent variable. [5]

14. Differentiate between correlation and regression? From following data find the Karl Pearsons coefficient correlation and interpret the result? [5]

| Marks in Statistics | 39 | 65 | 62 | 90 | 82 | 75 | 25 | 98 | 36 | 78 |
|---|---|---|---|---|---|---|---|---|---|---|
| Marks in Mathematics | 47 | 53 | 58 | 86 | 62 | 68 | 60 | 91 | 51 | 84 |

15. Following data reveals the sample of 22 pairs of observation (X,Y) drawn from large population.

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

i) Find the sample mean for each variable X and Y.
ii) Which series is more consistent and why?
iii) Find the standard error of the difference of mean.
iv) Find the coefficient of Karl Pearson correlation. [6]

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12 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2074 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B.Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

## *Subject:* - Probability and Statistics *(SH602)*

- ✓ 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 measures of central tendencies? Write favorable points of each of them. Calculate approximate measures of central tendency from following data; [1+2+3]

| Wages in Rs/ week | Less than 35 | 35-37 | 38-40 | 41-43 | Over 43 |
|---|---|---|---|---|---|
| No. of wage earned | 14 | 82 | 99 | 18 | 7 |

2. From a group of 4 Engineers, 3 Doctors and 2 Statistician a sub-group of 3 has to be made, what is the probability that sub-group consists of
   a) One from each profession
   b) Atleast one engineer [4]
3. Define discrete probability distribution with suitable example. Compare Negative Binomial and Binomial probability distributions. [3+3]
4. A quality control engineers inspects a random sample of 3 batteries from each lot of 24 car batteries that is ready to shipment. If such a lot contain six batteries with slight defects, what is the probabilities that the inspector's sample will contain
   a) None of the batteries with defect
   b) Only one of the batteries with defect
   c) At least two of the batteries with defect [6]
5. Write major characteristics of normal distribution. Discuss relation between Normal distribution and Standard Normal distribution. [2+3]

***OR***

What are Gamma and Chi-squared distributions? Specify relationship between them.

6. The life of an electric light bulbs follows Normal distribution with mean 800 hours and a standard deviation of 50 hours. Find the probability that a bulb burns
   a) Between 750 and 825 hours
   b) More than 900 hours [5]

***OR***

Define exponential distribution. Suppose that the service life of a semiconductor is exponentially distributed with an average of 60 hours. Find the probability that a semi-conductor will a) still working after 90 hours
b) fail within 120 hours

7. A population consists of five numbers 2, 4, 6 and 8
   a) Enumerate all possible sample of size two without replacement
   b) Show that the mean of the sampling distribution of sample mean is equal to population mean [4]

8. State central limit theorem. A random sample of size 100 is taken from an infinite population with mean 75 and variance 256. Assert the chances of sample mean between 67 and 83. [6]

9. What is type Ist error? Describe the procedure of the for difference of two Mean for large sample. [6]

10. Define chi-square distribution. A book containing 500 pages, was thoroughly checked. The distribution of number of error page was given below as

| Number of errors: | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Number of pages: | 275 | 138 | 75 | 7 | 4 | 1 |

Using chi-square test of goodness of fit, verify whether the arrivals follow a poison distribution at 5% level of significance. [6]

11. Define hypothesis. Describe the procedure of testing of hypothesis of significant difference between two population means for large samples.

*OR*

Describe the types of error in Hypothesis Testing. Write the procedure testing of Hypothesis of single proportion. [6]

12. Write the Decision criteria in test of Hypothesis with diagram. [4]

13. In trying to evaluate the effectiveness of antibiotics in killing bacteria, a research institute compiled the following information

| Antibiotics (mg) | 12 | 15 | 14 | 16 | 17 | 10 |
|---|---|---|---|---|---|---|
| Bacteria | 5 | 7 | 5.6 | 7.2 | 8.6 | 6.2 |

Find strength and direction of relationship between them. [4]

14. Differentiate between Correlation and regression analysis. [4]

15. Following data revels the scores of sixty candidates of IOE entrance examination

| | | | | | |
|---|---|---|---|---|---|
| 51.43 | 40 | 78.57 | 46.43 | 51.43 | 50.71 |
| 42.14 | 50.71 | 42.86 | 55 | 71.43 | 64.29 |
| 52.86 | 42.14 | 57.14 | 45.71 | 43.57 | 40 |
| 44.29 | 55.71 | 40 | 48.57 | 48.57 | 49.29 |
| 51.43 | 47.14 | 54.29 | 45 | 53.57 | 50 |
| 49.29 | 60 | 48.57 | 50.71 | 50 | 49.29 |
| 47.14 | 53.57 | 58.57 | 43.57 | 47.14 | 53.57 |
| 47.86 | 47.14 | 40 | 43.57 | 52.86 | 47.86 |
| 49.29 | 49.29 | 42.86 | 47.14 | 48.57 | 50 |
| 47.14 | 50.71 | 52.86 | 47.86 | 47.14 | 70 |

a) Estimate average score of candidates
b) Find unbiased estimator of true standard deviation and standard error of average score
c) Also test for consistency of score [8]

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**

**2073 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B. Agri | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

## *Subject:* - Probability and Statistics *(SH602)*

- ✓ 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 various measures of central tendency and its application. The following table represents the marks of 100 students. [6]

| Marks | 0-20 | 20-40 | 40-60 | 60-80 | 80-100 |
|---|---|---|---|---|---|
| No. of students | 14 | 18 | 27 | 26 | 15 |

Find the mean, median and standard deviation of all 100 students.

2. Explain Baye's theorem. A chain of video stores sells three different brands of DVD players; Of its DVD players sales, 50% are brand 1 (the least expensive), 30% are brand 2, and 20% are brand 3. Each manufacturer offers a 1-year warranty on parts and labor. It is known that 25% of brand 1's DVD players require warranty repair work, where as the corresponding percentages for brands 2 and 3 are 20% and 10%, respectively. [2+4]
   a) What is the probability that a randomly selected purchaser has bought a brand 1 DVD players that will need repair while under warranty?
   b) What is the probability that a randomly selected purchaser has a DVD player that will need repair while under warranty?
3. Define negative binomial distribution with its important characteristics. [5]
4. If a publisher of nontechnical books takes great pains to ensure that its books are free of typographical errors, so that the probability of any given page containing at least one such error is 0.005 and errors are independent from page to page, what is the probability that one of its 400-page novels will contain. [5]
   a) Exactly one page with errors?
   b) At most three pages with errors?
5. In a certain examination test 2000 students appeared in Statistics. The average marks obtained were 50% and the standard deviation was 5%. How many students do you expect to obtain more than 60% marks? What are the minimum marks of the top 100 students? Assume that the marks are normally distributed. [5]

***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? [5]

6. The distribution function of a random variable x is

$$F(x) = 1 - e^{-2x} \quad \text{for } x \geq 0$$
$$= 0 \quad \text{for } x < 0$$

   a) Find $P(x > 2)$
   b) Find mean and variance of the variable x.

7. What do you mean by central limit-theorem and discuss its applications. [4]

8. An electrical firm manufactures light bulbs that have a length of life that is approximately normally distributed with mean equal to 800 hours and standard deviation of 40 hours. Find the probability that a random sample of 16 bulbs will have an average life of (a) less than 850 hours (b) between 750 to 900. [6]

9. Define partial and multiple correlation with suitable examples. Write down the properties of partial and multiple correlation. [5]

10. Raw material used in the production of a synthetic fiber is stored in a place which has no humidity control. Measurements of the relative humidity in the storage place and moisture content of sample of the raw material (both in percentage) on 12 days yielded the following results: [5]

| Humidity, X | 42 | 35 | 50 | 43 | 48 | 62 | 31 | 36 | 44 | 39 | 55 | 48 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Moisture content, Y | 12 | 8 | 14 | 9 | 11 | 16 | 7 | 9 | 12 | 10 | 13 | 11 |

Verify that it is reasonable to fit a straight line. Fit the straight by the method of least squares.

11. Describe the procedure of the test of significance for difference of two properties for large sample. [5]

12. Six sample of each of four types of cereal grain grown in a certain region were analyzed to determine thiamin content, resulting in the following data (mg/g): [5]

| Wheat | 5.2 | 4.5 | 6.0 | 6.1 | 6.7 | 5.8 |
|---|---|---|---|---|---|---|
| Barley | 6.5 | 8.0 | 6.1 | 7.5 | 5.9 | 5.6 |
| Maize | 5.8 | 4.7 | 6.4 | 4.9 | 6.0 | 5.2 |
| Oats | 8.3 | 6.1 | 7.8 | 7.0 | 5.5 | 7.2 |

Does this data suggest that at least one of the grains differ with respect to true average thiamin content? Use 0.05 level of significance.

*OR*

A liquid dietary product implies in its advertising that use of the product for one month results in an average weight loss of at least 3 pounds. Eight subjects use the product for one month, and the resulting weight loss data are reported below. Do the data support the claim of the producer of the dietary product with the probability of a type I error set to 0.05?

| Subjects | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Weight (lb) | 165 | 201 | 195 | 198 | 155 | 143 | 150 | 187 |
| Weight (lb) | 161 | 195 | 192 | 193 | 150 | 141 | 146 | 183 |

13. From the following data can you conclude that there is association between the purchase of brand and geographical region? [5]

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

Use 5% level of significance.

14. Two different areas of a city are being considered as sites for day-care centers. Of 200 households surveys in one section, the proportion in which the mother worked full-time was 0.52. In another section, 40% of 150 households surveyed had mothers at full time jobs. At 0.05 level of significance, is there a significant difference in the proportion of working mothers in the two areas of the city? [5]

P.T.O.

15. The entrance score of three engineering institutes are as follows: [8]

| Institutes | Entrance scores | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A | 740 | 800 | 830 | 840 | 860 | 890 | 830 | 930 | 1070 |
| B | 655 | 775 | 825 | 978 | 989 | 1025 | 950 | 980 | 1100 |
| C | 850 | 825 | 749 | 870 | 565 | 978 | 925 | 950 | 1000 |

a) Calculate mean and standard deviation for institute A, B and C
b) Which institute is good?
c) Which institute is consistent?

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2074 Ashwin**

| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B. Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

***Subject:*** - Probability and Statistics *(SH602)*

- ✓ 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 is Box plot and what does it measure? Explain the meaning of its different parts with diagram.

   A civil engineering monitors water quality by measuring the amount of suspended solids in a sample of river water. Over 11 weekdays, he observed 14, 12, 21, 28, 30, 63, 29, 65, 55, 19, 20 suspended solids (parts per million).

   Find the third quartile and interpret its meaning. [3+3]

2. Write sown the difference between the sample space and sample points, dependent and independent events. Urn A contains 2 white 1 black and 3 red balls. Urn B contain 3 white 2 black and 4 red balls. Urn C contain 4 white 3 black and 2 red balls. One Urn is choosen at random and 2 balls are drawn. They happen to be red and black. What is the probability that both come from Urn B. [6]

3. What are the characteristics of Binomial Distribution and how does it differ from Negative Binominal Distribution? [4]

4. A quality control engineer inspects a random sample of 4 batteries from each lot of 24 car batteries that is ready to shipment. If such a lot contain six batteries with slight defects. What are the probabilities that the inspector's sample will contain. [5]

   i) None of the batteries with defect?
   ii) At least two of the batteries with defects?
   iii) At most three of the batteries with defects?

5. The breakdown voltage X of a randomly chosen diode of a particular type is known to be normally distributed with mean 40 volts and variance 2.25 volts. What is the probability that the breakdown voltage will be [5]

   i) Between 39 and 42 volts
   ii) Less than 44 volts
   iii) More than 43 volts

***OR***

The daily consumption of electric power in a certain city follow a gamma distribution with $\alpha = 2$ and $\beta = 3$. If the power plant of this city has daily capacity of 12 million kilowatt hours, what is the probability that this power supply will be inadequate on any given day?

6. 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 [5]

$$f(x) = kx^2, 0 \le x \le 1$$
$$= 0, \text{otherise}$$

i) Find the value of k
ii) What is the probability that the lecture ends with ½ minute of the bell ringing?
iii) What is the probability that the lecture continues beyond the bell for between 15 and 30 seconds?

7. Define Central Limit Theorem. The amount of impurity in a batch of a certain chemical product is a random variable with mean value 4.0 gm and standard deviation 1.5 gm. If 50batches are independently prepared, what is the probability that the sample average amount of impurity is between 3.5 and 3.8 gm? [5]

8. Define population. Sample parameter and statistic with suitable examples. 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 Standard error of mean. [6]

9. What are the two regression coefficients and what do they represent when these two will be same? Write any three properties of regression coefficient. [5]

10. A sample of 8 values of three variables $X_1$, $X_2$ and $X_3$ were obtained as [5]

| | | |
|---|---|---|
| $\Sigma X_1 = 360$ | $\Sigma X_2 = 64$ | $\Sigma X_3 = 48$ |
| $\Sigma X_1^2 = 17172$ | $\Sigma X_2^2 = 546$ | $\Sigma X_3^2 = 320$ |
| $\Sigma X_1 X_2 = 2845$ | $\Sigma X_1 X_3 = 2269$ | $\Sigma X_2 X_3 = 396$ |

Find:

i) Partial correlation between $X_1$ and $X_3$ eliminating the effect of $X_2$
ii) Multiple correlation between $X_1$, $X_2$ and $X_3$ assuming $X_3$ as dependent

11. Discuss difference between estimation and hypothesis test of significance of population [5]

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 66.3 | 63.5 | 64.9 | 61.9 | 64.3 | 64.7 | 65.1 | 64.5 | 68.4 | 63.2 |

Find 99% confidence interval for true hardness of magnesium alloy.

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 these 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.

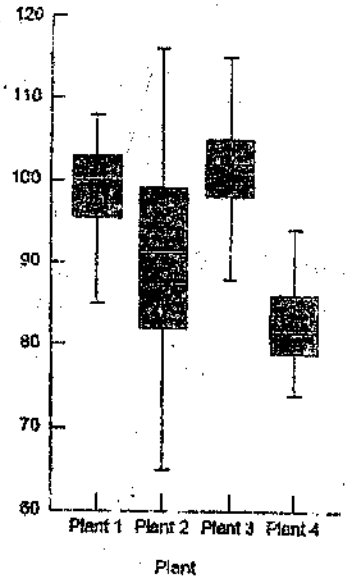
13. A random sample of smokers was obtained and each individual was classified both with respect to gender and with respect to the age at which he/she first started smoking. [5]

| Age | Gender | |
|---|---|---|
| | Male | Female |
| <16 | 25 | 10 |
| 16-17 | 24 | 32 |
| 18-20 | 28 | 17 |
| >20 | 19 | 34 |

Carry out a test of hypotheses to decide whether there might be an association between gender and the age at which an individual first smokes?

14. Explain the concept of (i) point estimation and (ii) Internal estimation of population properties. In a random sample of 400 industrial accidents, it was found that 231 were due to at least partially to unsafe working condition. 95% confidence intervals for the corresponding true proportion. [5]

15. Following multiple box plots shows the quality index at 4 manufacturing plants. Comment on the relationships between quality at different plants and the variability present those 4 plants. [7]

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23 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**

**2073 Shrawan**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B. Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

***Subject:*** - Probability and Statistics *(SH602)*

- ✓ 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. In two companies A and B engaged in similar type of industry, the average weekly wage and standard deviation are given below: [6]

| | Company A | Company B |
|---|---|---|
| Average weekly wage (Rs) | 460 | 490 |
| Standard deviation | 50 | 40 |
| No. of wage earners | 100 | 80 |

   i) Which company pays larger amount as weekly wags?
   ii) Which company show greater variability in the distribution weekly wages?
   iii) What is the mean and standard deviation of all the workers in two companies taken together?

2. State the law multiplication of probability. An Electronics company has an engineering position open. The Probability that an applicant is capable is 0.7. Each applicant is given written test and oral examination. A capable applicant passes with Probability 0.9 while an incapable applicant passes with Probability of 0.4. Find (a) the probability that an applicant passes the test (b) the probability that the applicant is capable given he/she passes the test. [6]

3. Define negative Binominal Distribution. If a boy is throwing stone at a target what is the probability that his $10^{th}$ throw is his $5^{th}$ hit, if the probability of hitting the target at any trial is 0.6. Also find the mean and variance of random variable. [5]

4. Define hypergeometric probability distribution with an example. Describe the conditions for the binomial approximation to hypergeometric distribution? [5]

5. Let X denote the amount of time for which a book on two hour reserve at a college library is checked out by a randomly selected student and suppose that X has density function, [5]

$$f(x) = 1/2x, \quad 0 \le x \le 2$$
$$= 0 \quad \text{otherwise}$$

   Calculate $P(X \le 1)$ and $P(0.5 \le X \le 1.5)$

6. Define continuous random variable with suitable example. Describe the properties of probability density function and distribution function. [5]

7. State Central limit theorem with an example. Explain why it is important in engineering field? [5]

8. A population consists of the four number 2,8,14,20
   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 [5]

9. Define Karl Person coefficient of Correlation and coefficient of determination. What it is input in analysis.

10. A house survey on monthly expenditure on food yield following data: [5]

| 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 |

Obtain the multiple correlation coefficient.

11. There was a research on voltage supply by Ba Hries supplied by two companies. Both company claims that same. But researcher suspects that there is significance difference between mean voltages between two companies. To test this, she selected independent samples from both company and in lab test the result were as follows: [5]

| | | Mean | Sample Standard deviation |
|---|---|---|---|
| Company A | 13 | 3.59V | 0.3V |
| Company B | 10 | 3.15V | 0.4V |

Test the researcher suspect was correct at 5% level of significance.

12. Shyam and Co. produces three varieties of certain product: deluxe, find and ordinary. A recent market survey is conducted for preference of products. The preference was found as follow: [5]

| Product | Production | | | |
|---|---|---|---|---|
| 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 test it using ANOVA test. Use $\alpha = 5\%$

*OR*

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

| Before | 45 | 73 | 46 | 124 | 33 | 57 | 83 | 34 | 26 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|
| After | 36 | 60 | 44 | 119 | 35 | 51 | 77 | 29 | 24 | 11 |

Use the 0.05 level of significance to test whether the safety program is effective.

13. Define critical value. A manufacturer claimed that at least 95% of the water pumps supplied to the ABC Company confirmed to specification. However, the product 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 water pumps supplied last month and found that 228 water pumps as per the specification. Can you conclude that the production manager is right to doubt on the claim of the manufactures? ($\alpha$=0.01) [5]

14. Describe the Hypothesis testing procedure of Chi-square test of independence for 2×2 table. [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) Compare a value that measures the amount of variability relative to the value of mean

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**

**2072 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B. Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

***Subject:*** - Probability and Statistics *(SH602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ ***<u>Necessary tables are attached herewith.</u>***
- ✓ *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: (i) the wrong item is omitted (ii) it is replaced by 12. [6]

2. Define conditional probability. An assembly plant receives its voltage regulators from these three different suppliers, 60% from supplier A, 30% from supplier B, and 10% form supplier C. It is also known that 95% of voltage regulators from A, 80% of these from B, and 65% these from C perform according to specifications. What is the probability that [6]
   i) Anyone voltage regulator received by the plant will perform according to specifications
   ii) A voltage regulator that perform according to specification came from B

3. Write the differences and similarities between Binomial and Negative Binomial Distribution. [2+3]

4. In certain factory turning out optical lenses, there is a small change, 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 vasriable. 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) $P(X \geq 4)$; (b) $p(0 < X < 4)$; (c) mean and variance of X

5. Define standard normal distribution. Give the condition for normal approximation of Poisson distribution. [5]

6. The mean inside diameter of a sample of 200 washers produced by a machine is 0.502 cm and the standard deviation as 0.005 cm. The purpose for these washers are interned allows a maximum tolerance in the diameter of 0.496 to 0.508 cm, otherwise the washers are considered defective. Determine the percentage of defective washers produced by the machine. Assume the diameter is normally distributed. [5]

7. What do you mean by sampling distribution of a sample mean and its Standard Error? Explains with example. What would be the variance of sampling distribution of mean, if sample is taken from finite population? [5]

8. Define the Central Limit Theorem. A sample of 100 mobile battery cells tested to find the length of life produced the following results as mean 13 months and standard deviation of 3 months. Assuming the data to be normally distributed by using Central Limit Theorem what percentage of battery cells expected to have Average life? [5]

   i) More than 15 months (ii) Less than 9 months

9. Define partial and multiple correlations with examples. Write down the properties of partial and multiple correlation. [5]

10. An article in wear (Vol.152, 1992, pp. 171-181) presents data on the fretting wear of mild steel and oil viscosity. Representative data follow, with x = oil viscosity and y = wear volume ($10^{-4}$ cubic millimeters). [5]

| y | 240 | 181 | 193 | 155 | 172 | 110 | 113 | 75 | 94 |
|---|---|---|---|---|---|---|---|---|---|
| x | 1.6 | 9.4 | 15.5 | 20.0 | 22.0 | 35.5 | 43.0 | 40.5 | 33.0 |

   i) Fit the sample linear regression model using least
   ii) Predict fretting wear when viscosity x = 30

11. Describe the procedure of the test of significance for difference of two population mean for large sample. [5]

12. Ten objects were chosen at random from the large population and their weights were found to be in grams 63, 63, 64, 65, 66, 69, 65, 66.1, 64.5. In the light of above data, discuss the suggestion that the mean weight in the population is 65 gm. Use $\alpha = 0.05$. [5]

13. 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 |

14. In a postal survey of 500 households, 330 said that they thought they were being overcharged for the public services within their area. [5]

   i) Calculate an approximate 99% confidence interval for the population proportion, p, of households who thought they were being overcharged for public services within their area.
   ii) Estimate the size of sample required to estimate the value of p to be within 99% confidence limits of ±0.025.

15. Following data gives the sample records of number of passenger take ticket at the counter of Bus during one hour period. [8]

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 22 | 58 | 32 | 36 | 62 | 57 | 25 | 45 | 23 | 37 |
| 64 | 56 | 46 | 60 | 29 | 49 | 63 | 36 | 26 | 58 |
| 60 | 26 | 58 | 58 | 29 | 43 | 53 | 36 | 45 | 22 |
| 52 | 43 | 45 | 31 | 45 | 39 | 35 | 38 | 30 | 60 |
| 58 | 42 | 54 | 62 | 52 | 42 | 65 | 58 | 51 | 60 |
| 53 | 45 | 31 | 53 | 22 | 53 | 51 | 52 | 47 | 59 |

   Find the

   i. Sample mean of Number of passenger
   ii. Sample Standard deviation and Coefficient of variation.
   iii. Standard error of the sample mean.
   iv. Find the 95% and 99% confidence limit of sample mean

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2072 Kartik**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B.Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

***Subject:*** - Probability and Statistic *(SH602)*

- ✓ 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 is absolute and relative Measure of Dispersion? Construct a Box plot from the following data of marks of students as: [1+5]

| Marks | 10-20 | 20-30 | 30-40 | 40-50 | 50-60 |
|---|---|---|---|---|---|
| No. of students | 2 | 6 | 22 | 13 | 7 |

2. State the law of addition of probability. In a training, the 70% of persons achieved a rating of Satisfactory. Of those as rated as Satisfactory, 80% had Acceptable Scores on the personality test. Of those rated as Unsatisfactory, 35% had Acceptable Scores. Find the probability that an applicant would be a Satisfactory trainee given the Acceptable scores on personality test. [2+4]
3. Define Negative binomial distribution with its important characteristics. [5]
4. A particularly long traffic light on your morning commute is green 20% of the time that you approach it. Assume that each morning represents as independent trial. [5]
   i) Over five mornings, what is the probability that the light is green on exactly one day?
   ii) Over 20 mornings, what is the probability that the light is green on exactly four days?
5. The distribution function for a random variable X is [5]

$$F(x) = 1 - e^{-2x} \text{ for } x \geq 0$$
$$= 0 \quad \text{for } x < 0$$

   i) Find $P(X > 2)$
   ii) Find mean and variance of the variable X.
6. Define Standard Normal Distribution with their respective probability density function and describe its properties. [5]
7. An article in Wear (Vol.152, 1992, pp.171-181) presents data on the fretting wear of mild steel and oil viscosity. Representative data follow, with x = oil viscosity and y = wear volume ($10^{-4}$ cubic millimeters). [5]

| y | 240 | 181 | 193 | 155 | 172 | 110 | 113 | 75 | 94 |
|---|---|---|---|---|---|---|---|---|---|
| x | 1.6 | 9.4 | 15.5 | 20.0 | 22.0 | 35.5 | 43.0 | 40.5 | 33.0 |

   i) Fit the simple linear regression model using least
   ii) Predict fretting wear when viscosity x = 30
8. What are the two regression coefficients and what do they represent? Write the properties of regression coefficient. [5]
9. Define Central Limit Theorem. An electronics company manufactures resistors that have a mean resistance of 100 ohms and a standard deviation of 10 ohms. The distribution of resistance is normal. Find the probability that a random sample of 25 resistors will have an average resistance less than 95 ohms. [5]

10. Define standard error of sample mean. A population consist of the four numbers 12, 19, 13, 16. [5]

i) Write down all possible sample size of two without replacement.
ii) Find standard error of the sample mean.

11. Describe the procedure of the test of significance for difference of two population mean for large sample. [5]

12. In the investigation of a citizens' committee complaint about the availability of fire protection within the country, the distance in miles to the nearest fire station was measured for each of five randomly selected residences in each of four areas. [5]

| | | | | | |
|---|---|---|---|---|---|
| Area 1 | 7 | 5 | 5 | 6 | 8 |
| Area 2 | 1 | 4 | 3 | 4 | 5 |
| Area 3 | 7 | 9 | 8 | 7 | 8 |
| Area 4 | 4 | 6 | 3 | 7 | 5 |

Do these data provide sufficient evidence to indicate a difference in mean distance for the four areas at the = 0.05 level of significance?

***OR***

The diameter of steel rods manufactured on two different extrusion machines is being investigated. Two random samples of sizes $n_1 = 15$ and $n_2 = 17$ are selected, and the sample means and sample variances are $\bar{x}_1 = 8.73, s_1^2 = 0.35, \bar{x}_2 = 8.68$, and $s_2^2 = 0.40$, respectively. Assume that $\sigma_1^2 = \sigma_2^2$ and that the data are drawn from a normal distribution. Is there evidence to support the claim that the two machines produce rods with different mean diameters? Use $\alpha = 0.05$ in arriving at this conclusion.

13. A random sample of 500 adult residents of Maricopa County found that 385 were in favor of increasing the highway speed limit to 75 mph, while another sample of 400 adult residents of Pima County found that 267 were in favor of the increased speed limit. Construct 95% confidence interval on the difference in the two proportions. [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? [5]

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

Use 5% level of significance.

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 |

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

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**

**2071 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B.Agri | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

***Subject:*** - Probability and Statistic *(SH602)*

- ✓ 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. Two different sections of a statistics class take the same quiz and the scores are recorded below: [6]

   a) Find the range and standard deviation for each section
   b) What do the range values lead you to conclude about the variation in the two sections?
   c) Why is the range misleading in this case?
   d) What do the standard deviation values lead you to conclude about the variation in two sections?

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Section 1 | 1 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Section 2 | 2 | 3 | 4 | 5 | 6 | 14 | 15 | 16 | 17 | 18 | 19 |

2. Define dependent and independent events with suitable examples. The independent probabilities that the three sections of a costing department will encounter a computer error are 0.2, 0.3 and 0.1 per week respectively. What is the probability that there would be: [6]

   i) At least one computer error per week
   ii) One and only one computer error per week

3. Write the differences and similarities between Binominal and Negative Binominal Distribution. [2+3]

4. A quality control engineer inspects a random sample of 4 batteries from each lot of 24 car batteries that is ready to shipment. If such a lot contain six batteries with slight defects. What are the probabilities that the inspector's sample will contain: [5]

   i) None of the batteries with defect?
   ii) At least two of the batteries with defects?
   iii) At most three of the batteries with defect?

5. A random variable X has the following probability density function as: [5]

$$f(x) = \begin{cases} kx^3(4-x)^2, 0 < x < 1 \\ 0, \text{otherwise} \end{cases}$$

   Find the value of k, using this value of k find mean and variance of distribution.

6. The breakdown voltage X of a randomly chosen diode of a particular type is known to be normally distributed with mean 40 volts and variance 2.25 volts. What is the probability that the breakdown voltage will be: [5]

   i) Between 39 and 42 volts
   ii) Less than 44 volts
   iii) More than 43 volts

***OR***

The daily consumption of electric power in a certain city follow a gamma distribution with $\alpha = 2$ and $\beta = 3$. If the power plant of this city has daily capacity of 12 million kilowatt hours, what is the probability that this power supply will be inadequate on any given day?

7. State central limit theorem. An electrical firm manufactures light bulbs that have a length of life that is approximately normally distributed with mean equal to 800 hours and standard deviation of 4 hours. Find the probability that a random sample of 16 bulbs will have an average life of less than 12775 hours. [5]

8. What do you mean by sampling distribution of a sample mean and its standard Error? What would be the variance of sampling distribution of mean if sample is taken from finite population? [3+1]

9. Define partial and multiple correlation with suitable examples. Write down the properties of partial and multiple correlation. [5]

10. The following data gives the number of twists required to break a certain kind of forged alloy bar and percentage of alloying element A present in the metal. [5]

| Number of twists | 41 | 49 | 69 | 65 | 40 | 50 | 58 | 57 | 31 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|
| Percentage of element A | 10 | 12 | 14 | 15 | 13 | 12 | 13 | 14 | 13 | 12 |

i) Fit the regression equation of number of twists on percentage of element A. Determine the predicted number of twists required to break an alloy when percentage of element is 20.

ii) Find 99% confidence interval for the regression coefficient (i.e.slope)

11. In a certain factory, there are two independent processes manufacturing the same item. The average weight in a sample of 250 items produced from one process is found to be 120 gram with a standard deviation of 12 gram, while the corresponding figures in a sample of 400 items from the other process are 124 and 14 respectively. Test whether the two mean weights differ significantly or not at 5 percent level of significance. [5]

12. Three trained operators work on production of new product. The productivity of the operators are recorded as below: [5]

| Operators | Production | | | |
|---|---|---|---|---|
| 1 | 10 | 12 | 14 | 16 |
| 2 | 12 | 11 | 13 | 15 |
| 3 | 14 | 15 | 12 | 11 |

Using ANOVA test whether the difference in average productivity due to the difference in operators are significant. Use $\alpha = 5\%$

***OR***

Define confidence level and significance level. A company claims that its light bulbs are superior to those of its main competitor. If a study showed that a sample of 40 of its bulbs has mean lifetime of 647 hours of continuous use with standard deviation of 27 hour. While a sample of 40 bulbs made by its main competitor had mean lifetime of 638 hours of continuous use with standard deviation of 31 hours. Does this substantiate claim at 1% level of significance?

13. Write down the steps for testing hypothesis on difference between two population proportions for the large sample size. [5]

14. 1072 students were classified according to their intelligence and economic conditions. Test whether there is any association between intelligence and economic condition. [6]

| Economic Condition | Intelligence | | | |
|---|---|---|---|---|
| | Excellent | Good | Mediocre | Dull |
| Good | 48 | 199 | 181 | 82 |
| Not good | 81 | 185 | 190 | 106 |

23 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2071 Shawan**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B.Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

***Subject:*** -Probability and Statistics *(SH602)*

- ✓ 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 difference between measure of central tendency and measure of dispersion and their importance. The following table represents the marks of 100 students. [6]

| Marks | 0-20 | 20-40 | 40-60 | 60-80 | 80-100 |
|---|---|---|---|---|---|
| No. of Students | 14 | ? | 27 | ? | 15 |

If the mode value is 58, find the missing frequencies and the mean of all 100 students.

2. Define multiplication law of probability for dependent and independent events with suitable examples. The independent probabilities that the three sections of a costing department will encounter a computer error 0.2, 0.3 and 0.1 per week respectively. What is the probability that there would be: [6]
   i) At least one computer error per week?
   ii) One and only one computer error per week?

3. Define Negative binomial distribution with an example. How does the negative binomial distribution differ from binomial distribution? [2+3]

4. A heavy machinery manufacturer has 3840 large generators in the field that are under warranty. If the probability is 1/1200 that any one will fail during the given year, find the probability: [5]
   i) That exactly 3 generators will fail during the given year?
   ii) That between 2 and 6 are fail during the given year?

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

6. The breakdown voltage X of a randomly chosen diode of a particular type is known to be normally distributed with mean 40 volts and variance 2.25 volts. What is the probability that the breakdown voltage will be: [5]
   i) Between 39 and 42 volts
   ii) Between 40 and 43 volts
   iii) Less than 44 volts

   ***OR***

   A probability density function is given by $f(x)=Ax\,(6-x)^2$ for $0 < x < 6$
   i) Find the value of A
   ii) Find the mean and variance of this distribution

7. Define sampling distribution of proportion with example. [4]
8. The monthly income of a particular group of retailer's follows a normal distribution with mean Rs.21,000.00 and standard deviation of Rs.9,487.00. A random sample of size 10 retailers was taken and the mean income is calculated. Find the probability that this sample lies between Rs.18,000.00 and Rs.27,000.00. [6]
9. Define partial correlation and multiple correlations with suitable examples. Write down properties of partial and multiple correlations. [5]
10. The following data gives the number of twists required to break a certain kind of forced alloy bar and percentage of alloying element A present in the metal. [5]

| Number of twists | 41 | 49 | 69 | 65 | 40 | 50 | 58 | 57 | 31 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|
| Percentage of element A | 10 | 12 | 14 | 15 | 13 | 12 | 13 | 14 | 13 | 12 |

   i) Fit the regression equation of number of twists on percentage of element A. Determine the predicted number of twist required to break an alloy when percentage of element is 20.

11. The mean weight loss of n = 16 grinding balls after a certain length of time in mill slurry is 3.42 grams with a standard deviation of 0.68 gram. Construct a 99% confidence interval for the true mean weight loss of such grinding balls under the stated conditions. [4]

'35

12. Four trained operators works on production of new product. The productivity of the operators are recorded as below: [6]

| Operators | Production | | | |
|---|---|---|---|---|
| 1 | 10 | 12 | 14 | 16 |
| 2 | 12 | 11 | 13 | 16 |
| 3 | 14 | 15 | 12 | 11 |
| 4 | 16 | 10 | 17 | 17 |

Using ANOVA, test whether the difference in average productivity due to the difference in operators are significant. Use $\alpha = 5\%$

***OR***

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

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Before | 45 | 73 | 46 | 124 | 33 | 57 | 83 | 34 | 26 | 17 |
| After | 36 | 60 | 44 | 119 | 35 | 51 | 77 | 29 | 24 | 11 |

Use the 0.05 level of significance to test whether the safety program is effective.

13. Define confidence level and significance level. A manufacturer claimed that at least 95% of the cables 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 cables supplied last month and found that 228 cables 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 book containing 500 pages was thoroughly checked. The distribution of number of error page was given below as: [5]

| Number of errors | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Number of pages | 275 | 138 | 75 | 7 | 4 | 1 |

Using chi-square test of goodness of fit, verify whether the arrivals follow a Poisson distribution at 5% level of significance.

15. The sample of length of life of bulbs from two companies are given below: [8]

| Length of Life (hours) | Company | |
|---|---|---|
| | A | B |
| 500-600 | 10 | 3 |
| 600-700 | 21 | 8 |
| 700-800 | 6 | 15 |
| 800-900 | 8 | 12 |
| 900-1000 | 21 | 4 |
| 1000-1100 | 10 | 5 |
| 1100-1200 | 2 | 15 |
| 1200-1300 | 12 | 13 |
| 1300-1400 | 19 | 7 |
| 1400-1500 | 9 | 7 |
| 1500-1600 | 3 | 4 |
| 1600-1700 | 7 | 6 |
| 1700-1800 | 5 | 3 |
| 1800-1900 | 4 | 2 |
| 1900-2000 | 1 | 3 |

i) Calculate mean length of life of bulbs for Company A and Company B.
ii) Calculate sample standard deviation and sample variance for given data.
iii) Which Company's bulbs are more uniform?

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22 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2070 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B.Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

## *Subject:* - Probability and Statistics *(SH602)*

- ✓ 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. Calculate the standard deviation from the following data regarding marks obtained by students in a test: [3+3]

| Marks: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| No. of Students | 32 | 41 | 57 | 98 | 123 | 83 | 46 | 17 | 3 |

What will be the value of standard deviation if the marks obtained by each of the students are increased by one?

2. State Baye's theorem. A manufacturer of air-conditioning units purchases 70% of its thermostats from company A, 20% from company B and the rest from company C. Past experience shows that 0.5% of company A's thermostats, 1% of company B's thermostats and 1.5% of company C's thermostats are likely to be defective. An air-conditioning unit randomly selected from this manufacturer's production line was found to have a defective thermostat. Find the probability that company A supplied the defective thermostat. [2+4]

3. Write the differences and similarities between Binomial probability Distribution and Negative Binomial Probability distribution. [2+3]

4. The number of accident in a year attributes to taxi drivers in a city follows Poisson distribution with mean 3. Out of 1000 taxi driver, find the approximately the number of driver with: [5]

   i) No accidents in a year
   ii) More than 3 accident in a year

5. Define normal distribution. Give the condition for normal approximation of Binomial distribution and Poisson distribution. [6]

6. The time required to assemble a piece of machinery is a random variable having approximately a normal distribution with mean 12.9 minutes and standard deviation of 2 minutes. What are the probabilities that the assembly of a piece of machinery of this kind will take (a) at least 11.5 minutes (b) between 11.0 to 14.8 minutes? [4]

*OR*

The probability density function given by

$$f(x) = cx^2, 0 < x < 3$$
$$0, \text{Otherwise}$$

   i) Find the value constant C?
   ii) Compute $P(1<x<2)$
   iii) Find the distribution function [4]

7. What do mean by central limit theorem? Write its applications.

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 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. [2+4]

9. Define partial correlation and multiple correlations with suitable examples. Write two properties of each. [6]

10. Observation on the yield of a chemical reaction taken at various temperatures was recorded as follows: [4]

| X (°C) | 150 | 150 | 200 | 250 | 250 | 300 | 150 |
|---|---|---|---|---|---|---|---|
| Y% | 75.4 | 81.2 | 85.5 | 89 | 90.5 | 96.7 | 75.4 |

Fit a simple linear regression and estimate value of yield at 200°C.

11. An analysis for pH (acidity) in an random sample of water from 40 rainfalls showed that mean is 6.7 and s.d. is 0.5. Find a 99% confidence interval for the mean pH in rainfalls. [4]

12. As a part of 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 ANOVA to test at the 0.05 level of significance whether the difference among the sample means at the three positions are significant.

***OR***

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

45 and 36, 73 and 60, 46 and 44, 124 and 119, 33 and 35, 57 and 51, 83 and 77, 34 and 29, 26 and 24, 17 and 11. Use the 0.05 level of significance to test whether the safety program is effective.

13. The results of polls conducted two weeks and four weeks before an election are shown in the following table: [5]

| | Two weeks before election | Four weeks before election |
|---|---|---|
| For republican candidate | 79 | 91 |
| For democratic candidate | 84 | 66 |
| Undecided | 37 | 43 |

Use the 0.05 level of significance to test whether there has been change in opinion during the 2 weeks between the polls.

14. A manufacturer of submersible pumps claims that at most 30% of the pumps require within the first 5 years of operation. If a random sample of 120 of these pumps includes 47 which required repairs within the first 5 years, test the null hypothesis $p = 0.30$ against the alternative hypothesis $P > 0.30$ at the 0.05 level of significance. [5]

15. The following data are the ages (in months) at which n = 50 children were first enrolled in a preschool. [8]

| | | | | |
|---|---|---|---|---|
| 38 | 40 | 30 | 35 | 39 |
| 47 | 35 | 34 | 43 | 41 |
| 32 | 34 | 41 | 30 | 46 |
| 55 | 39 | 33 | 32 | 32 |
| 42 | 50 | 37 | 39 | 33 |
| 40 | 48 | 36 | 31 | 36 |
| 36 | 41 | 43 | 48 | 40 |
| 35 | 40 | 30 | 46 | 37 |
| 45 | 42 | 41 | 36 | 50 |
| 45 | 38 | 46 | 36 | 31 |

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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23 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**

**2070 Ashad**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B.Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

*Subject:* - Probability and Statistics *(SH602)*

- ✓ 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. In statistics paper five candidates obtain the marks as 33, 38, 48, 59 and 72. Calculate the mean and standard deviation of these marks. If 10 marks are added for each student, what will be mean and standard deviation? [3+3]
2. Distinguish between mutually exclusive and equally likely events with examples. What is the use of Bayes theorem in theory of probability? In a college 45% students belong to Civil, 30% Electronics and remaining to other faculties. The probability of being top is 5%, 4% and 2% respectively in civil, electronics and others. If this year's result is published, what is the probability that the topper is form electronics? [6]
3. Define poisson probability Distribution. Write the conditions for poisson approximation to Binomial Distribution. [2+3]
4. A quality control engineers inspects a random sample of 3 batteries from each lot of 24 car batteries that is ready to shipment. If such a lot contain six batteries with slight defects, what is the probabilities that the inspector's sample will contain. [5]
   i) None of the batteries with defect?
   ii) Only one of the batteries with defect?
   iii) At least two of the batteries with defect?
5. Define standard normal distribution with area property. [6]
6. The marks obtained by IOE students in statistics are 50 on average with variance 16. If 5000 students have given the exam, find the following: [4]
   a) The number of students securing marks less than 40?
   b) The number of students securing marks between 35 to 60?

   ***OR***

   Let X denotes the amount of time for which a book on two-hour reserve at a college library is checked out by a randomly selected students, and suppose that X has density function $f(x) = kx, 0 \le x \le 2$
   0, otherwise
   a) Find the value of k
   b) Calculate $P(X \le 1)$
   c) Calculate $P(0.5 \le X \le 1.5)$
   d) Calculate $P(1.5 < X)$ [4]
7. Define sampling distribution of mean.
8. Define Central Limit Theorem. In a sample of 16 observations from a normal distribution with mean of 150 and a variance of 256, what is (a) $P(\bar{x} < 160)$ (b) $P(\bar{x} > 142)$ [2+4]
9. What is the difference between correlation and regression? Plot the sample regression line of Y on X. [2+4]

| Speed x | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|
| Stopping distance y | 160 | 240 | 330 | 435 | 500 |

10. What do you mean by correlation coefficient? Show that correlation coefficient lies between -1 and +1. [4]

11. Describe the procedure of the test of significance of difference between two means for large sample. [4]

12. Set up an ANOVA table for the following acre production of data for three varieties of wheat, each growth on 4 plots and state if the variety differences are significant. Use $\alpha = 0.05$ [6]

| Plot of land | Variety of wheat | | |
|---|---|---|---|
| 1 | 6 | 5 | 5 |
| 2 | 7 | 5 | 4 |
| 3 | 3 | 3 | 3 |
| 4 | 8 | 7 | 4 |

***OR***

The following random samples are measurement of the heat producing capacity (in millions of calories per ton) of specimens of coal from two mines:

| | | | | | | |
|---|---|---|---|---|---|---|
| Mine 1 | 8260 | 8130 | 8350 | 8070 | 8340 | - |
| Mine 2 | 7950 | 7890 | 7900 | 8140 | 7920 | 7840 |

Use the 0.01 level of significance to test whether the difference between means of these two samples is significant.

13. What do you mean by chi square distribution? The following test gives the information for the engineering students interest with ability in computer. Is there any significant relationship between interest in engineering and ability in computer? [5]

| Ability in computer | Interest in Engineering | Low | Average | High |
|---|---|---|---|---|
| | Low | 6 | 12 | 32 |
| | Average | 33 | 61 | 18 |

14. Two different types of injection-molding machines are used to from plastic parts. A part is considered defective if it has excessive shrinkage or is discolored. Two random samples, each of size 300, are selected and 15 defective parts are found in the sample from machine 1 while 8 defective parts are found in the sample from machine 2. Is it reasonable to conclude that both machines produce the same fraction of defective parts, using $\alpha = 0.05$? [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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23

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

**2069 Chaitra**

| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX, BCT, B.Agri. | Pass Marks | 32 |
| Year / Part | III / I | Time | 3 hrs. |

*Subject:* - Probability and Statistics *(SH602)*

- ✓ 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 are data on the breaking strength (in pounds) of 3 kinds of material: [2×3]

| | | | | | | |
|---|---|---|---|---|---|---|
| Material 1 | 144 | 181 | 200 | 187 | 169 | 171 |
| Material 2 | 186 | 194 | 176 | 182 | 133 | 183 |
| Material 3 | 197 | 165 | 180 | 198 | 175 | 164 |

   i) Calculate the average breaking strength and the median breaking strength for each material.
   ii) Calculate standard deviation and variance for each material.

2. Define independent and mutually exclusive events with an example. An assembly plant receives its voltage regulators from these three different suppliers, 60% from supplier A, 30% from supplier B and 10% from supplier C. It is also known that 95% of voltage regulators from A, 80% of these from B and 65% these from C perform according to specifications. What is the probability that: [2×3]
   i) Anyone voltage regulator received by the plant will perform according to specifications.
   ii) A voltage regulator that perform according to specification came from B and C.

3. Write difference between binominal distribution and negative binomial distribution with suitable examples. [2+2]

4. Among the 12 solar collectors on display at a trade show, 9 are flat-plate collectors and the others are concentrating collectors. If a person visiting the show randomly selects 6 of the solar collectors to check out, what is the probability that [2+2+2]
   i) Non of them will be flat-plate collectors.
   ii) At least 3 of them will be flat-plate collectors.
   iii) At most 2 of them will be concentrating collectors.

5. Define standard normal distribution. Write down its importance in engineering field. [4]

6. The breakdown voltage X of randomly chosen diode of a particular type is known to be normally distributed with mean 40 and standard deviation 1.5 volts. What is the probability that the breakdown voltage will be [6]
   i) Between 39 and 42 volts
   ii) At most 43 volts
   iii) At least 3.9 volts

***OR***

If a random variable X has a function

$$f(x) = \begin{cases} 2e^{-2x} & \text{for } x > 0 \\ 0 & \text{for } x \le 0 \end{cases}$$

Find (i) Verify that the function is probability density function
(ii) $P(1 < x < 3)$
(iii) Find mean and variance

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

8. A population consists of 5,6,9,12. Consider all possible samples of size two which can be drawn without replacement from this population. Find [2×3]

   i) Population mean and population standard deviation.
   ii) Mean of sampling distribution of mean.
   iii) Standard error of sampling distribution of mean.

9. The simple correlation coefficient between fertilizer ($X_1$), seeds ($X_2$) and productivity ($X_3$) are $r_{12}=0.69$, $r_{13}=0.64$ and $r_{23}=0.85$. Calculate the partial correlation $r_{12.3}$ and multiple correlations $R_{1.23}$. [4]

10. An article in Concrete Research presented data on compressive strength X and intrinsic permeability Y of various concrete mixes and cures. Summary quantities are n = 14, $\Sigma y = 572$, $\Sigma y^2 = 23{,}530$, $\Sigma x = 43$, $\Sigma x^2 = 157.42$ and $\Sigma xy = 1697.80$. Assume that the two variables are related according to the simple linear regression model. [6]

    i) Calculate the least squares estimates of the slope and intercept
    ii) Use the equation of the fitted line to predict what permeability would be observed when the compressive strength is x = 4.3.

11. The following are the breaking strength of three different brands of cables. [6]

| Brand | Breaking strength | | | | | |
|---|---|---|---|---|---|---|
| A | 40 | 30 | 50 | 60 | 30 | - |
| B | 60 | 40 | 55 | 65 | - | - |
| C | 60 | 50 | 70 | 65 | 75 | 40 |

Construction ANOVA table and test for the equality of the average breaking strength of cables at $\alpha$=5%

***OR***

In a manufacturing company the new modern manager is in a belief that music enhances the productivity of workers. He made observations on 6 workers for a week and recorded the production before and after the music was installed. From the data given below, can you conclude that the productivity has indeed changed due to music? ($\alpha$=1%)

| Week without music | 219 | 205 | 226 | 198 | 209 | 216 |
|---|---|---|---|---|---|---|
| Week with music | 235 | 186 | 240 | 203 | 221 | 205 |

12. A random sample of size 16 showed a mean of 52 with a standard deviation 4. Obtain 99% and 95% confidence limits population mean. [4]

13. From the following data can you conclude that there association between the purchase of brand and geographical region using Chi-square test at $\alpha$=1%? [5]

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

14. What are the steps in hypothesis testing? A study shows that 16 of 200 computers produced on one assembly need readjustment before shipping while same happens on 14 out of 300 produced. Test at 1% level of significance that the second assembly is superior than first one? [5]

15. Entrance scores of three engineering institutes is as follows: [1+2+2+3]

| Institutes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A | 740 | 800 | 830 | 840 | 860 | 890 | 830 | 930 | 1070 |
| B | 655 | 775 | 825 | 978 | 989 | 1025 | 950 | 980 | 1100 |
| C | 850 | 825 | 749 | 870 | 565 | 978 | 925 | 950 | 1000 |

Calculate mean, standard deviation, coefficient of variation and answer the following

i) Which institute is good?
ii) Which institute is consistent/reliable?

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