

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

2083 Baishakh

Exam.	Back (New Course)		
Level	BE	Full Marks	60
Programme	BCE,BEL,BME BAS,BAG	Pass Marks	24
Year / Part	II / II	Time	3 hrs.

Subject: - Probability and Statistics (ENSH 253)

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

1. Discuss difference between range and standard deviation. The running capacity (in units) of two machines, Machine A and Machine B, is recorded below:

Machine A	250	255	280	290	295	300
Machine B	280	282	290	295	298	295

Determine which machine shows more consistency in running capacity. Justify your answer using an appropriate statistical measure.

2. Define the additive law of probability for independent event, Probability that a man will be alive 25 years hence is 0.3 and the probability that his wife will be alive 25 years hence is 0.4. Find the probability that 25 years hence.
- a) Both will be alive b) Probability that at least one will be alive
3. Differentiate between discrete random variable and continuous random variable. If the probability density of a random variable is given by

$$f(x) = \begin{cases} (k+2)x^2 & \text{for } 0 < x < 1 \\ 0 & \text{for elsewhere} \end{cases}$$

- a) Find the value k and the probability that the random variable takes on a value
b) Greater than $3/4$
4. A university computer lab contains a network of 10 computers. A newly developed malware is known to infect each computer independently with a probability of 0.3.
- a) Define its random variable, and which probability distribution belongs to this problem. And why?
- b) What is the probability that the malware infects at least 5 computers in the network?
- c) What is the probability that the malware infects at most 4 computers in the network?
5. Discuss the relationship between the Normal Distribution and the Standard Normal Distribution. The life spans of LED bulbs manufactured by a company are normally distributed with a mean of 3,500 hours and a standard deviation of 700 hours. A municipality has installed 3,000 street lamps using this type of bulb. Estimate how many bulbs are expected to fail and need replacement within 1,800 operating hours.

OR

Define the Central Limit Theorem.

An electrical engineer is analyzing the voltage output (in volts) of a particular type of power regulator. The voltage output in the population is normally distributed with a mean of 50 volts and a standard deviation of 10 volts. A random sample of 25 regulators is selected for testing.

- a) What are the mean and standard deviation of the sampling distribution of the sample mean voltage?
- b) What is the probability that the sample mean voltage exceeds 52 volts?
6. Discussion: Parameter vs. Statistic in Statistics with suitable example.
- A sample of 100 iron rods is drawn from a large population of rods whose lengths are normally distributed with a mean of 4 ft and a standard deviation of 0.6 ft. If the sample mean is 4.6 ft, calculate the 95% confidence limits for the population mean.

7. If a researcher intends to apply ANOVA (Analysis of Variance) to analyze her data, what are the essential steps she should follow? Explain each step in detail.
8. An engineer wants to evaluate whether a newly applied pavement treatment significantly improves slip resistance (skid resistance). Slip resistance was measured on 8 different road sections before and after the treatment using a standardized scale. The recorded data are as follows:

Section	1	2	3	4	5	6	7	8
Before treatment	12	14	11	8	7	10	5	6
After treatment	15	16	13	9	9	12	8	8

Using an appropriate statistical test, determine whether the new treatment has a significant effect on improving slip resistance.

9. In a statistics course, students were graded based on the number of correct answers (out of 4 questions) they provided in an assessment. The grades were assigned as follows:

Grade	A	B	C	D	F
X(correct answer)	4	3	2	1	0
Observe frequency	14	18	32	20	16

Assuming that the number of correct answers follows a binomial distribution with parameters $n = 4$ and $p = 0.5$, test the hypothesis at the 0.05 level of significance that the observed grade distribution fits the binomial model.

10. The following data represent measurements of Total Dissolved Salts (TDS) and the corresponding Hardness Index (in ppm) for 8 water samples:

Sample Number	1	2	3	4	5	6	7	8
TDS (gm/L)	200	325	110	465	580	925	680	290
Hardness Index (ppm)	15	24	8	34	43	69	50	21

- Plot a scatter diagram of Hardness Index versus TDS
 - Calculate the correlation coefficient (r) between TDS and Hardness Index.
 - Based on the correlation value, interpret the relationship between TDS and Hardness Index.
11. Define the relation between correlation coefficient and regression coefficient. The following are measurements of the air velocity and evaporation coefficient of burning fuel droplets in an impulse engine:

Air velocity (cm/s)	20	60	100	140	180	220	260
Evaporation coefficient (mm ² /s)	0.18	0.37	0.35	0.78	0.56	0.75	1.18

Fit a straight line to these data by the method of least squares, and use it to estimate the evaporation coefficient of a droplet when the air velocity is 190 cm/s.

12. An engineer is monitoring the average thickness of an asphalt (blacktop) layer being placed on a highway. To ensure quality control, the engineer takes 4 random thickness measurements from each of 5 different sections (subgroups), with each subgroup measured after a new batch of asphalt (blacktop) is applied. The target thickness is 50 mm.

Section	1	2	3	4	5
Average Thickness ($\bar{X}$) mm	50.150	49.975	49.975	50.100	49.900
Range (R) mm	0.70	0.60	0.60	0.60	0.60

Subgroup size $n = 4$

$A_2 = 0.729$ (from control chart constants for $n = 4$)

Using $\bar{X}$ control chart, determine whether the asphalt (blacktop) laying process is statistically in control.

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- ✓ Attempt **All** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ **Necessary Tables are attached herewith.**
- ✓ Assume suitable data if necessary.

1. The following data represent the attendance (in days) of students in a particular subject at a certain college, recorded separately for boys and girls: [5]
- Boys :12, 13, 14, 15, 15, 16, 17, 18, 19, 20
Girls :5, 23, 12, 16, 18, 19, 23, 28, 18, 20

- Prepare a 5-point summary for both boys and girls.
- Raw boxplots for both groups on the same scale.
- Interpret the results in terms of attendance distribution and variability between boys and girls.

2. Define Baye's Theorem. In a factory that manufactures touch screens for mobile phones, production is distributed among three machines: machine A, machine B, and machine C. Machine A is responsible for 30% of the total production, machine B accounts for 40%, and the remaining 30% comes from machine C. However, not all touch screens are free of defects. It is observed that 8% of the touch screens produced by machine A are defective, while 6% of those from machine B and 12% from machine C are found to be defective. [5]

- If a touch screen is randomly chosen from the production line and is found to be defective, what is the probability that it was produced by machine A?
- If a touch screen is randomly chosen from the production line and is found to be defective, what is the probability that it was produced by machine B?
- If a touch screen is randomly chosen from the production line and is found to be defective, what is the probability that it was produced by machine C?

3. A random variable X has the following probability distribution: [5]

X	-1	0	1	2
P(x)	1/3	K	1/6	1/3

Find;

- The value of k
- Mean and standard deviation of distribution

4. Discuss the condition for poisson distribution. [5]

A traffic engineer has recorded that on average 2.5 traffic accidents occur per month at a particular intersection. What is the probability that

- exactly 2 accidents
- at least 1 accident
- at most 3 accidents will occur at the intersection in a randomly chosen month?

5. Define the normal distribution. A city installs 2,000 electric lamps for street lighting. The burning life of these lamps follows a normal distribution, with a mean of 1,000 hours and a standard deviation of 200 hours. [5]

- What is the probability that a lamp will burn for exactly 900 hours?
- After how many burning hours would we expect 10% of the lamps to still be working?

OR

Discuss the importance of central limit theorem.

A population consists of five numbers: 3, 5, 6, 8 and 10.

- Write down all possible sample size of 2 without replacement.
- Verify that population mean is equal to the mean of sample mean.

6. A engineering researcher wants to estimate the average compressive strength certain material. Suppose population the standard deviation of compressive strength is estimated to be 5MPa. [5]

The researcher wants the estimate to be maximum error within ± 1 MPa of the true mean with 95% confidence. How much sample should she collect?

7. If researcher wants to apply chi test for independence of two qualitative variable, what steps she should follow write in detail? [5]

8. Two types of drugs were used on 7 and 7 patients for reducing their weight. Drug A was imported and drug B was indigenous. The decrease in the weight after using the drugs for six months was as follows: [5]

Drug A	10	12	13	11	14	15	16
Drug B	8	9	12	14	15	10	9

Test whether there is a statistically significant effective to reduce weight Drug A than Drug B at an appropriate level of significance.

9. A engineering company is analyzing the distribution of defects found in blocks manufactured in one of its plants. The expected distribution (based on historical data) of defect types is as follows: [5]

Defect Type	Cracks	Air Bubbles	Surface Roughness	Uneven Edges
Expected Proportion	30%	25%	25%	20%

In a recent inspection of 200 concrete blocks, the following observed frequencies of defects were recorded:

Defect Type	Cracks	Air Bubbles	Surface Roughness	Uneven Edges
Observed Frequency	70	50	40	40

Using the Chi-square goodness-of-Fit test, determine whether the observed distribution of defects significantly differs from the expected distribution. Use a 5% level of significance.

10. Discuss the properties of correlation coefficient (r). [5]
Find Karl Pearson's coefficient correlation from the bi-variate distribution of curing time and compressive strength (MPa) of concrete. Also compute coefficient of determination and interpret it.

Curing time (days)	3	7	14	21	28	35	42
Com. Str. (MPa)	18	24	29	32	35	37	39

11. A transportation engineer is studying the factors that influence the pavement deterioration index (PDI) of highways, lower values mean more deterioration. From the data set given in the following table. [5]

- a) Find the regression equation of PDI on ADT (Average daily traffic in '000' vehicles),
b) Estimate the PDI when ADT is 32,000

Section	1	2	3	4	5	6	7	8	9	10
PDI	72	68	59	63	70	55	50	62	48	58
ADT	12	18	22	16	14	25	28	20	30	24

12. An inspector selects 10 samples, each of size 200, from 10 different lots of a production process. The number of defective items found in each sample is recorded as follows: [5]

Lot	1	2	3	4	5	6	7	8	9	10
Number of defective	8	12	2	20	10	15	6	20	13	9

- a) Calculate the control limits for the number of defective items using a p-chart (proportion defective chart).
b) Plot the control chart, indicating the control limits and points for each sample.
c) Determine whether the process is statistically under control, based on the plotted chart.
