

## 80 Problems in Statistics

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- 1- Define the following:  
a)Histogram. b)Experiment. c)Sample Space. d)Event. e)Conditional Probability.
- 2- What are the differences between Interval and Ratio scale?
- 3- State the differences between Mean deviation and Standard deviation?
- 4- Define Marginal and conditional probability?
- 5- What is the difference between descriptive statistics and inferential statistics?
- 6- Write the data types according to their level of measurements.
- 7- Draw three normal distribution curves having the same mean but different standard deviations.
- 8- Define the following: a) Population b) Sample c) Conditional Probability
- 9- What is the difference between the: a) Qualitative and Quantitative data b)Interval scale and ratio scale.
- 10- What is the difference between the population and the sample?
- 11- What are the types of relationships which can be concluded in a scatter plot? Explain the answer by sketches.
- 12- The same dimension was measured on each of six successive parts as they came off a production line. The results were 21.14 mm, 21.87 mm, 21.53 mm, 21.37 mm, 21.61 mm and 21.93 mm. Calculate the mean and median.
- 13- Four items in a sequence were measured as 50, 160, 100, and 400 mm. Find their arithmetic mean, geometric mean, and median.
- 14- The temperature in a chemical reactor was measured every half hour under the same conditions. The results were 78.1°C, 79.2°C, 78.9°C, 80.2°C, 78.3°C, 78.8°C, 79.4°C. Calculate the mean, median, lower quartile, and upper quartile.
- 15- In the period of the last five years, the inflation rate was 21%, 24%, 30, 35, and 44%. Find the geometric, harmonic, and quadratic mean of the inflation rate for these five years.
- 16- The following are the compressive strength data for 21 concrete Blocks. Draw the histogram and frequency polygon for the data. Use six classes.  
7.0 11.2 8.5 10.5 10.2 8.9 6.0 11.7 11.5 9.5 12.0 7.4 11.4 12.8 8.0 11.1  
9.0 14.0 11.0 10.1 9.8
- 17- Calculate the Coefficient of variation for the following Data:  
35.3 28.5 36.1 27.1 33.0 32.0 25.2 24.4 29.5 38.3 26.2
- 18- Draw the Boxplot and state the shape of the data, right-skewed, left-skewed, or bell-shaped.  
9.2 6.3 7.2 5.4 6.6 6.4 5.1 4.8 5.9 7.6 5.2
- 19- The following data is the compressive strength of concrete cubes in MPa, for a concrete mix. Calculate the mean and standard deviation.  
47.849.0 51.4 46.6 50.2 48.4 52.0 49.6 47.2 52.6 45.4 50.8 46.0
- 20- Arrange the following data into a frequency distribution table, using eight classes. Then, Determine the Mean, Mode, and third quartile.

95.2	87.9	92.7	83.0	90.4
95.6	88.3	93.1	84.3	91.2
96.1	89.1	93.7	85.2	91.6
96.8	89.5	94.1	86.3	91.8
97.4	90.0	94.3	86.5	92.1
98.4	90.2	94.5	87.2	92.5

21- Draw the frequency polygon for the following frequency distribution table.

class	Frequency
30 – 40	9
40 - 50	11
50 - 60	16
60 - 70	26
70 - 80	15
80 - 90	9
90 - 100	4

22- Calculate the Coefficient of variation for the following frequency distribution table.

class	Frequency
10 – 15	6
15 - 20	9
20 - 25	13
25 - 30	22
30 - 35	13
35 - 40	7

23- For the frequency distribution table shown, calculate the quadratic mean.

Class boundary	40 - 45	45 - 50	50 - 55	55 - 60	60 - 65	65 - 70	70 - 75
Frequency	4	6	10	12	8	6	2

24- The following frequency distribution table is constructed for a sample of cube compressive strength data. Determine the Mod and Third quartile.

class	Frequency
25 – 28	4
28 - 31	12
31 - 34	21
34 - 37	24
37 - 40	13
40 – 43	6

25- Arrange the following data into a frequency distribution table, using five classes.

115 132 159 168 141 120 137 94 161 152 155 175  
 125 90 124 130 139 145 187 144 111 156 134 135

26- Arrange the following data into a frequency distribution table, using five classes.

- Draw the frequency polygon.
- Calculate the mean and mode.
- Find the 65th percentile.

115	132	159	168
141	120	137	94
161	152	155	175
125	90	124	130
139	145	187	144
111	156	134	135

27- Determine the 3rd quartile, geometric mean, and harmonic mean, for the following data:

0.5                      0.42                      0.63                      0.68                      0.3                      0.32                      0.58

28- The flexural strength and dimension test was carried out on 500 tiles. The results are shown in the table. What is the probability that the results of a randomly selected tile are successful in the two tests? Calculate P(OK / Less than min. required).

Compressive strength	Size	
	OK	Not OK
More than min. required	437	36
Less than min. required	23	4

- 29- In a sample of 30 concrete blocks, 6 of which are defective. If three blocks are selected randomly, without replacement, from this sample. What is the probability that two are defective from the three one selected ?
- 30- 260 bolts are examined as they are produced. Five of them are found to be defective. On the basis of this information, estimate the probability that a bolt will be defective.
- 31- Three nuts with metric threads have been accidentally mixed with twelve nuts with U.S. threads. To a person taking nuts from a bucket, all fifteen nuts seem to be the same. One nut is chosen randomly. What is the probability that it will be metric?
- 32- A bag contains 6 red balls, 5 yellow balls and 3 green balls. A ball is drawn at random. What is the probability that the ball is: (a) green, (b) not yellow, (c) red or yellow?
- 33- A sample of four electronic components is taken from the output of a production line. The probabilities of the various outcomes are calculated to be:  $\Pr [0 \text{ defectives}] = 0.6561$ ,  $\Pr [1 \text{ defective}] = 0.2916$ ,  $\Pr [2 \text{ defectives}] = 0.0486$ ,  $\Pr [3 \text{ defectives}] = 0.0036$ ,  $\Pr [4 \text{ defectives}] = 0.0001$ . What is the probability of at least one defective?
- 34- A machinist produces 22 items during a shift. Three of the 22 items are defective and the rest are not defective. In how many different orders can the 22 items be arranged if all the defective items are considered identical and all the non-defective items are identical of a different class?
- 35- An engineer in technical sales must visit plants in Erbil, Suleimani, and Duhok. How many different sequences or orders of visiting these three plants are possible?
- 36- Four of the light bulbs in a box of ten bulbs are burnt out or otherwise defective. If two bulbs are selected at random without replacement and tested, (i) what is the probability that exactly one defective bulb is found? (ii) What is the probability that exactly two defective bulbs are found?
- 37- Past records show that 4 of 135 parts are defective in length, 3 of 141 are defective in width, and 2 of 347 are defective in both. Use these figures to estimate probabilities of the individual events assuming that defects occur independently in length and width.
- a) What is the probability that a part produced under the same conditions will be defective in length or width or both?
- b) What is the probability that a part will have neither defect?
- c) What are the fair odds against a defect (in length or width or both)?

- 38- The tensile strength and diameter test was carried out on 1000 steel bars. The results are shown in the table. It is known that the steel bar that not successful in any of the two tests is rejected. What is the probability that a randomly selected steel bar is rejected? Are the events (Less Than required) and (Too Thin) independent?

Strength	Diameter		
	Too Thin	OK	Too Thick
OK	38	900	4
Less than required	12	28	18

- 39- For a factory of concrete blocks, the compressive strength and dimension test was carried out on 1000 concrete blocks. The results are shown in the table. What is the probability that the results of a randomly selected block are successful in the two tests?

Compressive strength	Size	
	OK	Not OK
More than min. required	874	72
Less than min. required	46	8

- 40- Suppose that two factories (A and B) supply light bulbs to the market. Factory A supplies 60% of the total bulbs available, and factory B supplies 40% of the total bulbs available. Factory A's bulbs work for over 5000 hours in 98% of cases, whereas factory B's bulbs work for over 5000 hours in 93% of cases. Determine each of the following:

- a) The probability that a randomly selected bulb works for longer than 5000 hours.
- b) The probability that a randomly selected bulb was supplied by factory B and works for lesser than 5000 hours.
- c) The probability that a randomly selected bulb was supplied by factory A or it works lesser than 5000 hours.

41- From a total of fourteen concrete cylinders, five concrete cylinders have strength less than required by the specification. Three cylinders are selected randomly, without replacement, from this sample. Draw the Tree Diagram. What is the probability that at least two are having strength more than required by the specification?

42- In a total of 30 concrete blocks, 5 of which are defective. If two blocks are selected at random (without replacement) from these blocks, what is the probability that both are good?

43- In a sample of 40 concrete tiles that were manufactured by two companies A and B, 15 were manufactured by company A. 8 tiles are the total defective. From the 15 tiles that were manufactured by company A, 2 are defective.

- a) Draw the tree diagram.
- b) What is the probability (company B I G)?

44- Three different machines M1, M2, and M3 are used to produce similar electronic components. Machines M1, M2, and M3 produce 20%, 30% and 50% of the components respectively. It is known that probabilities that the machines produce defective components are 1% for M1, 2% for M2, and 3% for M3. If a component is selected randomly from a large batch, and that component is defective, find the probability that it was produced: (a) by M2, and (b) by M3.

45- The length and diameter test were carried out on 500 steel rods. The results are shown in the table.

Length	Diameter		
	Too Thin	OK	Too Thick
Too short	5	2	10
OK	2		17
Too long		23	1
	14		500

- a) Fill the empty cells with an appropriate number.
- b) Are the events (Too long) and (Too Thin) independent?
- c) Calculate the  $P(\text{Too Thick} | \text{Too short})$ .

46- A company produces machine components which pass through an automatic testing machine. 5% of the components entering the testing machine are defective. However, the machine is not entirely reliable. If a component is defective, there is 4% probability that it will not be rejected. If a component is not defective, there is 7% probability that it will be rejected.

- a) What is the probability that a randomly selected component was rejected?
- b) A rejected component was selected randomly. What is the probability that it is for not defective components?
- c) The probability that a randomly selected component was not defective and accepted.

47- In a sample of 50 concrete blocks that were manufactured on two machines. 30 were manufactured on Machine I. 7 blocks are the total defective. From the 30 blocks that were manufactured on Machine I, 4 are defective. Let A be the event that a randomly selected block is defective, and let C be the event that a randomly selected block was manufactured on Machine I. Are events A and C independent?

48- A company manager proposed that all employer take a course in management. 900 employer (E) and people (P) asked about their opinions on this issue. The table gives a two-way classification of the responses of these employers and people.

	Favor (F)	Oppose (O)	Neutral (N)
Employer (E)	135	45	29
People (P)	270	331	90

- a) Determine  $P(E \text{ and } O)$ .
- b) Find  $P(P \text{ or } F)$ .
- c) Are the two events P and N independents?

49- Past records show that 3% of parts are defective in length, 2% are defective in width, and 0.6% are defective in both.

- a) What is the probability that a part produced under the same conditions will be defective in length or width?
- b) What is the probability that a part will have neither defect?

50- A university president proposed that all students take a course in English as a requirement for graduation. Four hundred academic staff (A) and students (S) from this university were asked about their opinions on this issue. The table gives a two-way classification of the responses of these academic staff and students.

	Favor (F)	Oppose (O)	Neutral (N)
Academic Staffs (A)	60	20	13
Students (S)	120	147	40

- a) Determine  $P(A \text{ and } F)$ .
- b) Find  $P(A \text{ or } F)$ .
- c) Are the two events A and N independent, or no?
- 51- A set of bricks contain 20 bricks (8 hollow and 12 solids). If three bricks are selected randomly without replacement.

- a) What is the probability that the third one is solid?
- b) Determine the Probability of two hollow from these three selected bricks.

52- The following table presents the data of 200 samples of steel bars.

- a) Fill the empty cells with an appropriate number.
- b) Calculate the conditional probability that a randomly selected steel bar is a 16 mm diameter given that this steel bar is good.

Bar diameter	Quality		
	defective	good	
12 mm	18		120
16 mm		68	
			200

53- An oil company is bidding for the right to drill a well in field A and a well in field B. The probability it will drill a well in field A is 40%. If it does, the probability the well will be successful is 45%. The probability it will drill a well in field B is 30%. If it does, the probability the well will be successful is 55%. Calculate each of the following probabilities:

- a) probability of a successful well in field A.
- b) probability of both a successful well in field A and a successful well in field B.
- c) probability of no successful well in field B.
- d) probability of at least one successful well in the two fields together,
- e) probability of exactly one successful well in the two fields together.

54- Flip three coins at same time. Let  $x$  be the number of heads showing.

- a- Write the probability distribution of  $x$ .
- b- Find the probability that the number of heads showing is at least 2.

55- A new regulation was prepared to apply by the students. 90% of the students agree with this new regulation. Let  $x$  be the number of students who disagree with this new regulation. If three students are selected randomly. Write the probability distribution of  $x$ .

56- The probabilities of various numbers of failures in a mechanical test are as follows:  $\Pr[0 \text{ failures}] = 0.21$ ,  $\Pr[1 \text{ failure}] = 0.43$ ,  $\Pr[2 \text{ failures}] = 0.28$ ,  $\Pr[3 \text{ failures}] = 0.08$ ,  $\Pr[\text{more than 3 failures}] = 0$ .

- a) Show this probability function as a graph.
- b) Sketch a graph of the corresponding cumulative distribution function.

57- Three items are selected at random without replacement from a box containing ten items, of which four are defective. Calculate the probability distribution for the number of defectives in the sample. What is the expected number of defectives in the sample?

58- According to previous observations, 21% of bricks manufactured by a company have strength less than the minimum required. A sample of 24 bricks was selected randomly from this company. Determine

the probability that exactly 20 of these 24 bricks have strength more than the minimum required. Find the mean and standard deviation of the probability distribution of  $x$  if  $x$  is the number of bricks that have a strength less than the minimum required.

- 59- Under normal operating conditions 1.5% of the transistors produced in a factory are defective. An inspector takes a random sample of forty transistors and finds that two are defective. a) What is the probability that exactly two transistors will be defective from a random sample of forty under normal operating conditions? b) What is the probability that more than two transistors will be defective from a random sample of forty if conditions are normal?
- 60- Twelve doughnuts sampled from a manufacturing process are weighed each day. The probability that a sample will have no doughnuts weighing less than the design weight is 6.872%.  
a) What is the probability that a sample of twelve doughnuts contains exactly three doughnuts weighing less than the design weight?  
b) What is the probability that the sample contains more than three doughnuts weighing less than the design weight?  
c) In a sample of twelve doughnuts, what is the expected number of doughnuts weighing less than the design weight?
- 61- A machine produces parts that are very difficult to make. It turns out that 1 out of 20 are defective and must be thrown out.  
a) What is the probability that a sample of 10 parts will contain 10 good parts?  
b) What is the probability that a sample of 30 parts will contain at least 27 good parts?
- 62- According to previous observations, 18% of bricks manufactured by a company have strength less than the minimum required. A sample of 30 bricks was selected randomly from this company. Determine the probability that exactly 22 of these 30 bricks have strength more than the minimum required.
- 63- On the basis of past experience, the probability that a certain electrical component will be satisfactory is 0.98. The components are sampled item by item from continuous production. In a sample of 15 components, what are the probabilities of finding (a) zero, (b) exactly one, (c) two or more defectives?
- 64- Seven percent of all Tiles manufactured by a company are defective. A quality control inspector randomly selects 30 tiles from the production line. What is the probability that exactly one of these 30 tiles is defective.
- 65- Eight percent of all Tiles manufactured by a company are defective. A quality control inspector randomly selects 40 tiles from the production line. Find the mean and standard deviation of the probability distribution of  $x$  if  $x$  is the number of defective tiles.
- 66- According to previous observations, 12% of concrete blocks manufactured by a company is defective. A sample of 16 concrete blocks was selected randomly from this company.  
a) Determine the probability that exactly 3 of these 16 blocks are defective.  
b) Find the probability that at least 12 of these 16 blocks are not defective.
- 67- Suppose the life of a machine manufactured by a company has a normal distribution with a mean of 60 months and a standard deviation of 8 months. The company guarantees that a new one will replace any machine damaged within 40 months of the purchase. What is the probability of machines manufactured by this company, which is replaced by a new one?
- 68- The strengths of individual steel bars made by a certain manufacturing process are approximately normally distributed with mean 446 MPa and standard deviation 24.4 MPa. To ensure safety, a customer requires at least 95% of the bars to be stronger than 420 MPa. Do the bars meet the specification?
- 69- The compressive strength of samples of cement can be modeled by a normal distribution with a mean of 25.6 MPa and a standard deviation of 2.8 MPa.  
(a) What is the probability that a sample's strength is less than 30 MPa?  
(b) What is the probability that a sample's strength is between 22 and 28 MPa?

- 70- The time until recharge for a battery in a laptop computer under common conditions is normally distributed with a mean of 260 minutes and a standard deviation of 50 minutes.
- What is the probability that a battery lasts more than four hours?
  - What are the quartiles (the 25% and 75% values) of battery life?
- 71- The diameter of a shaft in an optical storage drive is normally distributed with mean 6.4 mm and standard deviation 0.013 mm. The specifications on the shaft are  $6.3 \pm 0.03$  mm. What proportion of shafts conforms to specifications?
- 72- In Erbil city 2500 electric lamps are installed for street lighting. The lamps come from a different manufacturer and have a mean burning life of 1050 hours. We know from past experience that the distribution of burning lives approximates a normal distribution. The 250th lamp fails after 819 hours. Approximately what is the standard deviation of burning lives for this set of lamps?
- 73- What is the probability that Z for a normal probability distribution is between  $-0.76$  and  $+0.76$ ?
- 74- Diameters of bolts produced by a particular machine are normally distributed with mean 7.6 mm and standard deviation 0.15 mm. Specifications call for diameters from 7.3 mm to 7.8 mm.
- What percentage of bolts will meet these specifications?
  - Calculate the first quartile percentile.
- 75- Compressive strength tests were conducted for a large number of concrete cubes. These cubes have a mean compressive strength of 45 MPa with a standard deviation of 12 MPa. Assume that the normal distribution is a close approximation to this case.
- What is the probability that a cube has a compressive strength of more than 30 MPa?
  - Determine the 65th percentile?
- 76- A city installs 3000 electric lamps for street lighting. These lamps have a mean burning life of 1000 hours with a standard deviation of 250 hours. The normal distribution is a close approximation to this case.
- What is the probability that a lamp will fail in the first 750 burning hours?
  - What is the probability that a lamp will fail between 950 and 1250 burning hours?
- 77- Suppose the life of a machine manufactured by a company has a normal distribution with a mean of 80 months and a standard deviation of 9 months. The company guarantees that a new one will replace any machine damaged within 36 months of the purchase. What should the warranty period be to replace a damaged machine if the company does not want to replace more than 3.5% of all the machines?
- 78- The strengths of individual bars made by a certain manufacturing process are approximately normally distributed with mean 200 MPa and standard deviation 20 MPa. To ensure safety, a customer requires at least 95% of the bars to be stronger than 165 MPa
- Do the bars meet the specification?
  - What is the probability that a bar has strength between 175 and 230 MPa?
- 79- The shear resistance of soil,  $y$  ( $\text{kN/m}^2$ ), is determined by measurements as a function of the normal stress,  $x$  ( $\text{kN/m}^2$ ). The data are as shown below:

$x_i$	10	11	12	13	14	15	16	17	18	19
$y_i$	14.1	15.6	16.9	17.7	18.3	20.0	21.0	21.7	22.6	24.0

Find the equation of the regression line of  $y$  on  $x$ .

- 80- An article in the Journal described a study investigating the relationship between noise exposure and hypertension. The following data are representative of those reported in the article.

(a) Draw a scatter diagram of  $y$  (blood pressure rise in milli meters of mercury) versus  $x$  (sound pressure level in decibels).

(b) Find the simple linear regression model.

$y$	1	0	1	2	5	1	4	6	2	3
$x$	60	63	65	70	70	70	80	90	80	80
$y$	5	4	6	8	4	5	7	9	7	6
$x$	85	89	90	90	90	90	94	100	100	100