THE OPEN UNIVERSITY OF SRI LANKA
Faculty of Engineering Technology
Department of Mathematics & Philosophy of Engineering

Bachelor of Industrial Studies Honours

265

Final Examination (2022/2023)
MHZ3576: Statistics for Industrial Studies

Date: 9th February 2024 (Friday) **Time: 0930 hrs. – 1230 hrs.**

Instructions:

Index No:

Part A is Compulsory

- *Provide short answers in the given space.*
- *Do not need to show any workings.*

- *Answer **five (05)** questions only out of seven (07) questions from **Part B**.*
  - *Provide answers in separate sheets (answer booklet) which will be provided in the examination.*
  - *Show all your workings.*
- *The number of pages in the paper is **Six (06)**.*
- *All the symbols are in standard notation unless they are defined.*
- *All the relevant statistical tables and equations are provided.*
- ***Attach Part A to the Answer script of Part B.***

Part A

Provide short answers in the given space. Do not need to show any workings or works. Please attach this part to your answer script.

1. Write down the sample space of tossing 2 coins.

Answer.....

[10%]

2. Let A and B be two independent events such that $P(A \cap B) = \frac{1}{10}$ .If it is given $P(A \cup B) = \frac{1}{2}$ and B has a probability of occurring twice that of A.Then find the values of $P(A)$ and $P(B)$.

Answer.....

[10%]

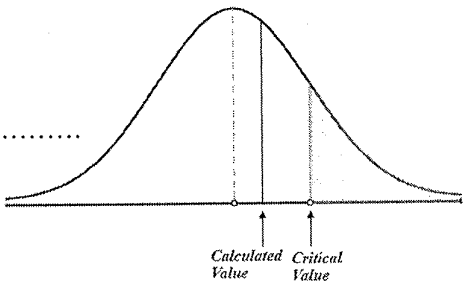
3. A textile company wants to examine the impact of various dyeing temperatures on the colorfastness of a particular fabric. Identify the response and predictor variables related to the above experiment.

Answer.....

[10%]

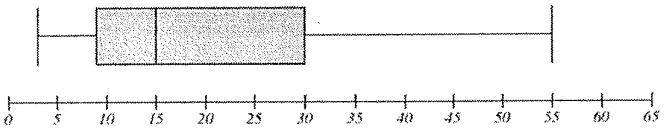
4. What is the decision that can be made according to the position of calculated and critical Z values as displayed in the graph when doing hypothesis testing?

Answer.....
.....



[10%]

5. What can you say about the shape of the distribution, which is represented by the following box and whisker plot?



Answer.....

[10%]

6. A factory manager wants to analyze the sales performance of different clothing categories over the past six months. The following tables represent the data he obtained.

	Sales Performance (in million rupees)					
Category	January	February	March	April	May	June
A	10	12	8	9	11	12
B	8	9	10	11	12	10
C	5	6	7	5	6	5
D	7	6	8	7	5	6

Suggest a suitable graph/chart to visualize the above data to highlight the sales trend.

Answer.....

[10%]

7. A fashion designer wants to have a fitting session to get feedback on the fit and comfort of her new jeans. She selects 50 customers at random from their database and invites them to the fitting session. State the sampling technique being used in this situation.

Answer.....

[10%]

8. Quality inspector of a certain garment factory is inspecting rolls of fabric for defects. If the number of rolls he needs to inspect before finding a defective one follows a geometric distribution with parameter p, obtain the variance of the distribution.

Answer.....

[10%]

9. What is the objective of inferential statistics?

Answer.....

[10%]

10. What is the difference between a nominal scale and an ordinal scale?

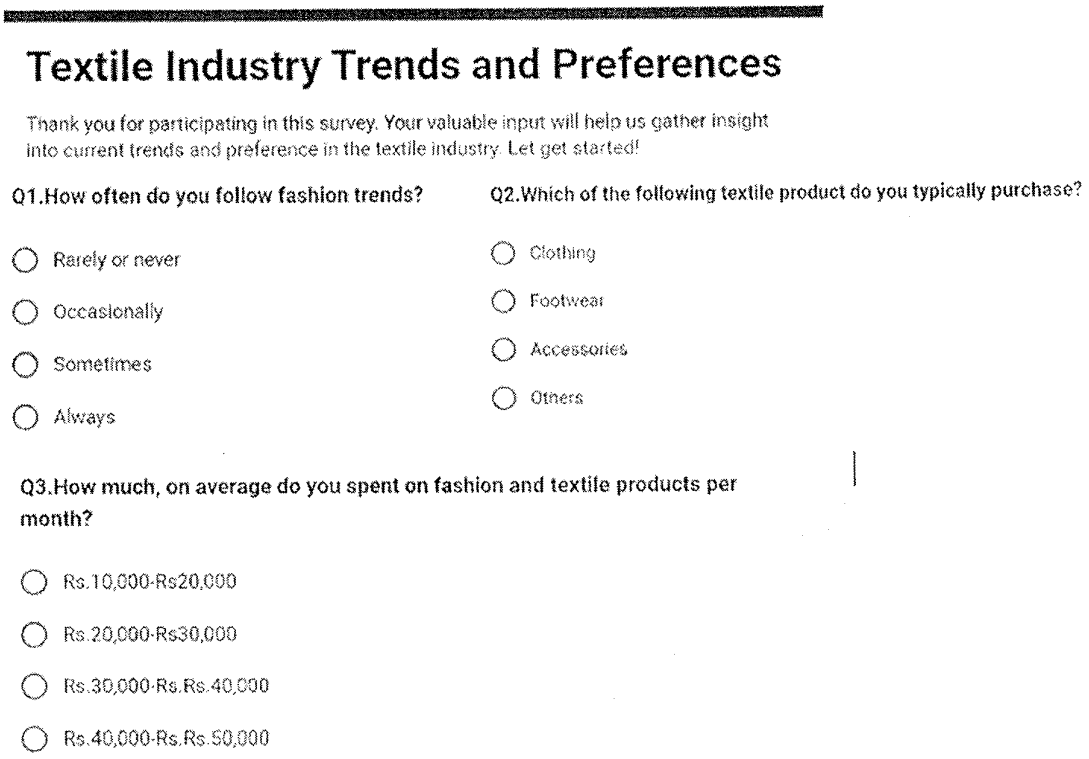
Answer.....

[10%]

Part B

Q1.

(a) Consider the part of a questionnaire given in the following figure.



Textile Industry Trends and Preferences

Thank you for participating in this survey. Your valuable input will help us gather insight into current trends and preference in the textile industry. Let get started!

Q1.How often do you follow fashion trends?

- ◯ Rarely or never
- ◯ Occasionally
- ◯ Sometimes
- ◯ Always

Q2.Which of the following textile product do you typically purchase?

- ◯ Clothing
- ◯ Footwear
- ◯ Accessories
- ◯ Others

Q3.How much, on average do you spent on fashion and textile products per month?

- ◯ Rs.10,000-Rs20,000
- ◯ Rs.20,000-Rs30,000
- ◯ Rs.30,000-Rs.Rs.40,000
- ◯ Rs.40,000-Rs.Rs.50,000

(i) Identify the scale of measurement associated with the variables,

I. in the first question (Q1) of the questionnaire (refer to the answers) in the above figure. **[05%]**

II. in the second question (Q2) of the questionnaire (refer to the answers) in the above figure. **[05%]**

(ii) State the type of data collected in question three (Q3) of the questionnaire. **[10%]**

(b) Following is the distribution of fabric samples according to the strength of the fabric.

Strength (N)	150-155	155-160	160-165	165-170	170-175
No. of Samples	8	10	12	17	7

(i) Construct a relative frequency distribution and cumulative frequency distribution. **[30%]**

(ii) Draw the corresponding ogive. **[20%]**

(iii) Draw the histogram for the above distribution. **[20%]**

(iv) Comment about the shape of the distribution of the data. **[10%]**

Q2. The following are the number of end breaks observed on a ring frame for the 30 days.

0	0	0	1	1	3	5	7	7	7	8	8
1	0	1	2	3	3	4	4	6	9		
2	0	1	3	3	7						
3	5	7									
4	0	1									
5	8										

Key: **4**|0 means 40 end breaks observed on a ring frame.
(You may use the result $\sum x = 494, \sum x^2 = 13{,}890$ for your calculations.)

(a) Find the Central Tendency measures (Mean, Median, Mode) of the given data. **[20%]**

(b) Compute the Range, Standard Deviation, and Interquartile range. **[25%]**

(c) Showing your work clearly, Identify any outliers for these data. **[15%]**

(d) Construct a box and whisker plot to represent the given data, clearly indicating the presence of any outliers. **[20%]**

(e) State, giving a reason, which measure of central tendency and measure of dispersion you would recommend to summarize these data. **[20%]**

Q3.

(a) In a certain garment factory, a knitting machine produces blankets, that are likely to have two independent defects, Snagging and bunching-up. Past experience indicates that, on average, 4% of the blankets have snagging faults, whereas 2% of them exhibit bunching-up problems. Determine the probability that a randomly selected blanket,

(i) has either kind of defect. **[20%]**

(ii) does not have either kind of defect. **[10%]**

(b) Mala works as a jewelry maker. She has a sack with a great number of colored beads, 15% of which are red. Mala selects 20 beads at random from the sack to make a bracelet.

(i) Which probability distribution would you suggest as the best model for predicting the number of red beads in Mala's bracelet? **[10%]**

(ii) Write down the two characteristics of the above-stated distribution. **[10%]**

(iii) Use the above-mentioned distribution to find the probability that Mala has at least 1 red bead in her bracelet. **[30%]**

(iv) Find the expected number of red beads in Mala's bracelet. **[20%]**

Q4.

(a) A machine is used to fill bags of buttons. The weights of a bag of buttons are modeled using a normal distribution with a mean μ and standard deviation 7.8g. It was found that 10% of the bags containing buttons weigh less than 200g.

(i) Find the value of μ. **[30%]**

(ii) Determine the probability of bags that contain more than 225g of buttons. **[30%]**

(a) The following data represents the average and range of linear density of the yarn obtained from five different samples each of size five, collected during a spinning process.

Sample Number	1	2	3	4	5
Average Liner Density	19.6	20.1	20.5	19.4	22.3
Range	1.2	2.1	1.6	1.8	2.0

(i) Explain the purpose of the control charts. **[05%]**

(ii) Construct the mean control charts by calculating the limits. **[25%]**

(iii) State the conclusion about the spinning process. **[10%]**

Q5.

(a) Define the following terms.

(i) Point estimation. **[10%]**

(ii) Interval Estimation. **[10%]**

(b) A sample of 10 yarn bobbins is chosen from the production of one shift in a spinning mill. The following are the records of the weight of the yarn in each bobbin measured in grams.

135 125 128 128 140 124 127 131 140 134

The past record indicates that the standard deviation of the weight of bobbin is 12g.

(i) Determine the best estimate for the population mean weight. **[20%]**

(ii) Find the standard error of the population mean weight of the bobbins. **[20%]**

(iii) Find the interval estimate for the population mean of bobbins at 5% significant level. **[30%]**

(iv) Interpret your results. **[10%]**

Q6.

(a) Discuss the Type I error and the Type II error about the hypothesis testing. **[10%]**

(b) A clothing company intends to develop a new fabric conditioner to improve the softness of their garments. The company firmly believes that its new product would exceed the industry standard of 8.2 in terms of softness. To validate their claim, they conducted a study using 50 garments treated with the new fabric conditioner. It has shown an average softness of 8.48 and a standard deviation of 0.26.

(i) State the null hypotheses and alternative hypotheses to be tested. **[20%]**

(ii) Find the test statistics associated with this hypothesis testing. **[20%]**

(iii) Test the hypothesis at 5% significant level. **[30%]**

(iv) State your conclusion regarding the hypothesis and comment on the claim of the company regarding the softness of the garments **[20%]**

Q7.

(a) Define the term correlation coefficient. **[10%]**

(b) The following data are related to the humidity percentage and the warp breakage rate recorded for a week in a loom shed.

Humidity (%)	54	85	86	50	42	75	65	56
Warp breakage rate	2.45	1.21	1.20	2.84	3.25	1.86	1.90	2.32

(i) Identify the independent variable and the dependent variable. **[10%]**

(ii) Calculate the correlation coefficient for the above data and interpret it. **[30%]**

(iii) Find the coefficient of determination. **[20%]**

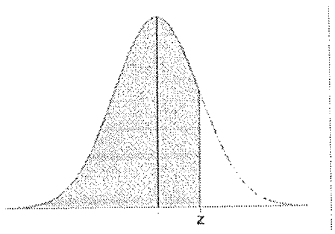
(iv) Draw the scatter plot for the dependent variable against the independent variable. **[20%]**

(v) What conclusion can you draw from the plot? **[10%]**

End.

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Standard Normal Cumulative Probability Table



Cumulative probabilities for POSITIVE z-values are shown in the following table:

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Important Formulas:

- $\bar{x} = \frac{\sum x_i}{n}$ *or* $\bar{x} = \frac{\sum f_i x_i}{\sum f_i}$
- $s^2 = \frac{\sum (x_i - \bar{x})^2}{n-1}$ *or* $\frac{\sum f_i (x_i - \bar{x})^2}{\sum f_i - 1}$
- Binomial distribution

  $$Pr(X = r) = \frac{n!}{r!(n-r)!} p^r q^{n-r}$$
- Poison Distribution

  $$Pr(X = r) = e^{-\pi} \frac{\mu^r}{r!}$$
- If random variable X, follows normal distribution ($X \sim N(\mu, \sigma^2)$)Then $Z = \frac{X-\mu}{\sigma}$ follows standard normal distribution where $Z \sim N(1,0)$.
- $UCL = \bar{x} + A\bar{R}$ and $LCL = \bar{x} - A\bar{R}$ or
- $UCL = \bar{x} + 3\frac{\sigma}{\sqrt{n}}$ and $LCL = \bar{x} - \bar{x} + 3\frac{\sigma}{\sqrt{n}}$
- $r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$

Factors useful in the Construction of Control Charts

Number of items in the sample	***Chart for Averages***	***Chart for Ranges***		
n	*Factors for Control Limit*	*Factors for Central line*	*Factors for Control Limit*	
		d_2	D_3	D_4
2	1.880	1.128	0	3.266
3	1.023	1.693	0	2.574
4	0.729	2.059	0	2.281
5	0.577	2.326	0	2.114