00318

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

Bachelor of Software Engineering Honours

Final Examination (2022/2023)
MHZ4377: Applied Statistics

Date: 03th November 2023 (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. Picking 2 marbles, one at a time, from a bag that contains 3 blue and 2 red marbles. Write down the sample space.

Answer.....

[10%]

2. Let A and B be two independent events such that $P(A) = \frac{1}{5}$ while $P(A \cup B) = \frac{1}{2}$. Then what is the value of $P(B)$?

Answer.....

[10%]

3. The standard deviation of SAT scores is known to be 100 points. A researcher decides to take a sample of 500 students' scores to estimate the mean score of students in a particular state. What is the standard deviation of the sample mean?

Answer.....

[10%]

4. In a study of a random sample of 100 coconut trees to identify whether there is any relationship between their harvested coconuts and their age, the correlation coefficient is given as r = 0.03. Explain the meaning of the value of r here.

Answer.....

[10%]

5. What can you say about the shape of the distribution, which is represented by the following stem-and-leaf diagram?

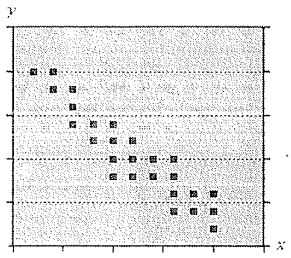
[10%]

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

Answer.....
.....
.....

6. Consider the scatter plot given in following figure and identify the relationship between the two variables x and y.

[10%]



Answer.....
.....

7. A software engineer claims that the average number of bugs obtain in a software is more than 4. Write down the corresponding null and alternative hypothesis for the above claim.

Answer.....

[10%]

8. If K is the mean of a random variable (X) which follows the Poisson distribution, what is the standard deviation of the random variable X ?

Answer.....

[10%]

9. Let it is given that the sample mean of a variable X is $\bar{X} = 100$. Suppose the random variable Y having the linear relationship with X as, $Y = 2X - 180$, then find the sample mean of variable Y.

Answer.....

[10%]

10. Let the mean of the observations: x,5, 6,8, and 7 is given as 6. Then find the value of the x.

Answer.....

[10%]

Part B

Q1. The following are the results of a size of a backup file generated by a software on 25 refinements.

60	60.8	61.2	61.8	62.4	62.8	63.5	64	64.2	64.2
65	65	65.2	65.5	67.5	68	68.2	68.2	68.4	69.1
70	70.2	71.2	72.1	74					

(a) Construct a group frequency distribution table with five classes. **[30%]**

(b) Draw the histogram for the above frequency distribution. **[30%]**

(c) Draw the frequency polygon for the above distribution on the same diagram of part (b). **[30%]**

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

Q2. For the period of 14 years, the number of laptops rejected by the customers due to software errors was recorded as follows.

20	11	11	18	15	40	8
10	9	11	10	14	20	13

(a) Find the Central Tendency measures (Mean, Median, Mode) of the given data. **[30%]**

(b) Compute the Range, Standard Deviation, and Interquartile range. **[30%]**

(c) Draw the Box-whisker plot for the above data. **[15%]**

(d) Are there any outliers in the given data set? Justify your answer. **[10%]**

(e) What is the best-suited measure for the central tendency? Explain your answer. **[15%]**

Q3. Suppose that the time (minutes) it needs to run a certain computer programme is given by the random variable T, with the probability density function:

$$f_T(t) = \begin{cases} k - \frac{1}{2}t; & 0 \le t \le 2 \\ 0 & otherwise \end{cases}$$

Here $k \in \mathbb{R}$.

(a) Find the value of k. **[20%]**

(b) Find the mean running time of the programme and the variance of the running time of a certain programme. **[50%]**

(c) Find the cumulative distribution function of the random variable running time of the programme. **[20%]**

(d) What is the probability that the running time of the programme is more than one minute? **[10%]**

Q4.

(a) Discuss the characteristics of Geometric distribution and the characteristic of Binomial distribution. [20%]

(b) An automated system is programmed to detect the defective items produced by a certain machine. Previous studies confirm that the probability of an item being a defective item is 0.02.

(i) Find the probability that the first defective item is obtained at the 4^{th} inspected item. [20%]

(ii) What is the probability that the system will inspect more than 3 items to detect the first defective item? [20%]

(iii) Let the same automated system use to detect the defective items in a batch of 20 items produce by the same machine. Find the probability that 10% of the batch of the items were detectives. [40%]

Q5. The credit card repayment patterns had changed due to the present financial crisis in the country. Thus, the central bank of the country had consulted a software engineering company to remodel the credit card repayment pattern in order to restructure the current automated service disconnection procedure. In this study of identifying the repayment pattern of the credit card payment, it was assumed that monthly repayment amount is normally distributed and a sample consisting of 25 credit card holders, having an average monthly repayment amount of Rs. 45000 and the standard deviation of the monthly repayment amount is Rs. 15000.

(a) Let the software company had collected data from 100 samples which having same sample size 25 credit card holders,

(i) What would be the expected mean and standard deviation of the resulting sampling distribution of sample means. [10%]

(ii) In how many samples would you expect to find the average monthly repayment amount is between Rs.40000 and Rs. 48000. [15%]

(b) Find the point estimate of the monthly credit card repayment amount in current situation. [10%]

(c) Find the standard error of the sample mean of the monthly credit card repayment amount. [15%]

(d) If the software company wants to find a 90% confidence interval for the monthly credit card repayment amount, then

(i) Find the margin of error for this calculation. [20%]

(ii) Find the confidence interval and interpret it in a meaningful way. [30%]

Q6. In a statistical study of identifying factors affecting the defects in software projects, the researcher concludes that if the line count of the code exceeds the 1500 lines there will be high chance of the obtaining defects in the said project. Depending on this conclusion, a certain software company is going to practice a new technique to reduce the line count in the code of the software project and that company say that if they use this technique then the chance of obtaining defect will be low. To test this claim, the quality assurance team had collected the data from 36 software projects which use the said technique and found that the average line count is 1470 and standard deviation of the line counts in code is 150.

(a) State the corresponding null hypotheses and alternative hypothesis to be tested. Comment whether this is two tail test or one tail test. **[30%]**

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

(c) If the analyst wants to test this hypothesis at 5% significant level, then what is the critical value/s associated with this test? Explain why you chose the corresponding table when finding critical value/s **[20%]**

(d) Test the hypothesis at 5% significant level and state your decision regarding the hypothesis. Explain your conclusion regarding the claim of the software company. **[30%]**

Q7. A study was conducted to determine whether the number of project involvement has an impact on the monthly compensation of software engineers. The table below provides the number of project involvement and monthly income of 10 software engineers.

NUMBER OF PROJECTS	13	16	22	2	8	26	19	20	1	4
MONTHLY COMPENSATION IN THOUSAND RUPEES	260	330	360	160	260	370	330	360	160	190

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

(b) Calculate the correlation coefficient for above data. Interpret your answer. **[30%]**

(c) Draw the scatter plot for dependent variable against the independent variable. **[10%]**

(d) Find the coefficient of the equation of the best fitted simple linear regression model of the above data. **[30%]**

(e) Interpret the found regression coefficient in part (d). **[10%]**

(f) Use the estimated line of regression to find the monthly income of a software engineer who is involved in 10 projects. **[10%]**

End.

Important Formulars:

- Binomial distribution

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

- Geometric distribution

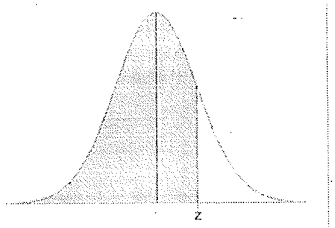
  $$Pr(X = r) = pq^{r-1}$$

- 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 $Z \sim N(1,0)$.
- $r = \frac{n\sum xy - \sum x \sum y}{\sqrt{n\sum x^2 - (\sum x)^2}\sqrt{n\sum y^2 - (\sum y)^2}}$
- $\beta_1 = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}$

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

t Distribution: Critical Values of *t*

		Significance level					
Degrees of freedom	*Two-tailed test:*	10%	5%	2%	1%	0.2%	0.1%
	One-tailed test:	5%	2.5%	1%	0.5%	0.1%	0.05%
1		6.314	12.706	31.821	63.657	318.309	636.619
2		2.920	4.303	6.965	9.925	22.327	31.599
3		2.353	3.182	4.541	5.841	10.215	12.924
4		2.132	2.776	3.747	4.604	7.173	8.610
5		2.015	2.571	3.365	4.032	5.893	6.869
6		1.943	2.447	3.143	3.707	5.208	5.959
7		1.894	2.365	2.998	3.499	4.785	5.408
8		1.860	2.306	2.896	3.355	4.501	5.041
9		1.833	2.262	2.821	3.250	4.297	4.781
10		1.812	2.228	2.764	3.169	4.144	4.587
11		1.796	2.201	2.718	3.106	4.025	4.437
12		1.782	2.179	2.681	3.055	3.930	4.318
13		1.771	2.160	2.650	3.012	3.852	4.221
14		1.761	2.145	2.624	2.977	3.787	4.140
15		1.753	2.131	2.602	2.947	3.733	4.073
16		1.746	2.120	2.583	2.921	3.686	4.015
17		1.740	2.110	2.567	2.898	3.646	3.965
18		1.734	2.101	2.552	2.878	3.610	3.922
19		1.729	2.093	2.539	2.861	3.579	3.883
20		1.725	2.086	2.528	2.845	3.552	3.850
21		1.721	2.080	2.518	2.831	3.527	3.819
22		1.717	2.074	2.508	2.819	3.505	3.792
23		1.714	2.069	2.500	2.807	3.485	3.768
24		1.711	2.064	2.492	2.797	3.467	3.745
25		1.708	2.060	2.485	2.787	3.450	3.725
26		1.706	2.056	2.479	2.779	3.435	3.707
27		1.703	2.052	2.473	2.771	3.421	3.690
28		1.701	2.048	2.467	2.763	3.408	3.674
29		1.699	2.045	2.462	2.756	3.396	3.659
30		1.697	2.042	2.457	2.750	3.385	3.646
32		1.694	2.037	2.449	2.738	3.365	3.622
34		1.691	2.032	2.441	2.728	3.348	3.601
36		1.688	2.028	2.434	2.719	3.333	3.582
38		1.686	2.024	2.429	2.712	3.319	3.566
40		1.684	2.021	2.423	2.704	3.307	3.551
42		1.682	2.018	2.418	2.698	3.296	3.538
44		1.680	2.015	2.414	2.692	3.286	3.526
46		1.679	2.013	2.410	2.687	3.277	3.515
48		1.677	2.011	2.407	2.682	3.269	3.505
50		1.676	2.009	2.403	2.678	3.261	3.496
60		1.671	2.000	2.390	2.660	3.232	3.460
70		1.667	1.994	2.381	2.648	3.211	3.435
80		1.664	1.990	2.374	2.639	3.195	3.416
90		1.662	1.987	2.368	2.632	3.183	3.402
100		1.660	1.984	2.364	2.626	3.174	3.390
120		1.658	1.980	2.358	2.617	3.160	3.373
150		1.655	1.976	2.351	2.609	3.145	3.357
200		1.653	1.972	2.345	2.601	3.131	3.340
300		1.650	1.968	2.339	2.592	3.118	3.323
400		1.649	1.966	2.336	2.588	3.111	3.315
500		1.648	1.965	2.334	2.586	3.107	3.310
600		1.647	1.964	2.333	2.584	3.104	3.307
∞		1.645	1.960	2.326	2.576	3.090	3.291