GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

Faculty of Engineering

Department of Mathematics

BSc Engineering Degree

Semester 5 Examination – May 2023

(Intake 38 – All steams)

MA 3102 – APPLIED STATISTICS

Time allowed: **2 (Two)** hours 19th May, 2023

ADDITIONAL MATERIAL PROVIDED

Statistical tables are provided

INSTRUCTIONS TO CANDIDATES

This paper contains 4 questions on 6 pages

Answer **all** questions

This is a opened book examination

This examination accounts for 70% of the module assessment. A total maximum mark obtainable is 100. The marks assigned for each question and parts thereof are indicated in square brackets

If you have any doubt as to the interpretation of the wordings of a question, make your own decision, but clearly state it on the script

Assume reasonable values for any data not given in or provided with the question paper, clearly make such assumptions made in the script

All examinations are conducted under the rules and regulations of the KDU

This Page is Intentionally Left Blank

Question 1

(a) An officer in the army randomly selected 36 soldiers in his camp and found the average meat they consume per week is 1.2 Kg. If the population standard deviation (σ) for the weight of the meat consume per week by a solder is 1.5 Kg, find the 95% confidence interval for the mean meat consumption by a solder per week.

[5 marks]

(b) Sixteen randomly selected cars in a city had the mean age of 5.2 years, and the standard deviation of 2.4 years. Find the 98% confidence interval of the mean age of the cars in this city. Assume the age of the cars in this city is normally distributed.

[5 marks]

(c) Suppose the waiting time to be seated for dinner in a restaurant is approximately normally distributed, with mean 23 minutes and standard deviation 5 minutes.

(i) What is the probability that a person just arrive will have to wait between 18 to 25 minutes?

[5 marks]

(ii) A group of friends with 20 persons are going for a dinner at that restaurant. All are agree, not to wait more than 20 minutes to get seated. What is the chance that the friends are not having dinner at the restaurant?

[5 marks]

(iii) How large the sample must be selected if you want to be 95% confident that the true mean waiting time will differ from sample mean by 1.2 minutes?

[5 marks]

Question 2

(a) An officer claimed that, the average monthly salary of the teachers in his school is greater than Rs. 70,000. A researcher randomly selected 16 teachers in this school and found that the average monthly salary of the teachers is Rs. 75000, with standard deviation of Rs. 9000.

(i) State the null and alternative hypotheses

[5 marks]

(ii) Calculate the test value.

[5 marks]

(iii) Write your final conclusion by justifying the claim at significance level α =0.025.

[5 marks]

(b) A report says that the average daily income of the taxi driver is Rs. 1200 in a province. A social worker claim that it is less than Rs. 1200 and he found, a random sample of 25 taxi drivers in this province has the mean income of Rs.1050. Test his claim for 0.05 significance level. The standard deviation of the population is Rs. 300.

[5 marks]

(c) A scientist wishes to estimate, with 95% confidence, the proportion of male fish of a particular species in a river. A previous study shows that 30% of this species fish are male. This scientist wishes to be accurate within 3% of the true proportion. Find the minimum sample size needed.

[5 marks]

Question 3

(a) The monthly income of a new employee (Y) in Rs. is given as:

$$Y = 50000 + 200X,$$

where X = number of hours of overtime worked in the month.

(i) Explain the coefficients 50000 and 200 in practical means.

[5 marks]

(ii) Estimate the monthly income of the new employee if he has worked for 20 hours of overtime in a given month.

[5 marks]

(b) When a stream is turbid, it is not completely clear due to suspended solids in the water. The higher the turbidity, the less clear is the water. A stream was studied on 26 days, half during dry weather (say, observations of X) and the other half immediately after a significant rainfall (say, observations of Y). Assume that the distributions of X and Y are $N(\mu_X, \sigma^2)$ and $N(\mu_Y, \sigma^2)$, respectively. The following turbidities were recorded in units of NTUs (nephelometric turbidity units):

X:	2.9	14.9	1.0	12.6	9.4	7.6	3.6
	3.1	2.7	4.8	3.4	7.1	7.2	
Y:	7.8	4.2	2.4	12.9	17.3	10.4	5.9
	4.9	5.1	8.4	10.8	23.4	9.7	

Test the null hypothesis $H_0: \mu_X = \mu_Y$ against $H_a: \mu_X < \mu_Y$ at 0.05 significance level and state your conclusion.

[15 marks]

Question 4

(a) The net weight (in grams) of a product is to be monitored by $\overline{X}$ and R control charts using a sample size of n = 5. Data for 10 preliminary samples are shown in Table 1. Set up a $\overline{X}$ and R control charts on this process and state whether the process is in statistical control with respect to each chart?

Sample Number	X_1	X_2	X_3	X_4	X_5
1	19	20	22	21	26
2	23	18	19	22	24
3	21	22	25	24	23
4	23	22	19	24	22
5	21	20	24	20	20
6	21	18	27	20	24
7	21	23	25	21	25
8	22	21	22	21	23
9	23	22	24	23	25
10	26	23	24	26	25

Table 1

[15 marks]

(b) Write a short note on acceptance sampling and list the advantage of sampling compare to the 100% inspection .

[10 marks]

---------------------End of the question paper-----------------------

Statistical tables

Table E *(continued)*

Cumulative Standard Normal Distribution

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

For z values greater than 3.49, use 0.9999.

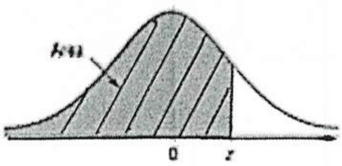

TABLE A-3 *t* Distribution: Critical *t* Values

			Area in One Tail		
	0.005	0.01	0.025	0.05	0.10
			Area in Two Tails		
Degrees of Freedom	0.01	0.02	0.05	0.10	0.20
1	63.657	31.821	12.706	6.314	3.078
2	9.925	6.965	4.303	2.920	1.886
3	5.841	4.541	3.182	2.353	1.638
4	4.604	3.747	2.776	2.132	1.533
5	4.032	3.365	2.571	2.015	1.476
6	3.707	3.143	2.447	1.943	1.440
7	3.499	2.998	2.365	1.895	1.415
8	3.355	2.896	2.306	1.860	1.397
9	3.250	2.821	2.262	1.833	1.383
10	3.169	2.764	2.228	1.812	1.372
11	3.106	2.718	2.201	1.796	1.363
12	3.055	2.681	2.179	1.782	1.356
13	3.012	2.650	2.160	1.771	1.350
14	2.977	2.624	2.145	1.761	1.345
15	2.947	2.602	2.131	1.753	1.341
16	2.921	2.583	2.120	1.746	1.337
17	2.898	2.567	2.110	1.740	1.333
18	2.878	2.552	2.101	1.734	1.330
19	2.861	2.539	2.093	1.729	1.328
20	2.845	2.528	2.086	1.725	1.325
21	2.831	2.518	2.080	1.721	1.323
22	2.819	2.508	2.074	1.717	1.321
23	2.807	2.500	2.069	1.714	1.319
24	2.797	2.492	2.064	1.711	1.318
25	2.787	2.485	2.060	1.708	1.316

Observations in Sample, n	Chart for Averages: Factors for Control Limits			Chart for Standard Deviations: Factors for Center Line		Factors for Control Limits				Chart for Ranges: Factors for Center Line		Factors for Control Limits					
	A	A_2	A_3	c_4	$1/c_4$	B_3	B_4	B_5	B_6	d_2	$1/d_2$	d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	1.2533	0	3.267	0	2.606	1.128	0.8865	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	1.1284	0	2.568	0	2.276	1.693	0.5907	0.888	0	4.358	0	2.575
4	1.500	0.729	1.628	0.9213	1.0854	0	2.266	0	2.088	2.059	0.4857	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	1.0638	0	2.089	0	1.964	2.326	0.4299	0.864	0	4.918	0	2.115
6	1.225	0.483	1.287	0.9515	1.0510	0.030	1.970	0.029	1.874	2.534	0.3946	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	1.04230	0.118	1.882	0.113	1.806	2.704	0.3698	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	1.0363	0.185	1.815	0.179	1.751	2.847	0.3512	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	1.0317	0.239	1.761	0.232	1.707	2.970	0.3367	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	1.0281	0.284	1.716	0.276	1.669	3.078	0.3249	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	1.0252	0.321	1.679	0.313	1.637	3.173	0.3152	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	1.0229	0.354	1.646	0.346	1.610	3.258	0.3069	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	1.0210	0.382	1.618	0.374	1.585	3.336	0.2998	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	1.0194	0.406	1.594	0.399	1.563	3.407	0.2935	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	1.0180	0.428	1.572	0.421	1.544	3.472	0.2880	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	1.0168	0.448	1.552	0.440	1.526	3.532	0.2831	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	1.0157	0.466	1.534	0.458	1.511	3.588	0.2787	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	1.0148	0.482	1.518	0.475	1.496	3.640	0.2747	0.739	1.424	5.856	0.391	1.608

(continued overleaf)