namibia university
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

QUALIFICATION: BACHELOR OF SCIENCES APPLIED MATHEMATICS AND STATISTICS	
QUALIFICATION CODE: 07BAMS	LEVEL: 7
COURSE CODE: SMS701S	COURSE NAME: SURVEY METHODS AND SAMPLING TECHNIQUES
SESSION: JUNE 2022	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER	Mr. J. J. SWARTZ
MODERATOR:	Dr. I. NEEMA

INSTRUCTIONS
1. Answer ALL the questions in the booklet provided.
2. Show clearly all the steps used in the calculations.
3. All written work must be done in blue or black ink and sketches must be done in pencil.

PERMISSIBLE MATERIALS
1. Non-programmable calculator without a cover.

ATTACHMENTS
1. Normal distribution table
2. T-table

THIS QUESTION PAPER CONSISTS OF 6 PAGES (Including this front page)

QUESTION 1 [25 MARKS]

1.1 Provide a diagrammatically representation of a survey from a process perspective. [6]

1.2 Define the following terms:
      1.2.1 A random variable [1]
      1.2.2 Sampling unit [1]
      1.2.3 Population parameter [1]
      1.2.4 Random Sample [1]
      1.2.5 Statistical modeling [1]

1.3 In the 2015 Namibia Income and Expenditure survey, the following data was collected from households. Write the appropriate variable type for each one of the variables and indicate what type of estimates that can be produced from the data.
      1.3.1 Total monthly household expenditure [2]
      1.3.2 Age in completed years of household heads [2]
      1.3.3 Marital status of household heads [2]

1.4 A questionnaire is a data collection tool used to collect data in all survey-based studies. Please state the three important sections in the structure of the questionnaire and elaborate on the type of information collected in the information section. [4]

1.5 Personal interviews is one of the approaches of gathering survey data, provide two advantages and two disadvantages of personal interviews. [4]

QUESTION 2 [25 MARKS]

2.1 State the four major sampling designs in probability sampling? [4]

2.2 The Ministry of Health and Social Services wants to estimate the rate of incidence of respiratory disorders among the middle-aged male and female smokers in Namibia. How large a sample should be taken to be 95% confident that the error of estimation of the proportion of the population with such disorders does not exceed 0.05? The true value of p is expected to be near 0.20. [4]

2.3 Surveys, which cover most real life situations, are multi-purpose. Thus, units within a stratum may be alike for certain major characteristics but may be very different for other characteristics. In such situations, strata must be formed with primary interest on major survey characteristics. Provide three other reasons for stratification. [3]

2.4 The following data was collected from a random sample of 20 households of a certain community consisting of 250 households. Assume the population distributions are close to a normal distribution.

Table 1: Sample data

Household ID	Sex of head: 1=Female, 2=Male	Household size	Monthly household income (N$)
1	1	8	150
2	2	2	245
3	2	3	450
4	1	5	120
5	2	4	300
6	2	5	200
7	2	1	500
8	1	7	175
9	2	3	275
10	1	10	200
11	2	2	250
12	1	3	550
13	1	2	500
14	2	1	230
15	2	2	250
16	2	5	580
17	2	6	600
18	1	2	350
19	2	1	450
20	1	3	500

2.4.1 Compute the estimates for the proportions (in %) of male and female headed households in this community. [2]

2.4.2 Calculate estimates for the average household size of the female and male headed households in this community. [2]

2.4.3 Estimate the total monthly income of this community based on the sample data. [3]

2.4.4 Calculate the standard error of the estimated total monthly income in (2.4.3) [3]

2.4.5 Construct a 95% confidence interval for the total monthly income of this population [3]

2.4.6 Comment about the monthly incomes of the female and male headed households. [1]

QUESTION 3 [25 MARKS]

3.1. Data can be classified by its scales of measurement. State the four scales of measurements and explain the difference between them. [4]

3.2. State the properties of estimators and illustrate the property **unbiasedness** of an estimator using the following information: A population consists of N = 6 HH's. Select a sample of n = 2 HH's to estimate the average HH size and the total number of persons in the households in the population. [11]

Population unit – Ui	Household size – Yi
U1	1
U2	3
U3	4
U4	5
U5	4
U6	1

3.3 Select a random sample of 10 elements from the following list using the random number table given below:

These serial numbers below indicate a list of 20 households:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Random number table:

55 09 79 15 11 56 65 88 08 16 96 95 33 17 60 45 81 31 50 46 79
19 16 49 99 08 80 01 56 35 41 42 72 58 20 39 33 53 85 26

[4]

3.4 A population consists of N = 5,000 persons. A Simple Random Sample, without replacement of n = 50 included 10 persons of Khoisan descent.

3.4.1 Calculate a 95% confidence interval for P, the proportion of persons of Khoisan descent in the population. [3]

3.4.2 Suppose we would like to estimate P the proportion of persons of Khoisan descent to within $\pm 3\%$ with 95% confidence. What sample size is necessary? (Assume P to be 0.5). [3]

QUESTION 4 [25 MARKS]

4.1 The two common forms of scanning techniques are the optical character reader (OCR) and optical mark reader (OMR). What are the advantages of OMR systems over other types of data entry, particularly where time and accuracy are important?   [5]

4.2 You have been approached by a client, Ministry of Health and Social Services to process the 2013 DHS PLUS data and are required to estimate the number of working days you will take to enter 10, 000 questionnaires.

Assumptions:
(i) **Ten** percent of the equipment may not be operational at any point in time because of mechanical breakdown or operator absence.
(ii) **Five** percent of the data will have to be rekeyed because of errors encountered in verification.
(iii) Keying of manual corrections during editing will be the equivalent of **five** percent of the original workload.

The following information is provided:
- 10 x data entry stations
- 2 x shifts of data entry operators
- 7 x productive hours per work
- 10 x operators
- Average of 8,000 strokes per hour
- 10,000 questionnaires
- 2,500 strokes per questionnaires
- 100 percent verification

[10]

4.3. You were asked by a client to analyze the 2009/10 Namibia Household Income and Expenditure Survey data. The following table and figure were produced from the data. Please write a short narrative or interpretation for the tables below on what they are depicting.

4.3.1 Table 2: Dependency ratios for 2008 and 2012

Age group	2008		2012	
	Number	Dependency ratio	Number	Dependency ratio
0 - 14	682 286	71.1	767 557	64.4
65+	102 614	10.7	106 904	9.0
Total	784 900	81.8	874 461	73.4

[5]

4.3.2 Table 3: Population by sex and age group

Age group	Female		Male		Both sexes		Sex ratio
	Number	%	Number	%	Number	%	
00-04	139 287	12.9	135 161	13.8	274 520	13.3	97.0
05-09	125 157	11.6	124 931	12.7	250 159	12.1	99.8
10-14	122 151	11.3	121 727	12.4	243 878	11.8	99.7
15-19	128 831	11.9	120 609	12.3	249 440	12.1	93.6
20-24	108 224	10.0	97 720	9.9	206 016	10.0	90.3
25-29	89 582	8.3	77 201	7.9	166 783	8.1	86.2
30-34	74 899	6.9	67 550	6.9	142 449	6.9	90.2
35-39	59 482	5.5	55 844	5.7	115 326	5.6	93.9
40-44	51 240	4.7	39 868	4.1	91 108	4.4	77.8
45-49	42 182	3.9	34 276	3.5	76 457	3.7	81.3
50-54	32 321	3.0	28 161	2.9	60 482	2.9	87.1
55-59	25 720	2.4	21 223	2.2	46 943	2.3	82.5
60-64	21 586	2.0	17 514	1.8	39 100	1.9	81.1
65-69	16 662	1.5	13 154	1.3	29 816	1.4	78.9
70-74	13 370	1.2	9 286	0.9	22 656	1.1	69.5
75-79	10 923	1.0	7 735	0.8	18 658	0.9	70.8
80-84	8 576	0.8	4 239	0.4	12 815	0.6	49.4
85-89	6 326	0.6	2 261	0.2	8 588	0.4	35.7
90-94	2 902	0.3	1 209	0.1	4 110	0.2	41.7
95+	2 122	0.2	709	0.1	2 831	0.1	33.4
Not Stated	1 805	0.2	2 458	0.3	4 263	0.2	136.2
	1 083				2 066		
Total	347	100	982 836	100	398	100	90.7

[5]

*****************************END OF PAPER*****************************
**TOTAL MARKS: 100**

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73565	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.9	.00005	.00005	.00004	.00004	.00004	.00004	.00004	.00004	.00003	.00003
-3.8	.00007	.00007	.00007	.00006	.00006	.00006	.00006	.00005	.00005	.00005
-3.7	.00011	.00010	.00010	.00010	.00009	.00009	.00008	.00008	.00008	.00008
-3.6	.00016	.00015	.00015	.00014	.00014	.00013	.00013	.00012	.00012	.00011
-3.5	.00023	.00022	.00022	.00021	.00020	.00019	.00019	.00018	.00017	.00017
-3.4	.00034	.00032	.00031	.00030	.00029	.00028	.00027	.00026	.00025	.00024
-3.3	.00048	.00047	.00045	.00043	.00042	.00040	.00039	.00038	.00036	.00035
-3.2	.00069	.00066	.00064	.00062	.00060	.00058	.00056	.00054	.00052	.00050
-3.1	.00097	.00094	.00090	.00087	.00084	.00082	.00079	.00076	.00074	.00071
-3.0	.00135	.00131	.00126	.00122	.00118	.00114	.00111	.00107	.00104	.00100
-2.9	.00187	.00181	.00175	.00169	.00164	.00159	.00154	.00149	.00144	.00139
-2.8	.00256	.00248	.00240	.00233	.00226	.00219	.00212	.00205	.00199	.00193
-2.7	.00347	.00336	.00326	.00317	.00307	.00298	.00289	.00280	.00272	.00264
-2.6	.00466	.00453	.00440	.00427	.00415	.00402	.00391	.00379	.00368	.00357
-2.5	.00621	.00604	.00587	.00570	.00554	.00539	.00523	.00508	.00494	.00480
-2.4	.00820	.00798	.00776	.00755	.00734	.00714	.00695	.00676	.00657	.00639
-2.3	.01072	.01044	.01017	.00990	.00964	.00939	.00914	.00889	.00866	.00842
-2.2	.01390	.01355	.01321	.01287	.01255	.01222	.01191	.01160	.01130	.01101
-2.1	.01786	.01743	.01700	.01659	.01618	.01578	.01539	.01500	.01463	.01426
-2.0	.02275	.02222	.02169	.02118	.02068	.02018	.01970	.01923	.01876	.01831
-1.9	.02872	.02807	.02743	.02680	.02619	.02559	.02500	.02442	.02385	.02330
-1.8	.03593	.03515	.03438	.03362	.03288	.03216	.03144	.03074	.03005	.02938
-1.7	.04457	.04363	.04272	.04182	.04093	.04006	.03920	.03836	.03754	.03673
-1.6	.05480	.05370	.05262	.05155	.05050	.04947	.04846	.04746	.04648	.04551
-1.5	.06681	.06552	.06426	.06301	.06178	.06057	.05938	.05821	.05705	.05592
-1.4	.08076	.07927	.07780	.07636	.07493	.07353	.07215	.07078	.06944	.06811
-1.3	.09680	.09510	.09342	.09176	.09012	.08851	.08691	.08534	.08379	.08226
-1.2	.11507	.11314	.11123	.10935	.10749	.10565	.10383	.10204	.10027	.09853
-1.1	.13567	.13350	.13136	.12924	.12714	.12507	.12302	.12100	.11900	.11702
-1.0	.15866	.15625	.15386	.15151	.14917	.14686	.14457	.14231	.14007	.13786
-0.9	.18406	.18141	.17879	.17619	.17361	.17106	.16853	.16602	.16354	.16109
-0.8	.21186	.20897	.20611	.20327	.20045	.19766	.19489	.19215	.18943	.18673
-0.7	.24196	.23885	.23576	.23270	.22965	.22663	.22363	.22065	.21770	.21476
-0.6	.27425	.27093	.26763	.26435	.26109	.25785	.25463	.25143	.24825	.24510
-0.5	.30854	.30503	.30153	.29806	.29460	.29116	.28774	.28434	.28096	.27760
-0.4	.34458	.34090	.33724	.33360	.32997	.32636	.32276	.31918	.31561	.31207
-0.3	.38209	.37828	.37448	.37070	.36693	.36317	.35942	.35569	.35197	.34827
-0.2	.42074	.41683	.41294	.40905	.40517	.40129	.39743	.39358	.38974	.38591
-0.1	.46017	.45620	.45224	.44828	.44433	.44038	.43644	.43251	.42858	.42465
-0.0	.50000	.49601	.49202	.48803	.48405	.48006	.47608	.47210	.46812	.46414

The t-distribution
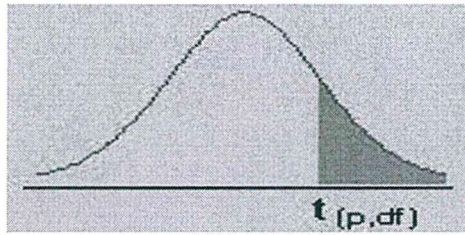
df\p	0.40	0.25	0.10	0.05	0.025	0.01	0.005	0.0005
1	0.324920	1.000000	3.077684	6.313752	12.70620	31.82052	63.65674	636.6192
2	0.288675	0.816497	1.885618	2.919986	4.30265	6.96456	9.92484	31.5991
3	0.276671	0.764892	1.637744	2.353363	3.18245	4.54070	5.84091	12.9240
4	0.270722	0.740697	1.533206	2.131847	2.77645	3.74695	4.60409	8.6103
5	0.267181	0.726687	1.475884	2.015048	2.57058	3.36493	4.03214	6.8688
6	0.264835	0.717558	1.439756	1.943180	2.44691	3.14267	3.70743	5.9588
7	0.263167	0.711142	1.414924	1.894579	2.36462	2.99795	3.49948	5.4079
8	0.261921	0.706387	1.396815	1.859548	2.30600	2.89646	3.35539	5.0413
9	0.260955	0.702722	1.383029	1.833113	2.26216	2.82144	3.24984	4.7809
10	0.260185	0.699812	1.372184	1.812461	2.22814	2.76377	3.16927	4.5869
11	0.259556	0.697445	1.363430	1.795885	2.20099	2.71808	3.10581	4.4370
12	0.259033	0.695483	1.356217	1.782288	2.17881	2.68100	3.05454	4.3178
13	0.258591	0.693829	1.350171	1.770933	2.16037	2.65031	3.01228	4.2208
14	0.258213	0.692417	1.345030	1.761310	2.14479	2.62449	2.97684	4.1405
15	0.257885	0.691197	1.340606	1.753050	2.13145	2.60248	2.94671	4.0728
16	0.257599	0.690132	1.336757	1.745884	2.11991	2.58349	2.92078	4.0150
17	0.257347	0.689195	1.333379	1.739607	2.10982	2.56693	2.89823	3.9651
18	0.257123	0.688364	1.330391	1.734064	2.10092	2.55238	2.87844	3.9216
19	0.256923	0.687621	1.327728	1.729133	2.09302	2.53948	2.86093	3.8834
20	0.256743	0.686954	1.325341	1.724718	2.08596	2.52798	2.84534	3.8495
21	0.256580	0.686352	1.323188	1.720743	2.07961	2.51765	2.83136	3.8193
22	0.256432	0.685805	1.321237	1.717144	2.07387	2.50832	2.81876	3.7921
23	0.256297	0.685306	1.319460	1.713872	2.06866	2.49987	2.80734	3.7676
24	0.256173	0.684850	1.317836	1.710882	2.06390	2.49216	2.79694	3.7454
25	0.256060	0.684430	1.316345	1.708141	2.05954	2.48511	2.78744	3.7251
26	0.255955	0.684043	1.314972	1.705618	2.05553	2.47863	2.77871	3.7066
27	0.255858	0.683685	1.313703	1.703288	2.05183	2.47266	2.77068	3.6896
28	0.255768	0.683353	1.312527	1.701131	2.04841	2.46714	2.76326	3.6739
29	0.255684	0.683044	1.311434	1.699127	2.04523	2.46202	2.75639	3.6594
30	0.255605	0.682756	1.310415	1.697261	2.04227	2.45726	2.75000	3.6460
inf	0.253347	0.674490	1.281552	1.644854	1.95996	2.32635	2.57583	3.2905