



**AMREF INTERNATIONAL UNIVERSITY**  
**SCHOOL OF PUBLIC HEALTH**  
**DEPARTMENT OF COMMUNITY HEALTH**  
**MASTER OF PUBLIC HEALTH**  
**END OF SEMESTER EXAMINATION DECEMBER 2025**

**UNIT CODE:** MPH 712      **UNIT NAME:** **Biostatistics**

**DATE:**      **XX** December 2025

**TIME:**      **Three Hours**

**Start:** 1600 Hours

**Finish** 1900 Hours

**INSTRUCTIONS**

1. This exam is marked out of 100 marks
2. This Examination comprises TWO Sections  
**Section A:** Compulsory Question (30 marks)  
**Section B:** Long Answer Questions (75 marks)

**SECTION A (25 marks)**

1. Answer the following questions
  - a) what is meant by standard error of the mean and how it differs from the standard deviation. (2mks)
  - b) Explain difference between descriptive and inferential statistics. (2 mks)
  - c) What is the difference between Type 1 error and Type 2 error giving an example (2mks)
  
2. Thirty observations of the relative return of over-the-counter stocks bought in the week of the 9<sup>th</sup> to the 13<sup>th</sup> of May, 1994 are given below. (4mks)

-0.2940	-0.1092	-0.1053	-0.0707	-0.0563
-0.0541	-0.0423	-0.0398	-0.0396	-0.0390
-0.0381	-0.0323	-0.0221	-0.0169	-0.0139
-0.0081	0.0038	0.0057	0.0156	0.0172
0.0182	0.0192	0.0423	0.0459	0.0476
0.0667	0.0714	0.0780	0.1176	0.1224

Note:  $\bar{x} = -0.01030$  and  $s = 0.0786$

Investors would like to know how the market performed. One measure of market performance is the mean relative return for the week. A 95% confidence interval for the mean relative return is  $[-0.040, 0.019]$ . Indicate True or False in the following statements

- The  $P$ -value for testing  $H_0 : \mu = 0$  versus  $H_1 : \mu \neq 0$  is larger than 0.05 .
  - There is  $n$  evidence, at the 5% level, to believe that the mean return is different from zero.
  - A 99% confidence interval for the mean return would be wider than the 95% confidence interval.  $n = 30$
  - Because the sample is large the assumption that the sample mean, approximately Normal is reasonable.
  - An estimate of the mean relative return is  $-0.01030$  .
- A rural clinic receives an average of 4 malaria cases per week. What is the probability that in a given week more than 4 cases will occur? (3mks)
  - A new rapid diagnostic test (RDT) for malaria is being evaluated in a field study. The true sensitivity of the test is believed to be 85%. To verify this, 200 individuals known to have malaria (confirmed by microscopy) are tested using the RDT.  
Compute the probability that at least 180 individuals test positive. (3mks)
  - A sample of daily hospital admissions over 10 days was recorded:  
25, 28, 30, 32, 29, 40, 35, 34, 50, 55 (9mks)

Compute:

- Mean
- Median
- IQR
- Standard deviation

- e) Standard error of the mean

Interpret what the SEM tells you about the precision of the mean estimate.

## SECTION B-ANSWER ANY THREE

### Question Two (25 marks)

1. In a nutrition survey, the mean BMI of 120 adolescent girls is 22.3 kg/m<sup>2</sup> with a standard deviation of 3.6. (5mks)
  - a) Construct a 95% confidence interval for the population mean BMI.
  - b) Interpret this interval in plain language.
2. A health officer compares weekly malaria cases reported from 30 clinics. The number of cases per clinic per week follows a Poisson distribution with mean 8. (10 mks)
  - a) Describe the sampling distribution of the average weekly number of malaria cases per clinic.
  - b) Compute the mean and standard error of this distribution.
  - c) Using the normal approximation, find the probability that the average number exceeds 9 cases per week.
3. A community health worker screens 15 individuals for tuberculosis. The probability that a person tests positive is 0.2. (10 mks)
  - a) What is the sampling distribution of the number of positive cases?
  - b) Compute the mean and standard deviation of this distribution.
  - c) Using the normal approximation, estimate  $P(X \leq 5)$ .

### Question Three (25 marks)

1. Define Central Limit Theorem (2mks)
2. A random sample of 100 adults has a mean systolic blood pressure (SBP) of 126 mmHg with a standard deviation of 15 mmHg. (3mks)
  - a) Estimate the 95% confidence interval for the mean SBP.

3. Average hemoglobin levels were compared between pregnant women attending ANC in two counties: (5mks)

County	n	Mean (g/dl)	SD
A	40	11.8	1.2
B	35	10.9	1.4

Test whether there is a significant difference in mean hemoglobin levels at  $\alpha = 0.05$ .

4. The following data were collected on weekly physical activity (hours) and BMI ( $\text{kg/m}^2$ ) for 10 adults:

<b>Physical Activity (X)</b>	2	3	5	4	6	8	7	3	5	9
<b>BMI (Y)</b>	30	28	26	27	25	23	24	28	26	22

- Fit a simple linear regression model to predict BMI from activity level. (8mks)
- Write the estimated regression equation. (1mk)
- Interpret the slope and intercept in context. (4mks)
- Predict BMI for an individual who exercises 6 hours weekly. (2mks)

### Question Four (25 marks)

1. The table below shows the systolic blood pressure (SBP) of 60 patients in a community clinic: (15mks)

SBP (mmHg)	100–119	120–139	140–159	160–179	180–199
Frequency	8	20	15	10	7

- Compute the mean, median, IQR, standard deviation, and coefficient of variation.
- Construct a box plot
- Which blood pressure category has the highest risk concentration? What might this imply for clinical interventions?

2. A community program assessed whether a training increased the use of mosquito nets:

	After: Uses Net	After: Does Not Use Net
Before: Uses Net	25	5
Before: Does Not Use Net	30	10

Perform a McNemar test to determine whether there was a significant change in net use after the training ( $\alpha = 0.05$ ). (8 marks)

3. Comment on when the Fisher's Exact Test is preferred to the Chi-square test. (2mks)

### Question Five (25 marks)

1. A nationwide poll was taken of 1,400 teenagers (ages 13-18). 600 of them said they have a TV in their bedroom.
- Construct the 95% confidence interval by calculating  $p^{\wedge}$  and margin of error to two decimal places. (4mks)
  - If the sample was increased to 2,000 , but none of the additional people had a TV, find the new confidence interval. (3mks)
  - What happens to the confidence interval as the sample size increases?(1mk)
2. Researchers compared the mean hemoglobin levels (g/dl) between pregnant and non-pregnant women: (6mks)

Group	n	Mean	SD
Pregnant	40	11.2	1.5
Non-pregnant	36	12.0	1.2

- State the null and alternative hypotheses. (2mks)
- Conduct an appropriate test statistic at  $\alpha = 0.05$ . (3mks)
- Interpret your findings in context. (1mk)

3. The ages of patients visiting a clinic were recorded as follows:

Age group (years)	Frequency
0–9	5
10–19	12
20–29	18
30–39	?
40–49	10
50–59	5

The mean age was found to be 28 years. Using the formula for the mean of grouped data, calculate the missing frequency for the 30–39 group. (6mks)

**Question Six (25 marks)**

1. Suppose 10% of the patients taking drug A experience gastrointestinal (GI) side effects, whereas 5% of patients taking drug B experience such side effects. If the side effects of the two drugs are independent events, then what would be the probability that a person taking both drugs will experience GI side effects (i.e., GI side effects from at least one of the two drugs)? (3mks)
2. Alice suspects that most smokers in her home area are male. She interviews 12 randomly selected individuals at the shopping center and records these data on their gender (M=male. F=female) and smoking status.

Respondent	1	2	3	4	5	6	7	8	9	10	11	12
Gender	M	M	F	M	F	F	F	M	F	M	M	F
Smoker	Yes	Yes	No	No	Yes	Yes	No	No	No	Yes	No	No

- a) What statistical test should Alice conduct to validate her suspicion? Explain (2 mks)
- b) State the null and alternative hypotheses for this test (2 mks)

3. Victor suspects that male students perform better, on average, in Mathematics courses than female students. He collected the following marks of 11 students in his class after they received their results for a Mathematics Exam.

Respondent	1	2	3	4	5	6
Female	26	25	43	34	18	52
Male	23	30	18	25	28	

- a) Propose a suitable statistical test that Victor could carry out. Explain your reasoning (2 marks)
  - b) State the null and alternative hypotheses that Victor should test (2 marks)
  - c) Perform the test in part (b) and comment on your results (4mks)
4. A group of 210 workers in certain company were categorized according to their exposure to smoking over the past 10 years. The workers were classified as belonging to one of 3 categories namely: A: Non-smoker, B: Passive smoker, C:Smoker. Based on a thorough medical examination of their respiratory system, the health of the workers was categorized as “poor” or “good”. The data on health workers was tabulated as follows:

	Poor Health	Good Health
Non-smoker	11	79
Passive smoker	19	51
Smoker	30	10

- a) Use the chi-square test (with  $\alpha=5\%$ ) to check if the data provides enough evidence to support the claim that exposure to cigarette smoke significantly affects the respiratory health of workers. (5 marks)

5. Suppose that a funding agency gives out 200 grants to different researchers to carry out various studies, and that 80 of those studies obtain statistically significant results. Of the 80 studies with statistically significant results, 10 were actually due to random chance. Of the 120 without statistically significant results, 30 investigators were actually studying meaningful differences which were not due to chance
- a) How many type I errors were made? (2mks)
- b) What was the type II error rate? (3mks)



Annexure 1:

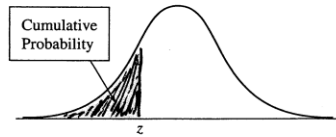
**t Table**

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	<b>0.50</b>	<b>0.25</b>	<b>0.20</b>	<b>0.15</b>	<b>0.10</b>	<b>0.05</b>	<b>0.025</b>	<b>0.01</b>	<b>0.005</b>	<b>0.001</b>	<b>0.0005</b>
two-tails	<b>1.00</b>	<b>0.50</b>	<b>0.40</b>	<b>0.30</b>	<b>0.20</b>	<b>0.10</b>	<b>0.05</b>	<b>0.02</b>	<b>0.01</b>	<b>0.002</b>	<b>0.001</b>
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
<b>Z</b>	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	<b>Confidence Level</b>										

Annexure 2:



# APPENDIX A



Cumulative probability for  $z$  is the area under the standard normal curve to the left of  $z$

**TABLE A Standard Normal Cumulative Probabilities**

$z$	.00
-5.0	.00000287
-4.5	.00000340
-4.0	.0000317
-3.5	.000233

$z$	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
-3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
-3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
-3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
-3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
-2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
-2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
-2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
-2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
-2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
-2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
-2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
-2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
-2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
-2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
-1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
-1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
-1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
-1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
-1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
-1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
-1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
-1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
-1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
-1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
-0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
-0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
-0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
-0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
-0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
-0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
-0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
-0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
-0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
-0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

Annexure 3:

**Two tails of Z**  
 Entries in the table represent two-tailed *P* values for *z* statistics

tenths	hundredths									
	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	1.00000	0.99202	0.98404	0.97607	0.96809	0.96012	0.95216	0.94419	0.93624	0.92829
0.1	0.92034	0.91241	0.90448	0.89657	0.88866	0.88076	0.87288	0.86501	0.85715	0.84931
0.2	0.84148	0.83367	0.82587	0.81809	0.81033	0.80259	0.79486	0.78716	0.77948	0.77182
0.3	0.76418	0.75656	0.74897	0.74140	0.73386	0.72634	0.71885	0.71138	0.70395	0.69654
0.4	0.68916	0.68181	0.67449	0.66720	0.65994	0.65271	0.64552	0.63836	0.63123	0.62413
0.5	0.61708	0.61005	0.60306	0.59611	0.58920	0.58232	0.57548	0.56868	0.56191	0.55519
0.6	0.54851	0.54186	0.53526	0.52869	0.52217	0.51569	0.50925	0.50286	0.49650	0.49019
0.7	0.48393	0.47770	0.47152	0.46539	0.45930	0.45325	0.44725	0.44130	0.43539	0.42953
0.8	0.42371	0.41794	0.41222	0.40654	0.40091	0.39533	0.38979	0.38430	0.37886	0.37347
0.9	0.36812	0.36282	0.35757	0.35237	0.34722	0.34211	0.33706	0.33205	0.32709	0.32217
1.0	0.31731	0.31250	0.30773	0.30301	0.29834	0.29372	0.28914	0.28462	0.28014	0.27571
1.1	0.27133	0.26700	0.26271	0.25848	0.25429	0.25014	0.24605	0.24200	0.23800	0.23405
1.2	0.23014	0.22628	0.22246	0.21870	0.21498	0.21130	0.20767	0.20408	0.20055	0.19705
1.3	0.19360	0.19020	0.18684	0.18352	0.18025	0.17702	0.17383	0.17069	0.16759	0.16453
1.4	0.16151	0.15854	0.15561	0.15272	0.14987	0.14706	0.14429	0.14156	0.13887	0.13622
1.5	0.13361	0.13104	0.12851	0.12602	0.12356	0.12114	0.11876	0.11642	0.11411	0.11183
1.6	0.10960	0.10740	0.10523	0.10310	0.10101	0.09894	0.09691	0.09492	0.09296	0.09103
1.7	0.08913	0.08727	0.08543	0.08363	0.08186	0.08012	0.07841	0.07673	0.07508	0.07345
1.8	0.07186	0.07030	0.06876	0.06725	0.06577	0.06431	0.06289	0.06148	0.06011	0.05876
1.9	0.05743	0.05613	0.05486	0.05361	0.05238	0.05118	0.05000	0.04884	0.04770	0.04659
2.0	0.04550	0.04443	0.04338	0.04236	0.04135	0.04036	0.03940	0.03845	0.03753	0.03662
2.1	0.03573	0.03486	0.03401	0.03317	0.03235	0.03156	0.03077	0.03001	0.02926	0.02852
2.2	0.02781	0.02711	0.02642	0.02575	0.02509	0.02445	0.02382	0.02321	0.02261	0.02202
2.3	0.02145	0.02089	0.02034	0.01981	0.01928	0.01877	0.01827	0.01779	0.01731	0.01685
2.4	0.01640	0.01595	0.01552	0.01510	0.01469	0.01429	0.01389	0.01351	0.01314	0.01277
2.5	0.01242	0.01207	0.01174	0.01141	0.01109	0.01077	0.01047	0.01017	0.00988	0.00960
2.6	0.00932	0.00905	0.00879	0.00854	0.00829	0.00805	0.00781	0.00759	0.00736	0.00715
2.7	0.00693	0.00673	0.00653	0.00633	0.00614	0.00596	0.00578	0.00561	0.00544	0.00527
2.8	0.00511	0.00495	0.00480	0.00465	0.00451	0.00437	0.00424	0.00410	0.00398	0.00385
2.9	0.00373	0.00361	0.00350	0.00339	0.00328	0.00318	0.00308	0.00298	0.00288	0.00279
3.0	0.00270	0.00261	0.00253	0.00245	0.00237	0.00229	0.00221	0.00214	0.00207	0.00200
3.1	0.00194	0.00187	0.00181	0.00175	0.00169	0.00163	0.00158	0.00152	0.00147	0.00142
3.2	0.00137	0.00133	0.00128	0.00124	0.00120	0.00115	0.00111	0.00108	0.00104	0.00100
3.3	0.00097	0.00093	0.00090	0.00087	0.00084	0.00081	0.00078	0.00075	0.00072	0.00070
3.4	0.00067	0.00065	0.00063	0.00060	0.00058	0.00056	0.00054	0.00052	0.00050	0.00048
3.5	0.00047	0.00045	0.00043	0.00042	0.00040	0.00039	0.00037	0.00036	0.00034	0.00033
3.6	0.00032	0.00031	0.00029	0.00028	0.00027	0.00026	0.00025	0.00024	0.00023	0.00022
3.7	0.00022	0.00021	0.00020	0.00019	0.00018	0.00018	0.00017	0.00016	0.00016	0.00015
3.8	0.00014	0.00014	0.00013	0.00013	0.00012	0.00012	0.00011	0.00011	0.00010	0.00010
3.9	0.00010	0.00009	0.00009	0.00008	0.00008	0.00008	0.00007	0.00007	0.00007	0.00007