Public Policy 529
Midterm Exam

Student ID number (8-digits): ____________________

1. In the United States, the cost of visits to hospital emergency rooms has a normal distribution with a mean \$1,200 and a standard deviation of 300.

   (a) What percentage of visits cost more than \$1,000?

   (b) What percentage of visits cost less than \$800?

   (c) For what percentage of visits are costs between \$1,200 to \$1,500?

2. True or False? The p-value from a significance test is calculated using the critical value of the test statistic. Explain your answer.

3. In a recent survey of supporters of presidential candidate Donald Trump (n=766), 81% said that they agree with Trump's statement that the election could be stolen from him as a result of voter fraud. The other supporters did not agree with the statement.

   (a) Calculate a 95% confidence interval for this estimate.

   (b) Interpret this confidence interval.

   (c) Perform a significance test in which the null hypothesis is 84% Trump supporters agree with the statement ($\alpha = .05$). Report the test statistic, critical value of test statistic, and p-value.

4. The variable `SpendingCategory` comes from a public opinion survey that asked respondents which federal budget category has the lowest spending: foreign aid, national defense, or Social Security. The survey also asked whether the respondent voted in the 2012 election (`Vote2012`). The resulting data are presented in the table below. The cells contain frequencies.

Spending Category	Did Not Vote	Voted	Total
Foreign Aid	130	178	308
National Defense	57	78	135
Social Security	123	168	291
Total	310	424	734

(a) What is P(Foreign Aid or Voted)?

(b) Are the variables `SpendingCategory` and `Vote2012` independent of each other? Demonstrate mathematically (round all probabilities to 2 decimal places).

5. In a sample of 25 people who completed a job training program, the mean amount of time needed to find a job was 45 days with a standard deviation of 15. Can we reject the null hypothesis that the true mean time is 40 days ($\alpha = .05$)? Report your test statistic, the critical value of the test statistic, and p-value (approximate if necessary).

6. Answer true or false to the following questions.

   (a) A researcher has two samples from the same population with $\sigma = 10$. In Sample A, n=1,200. In Sample B, n=200. According to the Central Limit Theorem, the mean from Sample A is closer to the population mean than is the mean from Sample B.

   (b) A t-statistic is an appropriate test statistic in all scenarios for which a z-statistic is appropriate, but the reverse is not true.

   (c) A measurement strategy can be biased but still perfectly reliable.

   (d) Random measurement errors affect the reliability of a measurement strategy but do not affect its validity.

7. Suppose that, in the population, the mean feeling thermometer score for Barack Obama is 50 with a standard deviation of 30. You will take a random sample of size 800. In what range will 80% of the possible sample means fall?

8. Suppose that 20% of the population has been exposed to a virus, and people can be tested for whether they have been exposed (test positive or negative). The test has a false positive rate of 10% (one out of every ten people who *have not* been exposed will test positive). The test has a false negative rate of 30% (three of of every ten people who *have been* exposed will test negative).

   It may help to make a Venn diagram, joint probability distribution table, or probability tree.

   (a) What is P(Not Exposed and Tests Positive)?

   (b) What is P(Exposed and Tests Positive)?

   (c) What is P(Exposed | Tests Positive)?

Space for Work

List of Formulas

Descriptive and Distributional Statistics

$$\bar{y} = \frac{\sum y_i}{n}$$

$$s^2 = \frac{\sum (y_i - \bar{y})^2}{n-1}$$

$$Z = \frac{y - \mu_y}{\sigma}$$

$$IQR = Q_3 - Q_1$$

$$SS = \sum (y_i - \bar{y})^2$$

$$s = \sqrt{\frac{\sum (y_i - \bar{y})^2}{n-1}}$$

$$\sigma_{\bar{y}} = \frac{\sigma}{\sqrt{n}}$$

Probability

$$P(B|A) = \frac{P(A \text{ and } B)}{P(A)}$$

$$P(A \text{ and } B) = P(A) \times P(B|A)$$

$$P(\sim A) = 1 - P(A)$$

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

$$P(A \text{ and } B) = P(A) \times P(B)$$

Confidence Intervals and Significance Tests

$$Z \text{ or } t = \frac{\bar{y} - \mu_0}{\hat{\sigma}_{\bar{y}}}$$

$$\hat{\sigma}_{\hat{\pi}} = \sqrt{\frac{\hat{\pi}(1 - \hat{\pi})}{n}}$$

$$Z = \frac{\hat{\pi} - \pi_0}{\hat{\sigma}_{\pi_0}}$$

$$\text{c.i.} = \bar{y} \pm t \cdot \hat{\sigma}_{\bar{y}}$$

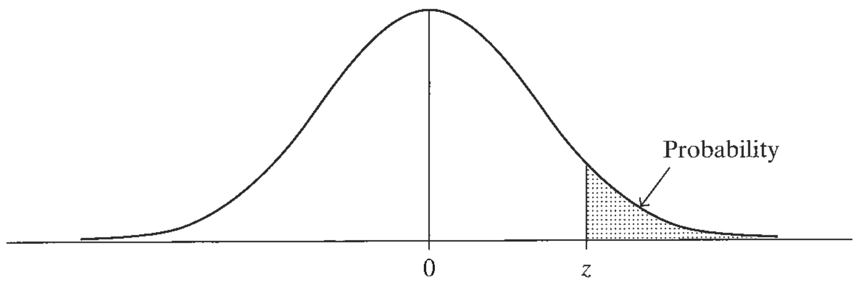
$$\hat{\sigma}_{\bar{y}} = \frac{s}{\sqrt{n}}$$

$$\text{c.i.} = \bar{y} \pm Z \cdot \hat{\sigma}_{\bar{y}}$$

$$\hat{\sigma}_{\pi_0} = \sqrt{\frac{\pi_0(1 - \pi_0)}{n}}$$

$$\text{c.i.} = \hat{\pi} \pm Z \cdot \hat{\sigma}_{\hat{\pi}}$$

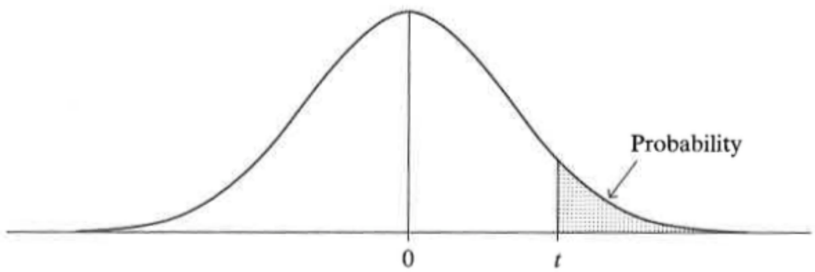
TABLE A: Normal curve tail probabilities. Standard normal probability in right-hand tail (for negative values of z, probabilities are found by symmetry)



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
	Second Decimal Place of z									
0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0722	.0708	.0694	.0681
1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
1.8	.0359	.0352	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
2.9	.0019	.0018	.0017	.0017	.0016	.0016	.0015	.0015	.0014	.0014
3.0	.00135									
3.5	.000233									
4.0	.0000317									
4.5	.00000340									
5.0	.000000287									

Source: R. E. Walpole, *Introduction to Statistics* (New York: Macmillan, 1968).

TABLE B: t Distribution Critical Values



	Confidence Level					
	80%	90%	95%	98%	99%	99.8%
	Right-Tail Probability					
df	$t_{.100}$	$t_{.050}$	$t_{.025}$	$t_{.010}$	$t_{.005}$	$t_{.001}$
1	3.078	6.314	12.706	31.821	63.656	318.289
2	1.886	2.920	4.303	6.965	9.925	22.328
3	1.638	2.353	3.182	4.541	5.841	10.214
4	1.533	2.132	2.776	3.747	4.604	7.173
5	1.476	2.015	2.571	3.365	4.032	5.894
6	1.440	1.943	2.447	3.143	3.707	5.208
7	1.415	1.895	2.365	2.998	3.499	4.785
8	1.397	1.860	2.306	2.896	3.355	4.501
9	1.383	1.833	2.262	2.821	3.250	4.297
10	1.372	1.812	2.228	2.764	3.169	4.144
11	1.363	1.796	2.201	2.718	3.106	4.025
12	1.356	1.782	2.179	2.681	3.055	3.930
13	1.350	1.771	2.160	2.650	3.012	3.852
14	1.345	1.761	2.145	2.624	2.977	3.787
15	1.341	1.753	2.131	2.602	2.947	3.733
16	1.337	1.746	2.120	2.583	2.921	3.686
17	1.333	1.740	2.110	2.567	2.898	3.646
18	1.330	1.734	2.101	2.552	2.878	3.611
19	1.328	1.729	2.093	2.539	2.861	3.579
20	1.325	1.725	2.086	2.528	2.845	3.552
21	1.323	1.721	2.080	2.518	2.831	3.527
22	1.321	1.717	2.074	2.508	2.819	3.505
23	1.319	1.714	2.069	2.500	2.807	3.485
24	1.318	1.711	2.064	2.492	2.797	3.467
25	1.316	1.708	2.060	2.485	2.787	3.450
26	1.315	1.706	2.056	2.479	2.779	3.435
27	1.314	1.703	2.052	2.473	2.771	3.421
28	1.313	1.701	2.048	2.467	2.763	3.408
29	1.311	1.699	2.045	2.462	2.756	3.396
30	1.310	1.697	2.042	2.457	2.750	3.385
40	1.303	1.684	2.021	2.423	2.704	3.307
50	1.299	1.676	2.009	2.403	2.678	3.261
60	1.296	1.671	2.000	2.390	2.660	3.232
80	1.292	1.664	1.990	2.374	2.639	3.195
100	1.290	1.660	1.984	2.364	2.626	3.174
∞	1.282	1.645	1.960	2.326	2.576	3.091

Source: "Table of Percentage Points of the t-Distribution." Computed by Maxine Merrington, Biometrika, 32 (1941): 300. Reproduced by permission of the Biometrika trustees.