

Table of z values and probabilities for the standard normal distribution. z is the first column plus the top row. Each cell shows $P(X \leq z)$. For example $P(X \leq 1.04) = .8508$. For $z < 0$ subtract the value from 1, e.g., $P(X \leq -1.04) = 1 - .8508 = .1492$.

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
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	0.8413	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	0.9772	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	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

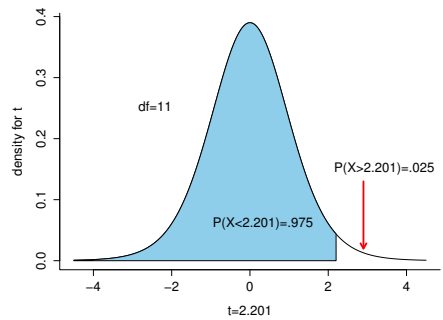


Table of t values and right tail probabilities. Degrees of freedom are in the first column (df). **Right tail probabilities** are in the first row. For example for $d.f. = 7$ and $\alpha = .05$ the critical t value for a two-tail test is 2.365 and for $d.f. = 10$ and $\alpha = .1$ the critical t value for a one-tail test is 1.372.

df	.1	.05	.025	.01	.005
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
40	1.303	1.684	2.021	2.423	2.704
50	1.299	1.676	2.009	2.403	2.678
75	1.293	1.665	1.992	2.377	2.643
100	1.290	1.660	1.984	2.364	2.626

Table of F values for right tail probabilities of .05. Degrees of freedom for denominator are in the first column and degrees of freedom for the numerator are in the top row.

denom.	numerator df									
df	1	2	3	4	5	7	10	15	50	100
1	161.45	199.5	215.71	224.58	230.16	236.77	241.88	245.95	251.77	253.04
2	18.51	19	19.16	19.25	19.3	19.35	19.4	19.43	19.48	19.49
3	10.13	9.55	9.28	9.12	9.01	8.89	8.79	8.7	8.58	8.55
4	7.71	6.94	6.59	6.39	6.26	6.09	5.96	5.86	5.7	5.66
5	6.61	5.79	5.41	5.19	5.05	4.88	4.74	4.62	4.44	4.41
6	5.99	5.14	4.76	4.53	4.39	4.21	4.06	3.94	3.75	3.71
7	5.59	4.74	4.35	4.12	3.97	3.79	3.64	3.51	3.32	3.27
8	5.32	4.46	4.07	3.84	3.69	3.5	3.35	3.22	3.02	2.97
9	5.12	4.26	3.86	3.63	3.48	3.29	3.14	3.01	2.8	2.76
10	4.96	4.1	3.71	3.48	3.33	3.14	2.98	2.85	2.64	2.59
11	4.84	3.98	3.59	3.36	3.2	3.01	2.85	2.72	2.51	2.46
12	4.75	3.89	3.49	3.26	3.11	2.91	2.75	2.62	2.4	2.35
13	4.67	3.81	3.41	3.18	3.03	2.83	2.67	2.53	2.31	2.26
14	4.6	3.74	3.34	3.11	2.96	2.76	2.6	2.46	2.24	2.19
15	4.54	3.68	3.29	3.06	2.9	2.71	2.54	2.4	2.18	2.12
16	4.49	3.63	3.24	3.01	2.85	2.66	2.49	2.35	2.12	2.07
17	4.45	3.59	3.2	2.96	2.81	2.61	2.45	2.31	2.08	2.02
18	4.41	3.55	3.16	2.93	2.77	2.58	2.41	2.27	2.04	1.98
19	4.38	3.52	3.13	2.9	2.74	2.54	2.38	2.23	2	1.94
20	4.35	3.49	3.1	2.87	2.71	2.51	2.35	2.2	1.97	1.91
21	4.32	3.47	3.07	2.84	2.68	2.49	2.32	2.18	1.94	1.88
22	4.3	3.44	3.05	2.82	2.66	2.46	2.3	2.15	1.91	1.85
23	4.28	3.42	3.03	2.8	2.64	2.44	2.27	2.13	1.88	1.82
24	4.26	3.4	3.01	2.78	2.62	2.42	2.25	2.11	1.86	1.8
25	4.24	3.39	2.99	2.76	2.6	2.4	2.24	2.09	1.84	1.78
26	4.23	3.37	2.98	2.74	2.59	2.39	2.22	2.07	1.82	1.76
27	4.21	3.35	2.96	2.73	2.57	2.37	2.2	2.06	1.81	1.74
28	4.2	3.34	2.95	2.71	2.56	2.36	2.19	2.04	1.79	1.73
29	4.18	3.33	2.93	2.7	2.55	2.35	2.18	2.03	1.77	1.71
30	4.17	3.32	2.92	2.69	2.53	2.33	2.16	2.01	1.76	1.7
40	4.08	3.23	2.84	2.61	2.45	2.25	2.08	1.92	1.66	1.59
60	4	3.15	2.76	2.53	2.37	2.17	1.99	1.84	1.56	1.48
100	3.94	3.09	2.7	2.46	2.31	2.1	1.93	1.77	1.48	1.39
1000	3.85	3	2.61	2.38	2.22	2.02	1.84	1.68	1.36	1.26

<p>Chapter 1: no key formulas. Chapter 2: Relative Frequency=freq. of the class / n. Approx. Class Width: =(largest value-smallest value) / number of classes. Chapter 3: sample and population means</p> $\bar{x} = \sum x_i/n \text{ and } \mu = \sum x_i/N$ <p>Weighted mean and geometric mean</p> $\bar{x} = \sum w_i x_i / w_i \text{ and } \bar{x}_g = [(x_1)(x_2) \dots (x_n)]^{1/n}.$ <p>Interquartile Range: IQR = $Q_3 - Q_1$. Population and sample variance</p> $\sigma^2 = \frac{\sum(x_i - \mu)^2}{N} \text{ and } s^2 = \frac{\sum(x_i - \bar{x})^2}{n - 1}$ <p>Population and sample standard deviation</p> $\sigma = \sqrt{\sigma^2} \text{ and } s = \sqrt{s^2}.$ <p>Coefficient of Variation</p> $\left(\frac{\text{Standard deviation}}{\text{Mean}} \times 100 \right) \%$ <p>z-Score: $z_i = \frac{x_i - \bar{x}}{s}$. Population and Sample Covariance</p> $\sigma_{xy} = \frac{\sum(x_i - \mu_x)(y_i - \mu_y)}{N} \text{ and } s_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{n - 1}$ <p>Population and Sample Pearson Correlation</p> $\rho_{xy} = \sigma_{xy} / (\sigma_x \sigma_y) \text{ and } r_{xy} = s_{xy} / (s_x s_y).$ <p>Chapter 4: Counting Rule for Combinations</p> $C_n^N = \binom{N}{n} = \frac{N!}{n!(N-n)!}.$ <p>Counting Rule for Permutations</p> $P_n^N = n! \binom{N}{n} = \frac{N!}{(N-n)!}.$ <p>Probability Rules: $P(A) = 1 - P(A^c)$</p>	<p>Chapter 4 continued:</p> $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ $P(A B) = \frac{P(A \cap B)}{P(B)}$ $P(A \cap B) = P(B)P(A B) = P(A)P(B A).$ <p>Multiplication Law for Independent Events</p> $P(A \cap B) = P(B)P(A).$ <p>Bayes' Theorem</p> $P(A_i B) = \frac{P(A_i)P(B A_i)}{P(A_1)P(B A_1) + P(A_2)P(B A_2) + \dots + P(A_n)P(B A_n)}$ <p>Chapter 5: Discrete Uniform Probability Mass Function: $f(x) = 1/n$. Expected Value of a Discrete R. V.: $E(x) = \mu = \sum x f(x)$. Variance of a Discrete R. V.:</p> $Var(x) = \sigma^2 = \sum (x - \mu)^2 f(x).$ <p>Number of Experimental Outcomes Providing Exactly x Successes in n Trials</p> $\binom{n}{x} = \frac{n!}{x!(n-x)!}.$ <p>Binomial Probability Mass Function</p> $P(X = x) = f(x) = \binom{n}{x} p^x (1-p)^{(n-x)}.$ <p>Expected Value for Binomial Distribution: $E(x) = \mu = np$. Variance for Binomial Distr.: $Var(x) = \sigma^2 = np(1-p)$. Poisson Probability Mass Function:</p> $P(X = x \mu) = f(x) = \frac{\mu^x e^{-\mu}}{x!}.$ <p>Hypergeometric Probability Mass Function and Expected Value:</p> $f(x) = \frac{\binom{r}{x} \binom{N-r}{n-x}}{\binom{N}{n}} \text{ and } E(x) = \mu = \frac{nr}{N}.$	<p>Chapter 5 continued: Variance for the Hypergeometric Distribution:</p> $Var(x) = \sigma^2 = n \left(\frac{r}{N} \right) \left(1 - \frac{r}{N} \right) \left(\frac{N-n}{N-1} \right).$ <p>Chapter 6: Uniform PDF</p> $f(x) = \begin{cases} \frac{1}{b-a} & \text{if } a \leq x \leq b \\ 0 & \text{otherwise} \end{cases}$ <p>Normal PDF The density function is</p> $f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right).$ <p>Converting to the Standard Normal rv:</p> $z = \frac{x - \mu}{\sigma}.$ <p>Exponential PDF and CDF for $x \geq 0$</p> $f(x) = \mu^{-1} e^{-x/\mu} \text{ and } P(x \leq x_0) = 1 - e^{-x_0/\mu}.$ <p>Chapter 7: expected value of \bar{x}</p> $E(\bar{x}) = \mu.$ <p>Standard Deviation of \bar{x} (Standard Error)</p> $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}.$ <p>Expected Value and Std Dev (Standard Error) of \bar{p}</p> $E(\bar{p}) = p \text{ and } \sigma_{\bar{p}} = \sqrt{\frac{p(1-p)}{n}}$ <p>Finite Pop. Correction Factor: $\sqrt{(N-n)/(N-1)}$. Chapter 8: Interval Estimate of Population Mean, σ known and unknown</p> $\bar{x} \pm z_{\alpha/2} \frac{\sigma}{\sqrt{n}} \text{ and } \bar{x} \pm t_{\alpha/2} \frac{s}{\sqrt{n}}$ <p>Necessary Sample Size for Interval Estimate of μ</p> $n = \frac{(z_{\alpha/2})^2 \sigma^2}{E^2}$
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Chapter 8 continued: Interval Estimate of p

$$\hat{p} \pm z_{\alpha/2} \frac{p(1-p)}{\sqrt{n}}$$

Necessary Sample Size for Interval Estimate of p

$$n = \frac{(z_{\alpha/2})^2 p^*(1-p^*)}{E^2}$$

Chapter 9: Test Statistic for Hypothesis Tests About μ , σ known and unknown

$$z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}} \text{ and } t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

Test Stat for Hypothesis About p

$$z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$$

Chapter 10: Point Estimate and Standard Error for Difference in Two Population Means

$$\bar{x}_1 - \bar{x}_2 \text{ and } \sigma_{\bar{x}_1 - \bar{x}_2} = \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

Interval Estimate and Test Statistic for Difference in Two Means with Known Variances

$$\bar{x}_1 - \bar{x}_2 \pm z_{\alpha/2} \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} \text{ and } z = \frac{\bar{x}_1 - \bar{x}_2 - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Interval Estimate and Test Statistic for Difference in Two Means with Unknown Variances

$$\bar{x}_1 - \bar{x}_2 \pm t_{\alpha/2} \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \text{ and } t = \frac{\bar{x}_1 - \bar{x}_2 - D_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Degrees of Freedom for t , Two Independent Random Samples

$$df = \frac{1}{\frac{1}{n_1-1} \left(\frac{s_1^2}{n_1}\right)^2 + \frac{1}{n_2-1} \left(\frac{s_2^2}{n_2}\right)^2} \left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2$$

Chapter 10 continued: Test Statistic (Matched Samples)

$$t = \frac{\bar{d} - \mu_d}{s_d/\sqrt{n}}$$

ANOVA Related:

$$\bar{x}_j = \frac{\sum_{i=1}^{n_j} x_{ij}}{n_j} \quad s_j^2 = \frac{\sum_{i=1}^{n_j} (x_{ij} - \bar{x}_j)^2}{n_j - 1} \quad \bar{\bar{x}} = \frac{\sum_{j=1}^k \sum_{i=1}^{n_j} x_{ij}}{n_T}$$

$$MSTR = \frac{SSTR}{k-1} \quad SSTR = \sum_{j=1}^k n_j (\bar{x}_j - \bar{\bar{x}})^2 \quad MSE = \frac{SSE}{n_T - k}$$

$$SSE = \sum_{j=1}^k (n_j - 1) s_j^2 \quad F = MSTR/MSE$$

$$SST = \sum_{j=1}^k \sum_{i=1}^{n_j} (x_{ij} - \bar{\bar{x}})^2 \quad SST = SSTR + SSE$$

Chapter 11: not covered in this course

Chapter 12: $y = \beta_0 + \beta_1 x + \epsilon$

$$E(y) = \beta_0 + \beta_1 x \quad \hat{y} = b_0 + b_1 x \quad b_0 = \bar{y} - b_1 \bar{x}$$

$$b_1 = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2} \quad SSE = \sum (y_i - \hat{y}_i)^2$$

$$SST = \sum (y_i - \bar{y})^2 \quad SSR = \sum (\hat{y}_i - \bar{y})^2 \quad SST = SSR + SSE$$

$$r^2 = \frac{SSR}{SST} \quad r_{xy} = (\text{sign of } b_1) \sqrt{r^2} \quad s^2 = MSE = \frac{SSE}{n-2}$$

Standard Error of the Estimate, $s = \sqrt{MSE}$.

$$\sigma_{b_1} = \frac{\sigma}{\sqrt{\sum (x_i - \bar{x})^2}} \quad s_{b_1} = \frac{s}{\sqrt{\sum (x_i - \bar{x})^2}} \quad t = \frac{b_1}{s_{b_1}}$$

For simple regression, $MSR = SSR$ because there is only one independent variable.

$$F = \frac{MSR}{MSE} \quad s_{\hat{y}^*} = s \sqrt{\frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum (x_i - \bar{x})^2}}$$

Confidence Interval for $E(y^*)$: $\hat{y}^* \pm t_{\alpha/2} s_{\hat{y}^*}$

$$s_{\text{pred}} = s \sqrt{1 + \frac{1}{n} + \frac{(x^* - \bar{x})^2}{\sum (x_i - \bar{x})^2}}$$

Chapter 12 continued: Prediction Interval for y^* :

$$\hat{y}^* \pm t_{\alpha/2} s_{\text{pred}}$$

Residual for Observation i : $y_i - \hat{y}_i$
Chapter 13:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p + \epsilon$$

$$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p$$

$$\hat{y} = b_0 + b_1 x_1 + b_2 x_2 + \dots + b_p x_p$$

$$SST = SSR + SSE \quad R^2 = \frac{SSR}{SST}$$

$$R_a^2 = 1 - (1 - R^2) \frac{n-1}{n-p-1}$$

$$MSR = \frac{SSR}{p} \quad MSE = \frac{SSE}{n-p-1} \quad F = \frac{MSR}{MSE}$$

$$t = \frac{b_i}{s_{b_i}}$$

Other Math Rule Reminders:

$$e^x = \exp(x)$$

$$\ln 1 = 0 \quad \ln e = 1$$

$$x! = (x)(x-1)(x-2) \dots (2)(1)$$

$$0! = 1 \quad x^0 = 1$$

Use the output below to answer the appropriate questions in the exam. Be sure to check which table the question references.

	SS	DF	MS	F	p
Treatments	4.793	3	1.598	8.868	0.0036
Error	1.802	10	0.18		

Here is regression output from a model where per capita income is the independent variable and % of children under 5 that are malnourished is the dependent variable. The data are for the countries where both variables were available for 2014. I retrieved the data from the [World Bank](#).

Regression Statistics	
R Square	0.3371212
Adjusted R Square	0.315738
Standard Error	10.2570561
Observations	33

	SS	DF	MS	F	p
Regression	1658.667	1	1658.667	15.766	0.0003964
Residual	3261.423	31	105.207		

	coefficients	standard error	t stat	p-value
intercept	27.895823	2.0409832	13.66784	0
per.cap.income	-0.0006865	0.0001729	-3.97061	0.0004

VERSION A

Choose the best answer. Do not write letters in the margin or communicate with other students in any way. If you have a question note it on your exam and ask for clarification when your exam is returned. In the meantime choose the best answer. Neither the proctors nor Dr. Cox will answer questions during the exam.

Please check each question and possible answers thoroughly as questions at the bottom of a page sometimes run onto the next page. Please verify that your test version and scantron version are the same.

This exam has 25 questions.

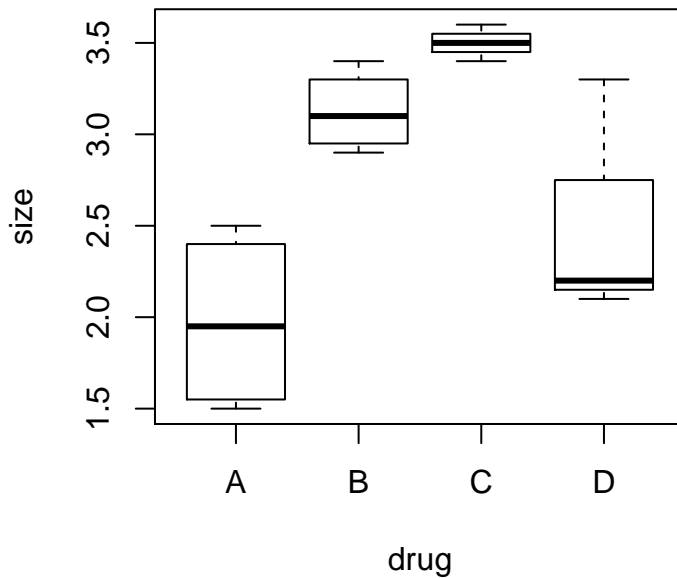
1. I have checked that my ID is bubbled in correctly. If it is bubbled in incorrectly I will get this question wrong. I also understand that questions and their possible answers may run onto the next page and so I should always check the top of the next page for possible answers. I understand that if I have a question I should simply make a note on my exam and ask Dr. Cox afterwards. I should always choose the best answer.

- (a) False.
- (b) I didn't read the directions.
- (c) True.

2. H_0 and H_a are mutually exclusive; the null hypothesis and the alternative hypothesis are mutually exclusive.

- (a) true
- (b) false

3. The graphs shown here are



- (a) histograms

- (b) scatter plots
 - (c) stem and leaf displays
 - (d) box and whiskers plots
4. The probability that a z value is less than 0.5 is
- (a) 0.5
 - (b) 0.8413447
 - (c) 0.6914625
 - (d) 0.6616608
5. Consult Table 1. From the table you can conclude that the total sum of squares is ?
- (a) -2.9916667
 - (b) 1.8016667
 - (c) 6.595
 - (d) 3.2975
6. Consult Table 1. From the table you can conclude that the total number of observations used in this analysis/experiment was?
- (a) 14
 - (b) 12
 - (c) 3
 - (d) 10
7. Consult Table 1. From the table what can you conclude concerning the null hypothesis?
- (a) reject the null
 - (b) fail to reject
 - (c) cannot be determined
 - (d) depends on the number of observations.
8. Consult Table 1. What is the test statistic?
- (a) 0.0036188.
 - (b) 8.8683318.

- (c) 1.5977778.
 - (d) 4.4341659.
9. Consult Table 1. What is the critical value for a test at the .05 level?
- (a) 2.21
 - (b) 3.71
 - (c) 5.41
 - (d) 19.16
10. Suppose that the number of homework assignments a professor gives follows a Poisson distribution with a mean of 10. What is the probability of drawing a professor that gives exactly 12 assignments?
- (a) 0.012764
 - (b) 0.1143679
 - (c) 0.072765
 - (d) 0.0947803
11. Suppose that you collect data on apartment prices in Tempe. You look at 51 different apartments and find a mean of 732 and a standard deviation of 197.9. Construct a 95% confidence interval for the mean apartment price. The interval is
- (a) [680.3397281, 783.6602719]
 - (b) [670.3397281, 793.6602719]
 - (c) [676.3397281, 787.6602719]
 - (d) [608.7057553, 708.8942447]
12. Suppose that you collect data on apartment prices in Tempe. You look at 51 different apartments and find a mean of 732 and a standard deviation of 197.9. Test the hypothesis, $H_0 : \mu = 630$ at the .05 level of significance.
- (a) the test statistic is 3.6807767 so we fail to reject
 - (b) the test statistic is 3.132699 so we reject the null
 - (c) the test statistic is 4.1588543 so we fail to reject
 - (d) the test statistic is 3.6807767 so we reject the null

13. Suppose you have a random variable that is exponentially distributed with a mean of 50. What is the probability of observing a random variable drawn from this distribution with a value of less than 50?
- (a) 0.6988058
 - (b) 0.6321206
 - (c) 0.550671
 - (d) 0.8646647
14. The p-value tells us whether or not the null hypothesis is true.
- (a) True.
 - (b) False.
 - (c) True, only if we know α .
15. The F distribution
- (a) is symmetric
 - (b) is right skewed
 - (c) has mean 0
 - (d) all of the above
 - (e) none of the above
16. Consider the regression output in Table 2. What is the estimated variance of the error term?
- (a) 105.2071998
 - (b) 5.128528
 - (c) 10.2570561
 - (d) 15.766
17. Consider the regression output in Table 2. What is the percentage of variation in the percentage of malnourished children that can be explained by the variation in the per capita income?
- (a) -32.7121206%
 - (b) 40.4545447%
 - (c) 31.5738019%

- (d) 33.7121206%
18. Consider the regression output in Table 2. What is the predicted or estimated percentage of malnourished children (under the age of 5) for a country where the percapita income is \$20,000?
- (a) 4.5533032%
(b) 21.030376%
(c) 14.164929%
(d) 10.0456608%
19. Consider the regression output in Table 2. Suppose you want to test the hypothesis that per capita income has no impact on the percentage of malnourished children, i.e. $H_0 : \beta_1 = 0$. What is the test statistic for this hypothesis?
- (a) 0.0001729
(b) 0.0003964
(c) 13.667836
(d) -3.9706062
20. Consider the regression output in Table 2. Suppose you want to test the hypothesis that per capita income has no impact on the percentage of malnourished children, i.e. $H_0 : \beta_1 = 0$. What is your conclusion for this hypothesis test?
- (a) This is inconclusive unless we know whether it is a right tail or a left tail test.
(b) This cannot be determined without the appropriate df.
(c) reject the null
(d) fail to reject
21. Because of the assumptions of the linear regression model we know that
- (a) The parameter estimate is unbiased.
(b) The error terms are not correlated.
(c) The slope is positive.
(d) the slope is not zero.
(e) none of the above.

22. You are in a business meeting and a colleague presents regression results in the following form

$$\hat{y} = 10 + 3.2X.$$

You know that the regression was performed with over 100,000 observations and your colleague reports that the p-value was .005 so that it is statistically significant. However, the executive to whom you are presenting asks what the standard error was. The value is not in your power point slides but you tell her you will give it to her in just a moment. While your colleague moves to the next slide you find that it is:

- (a) 1.1399934.
 - (b) 0.8540939.
 - (c) 0.4658694.
 - (d) 2.3867149.
 - (e) 1.3976081.
23. It is useful (a good idea) to perform residual diagnostics
- (a) True.
 - (b) False.
 - (c) This is only true when the assumptions of the linear regression model are violated.
24. The following graph shows the height of the tallest mountains in the world in hundreds of meters. The tallest mountain in the world is 8,848 meters; note that the ones place is missing in the graph below. What kind of graph is this?

```
## 1 | 2: represents 12
## leaf unit: 1
##           n: 14
##    5    80 | 23589
##   (4)   81 | 2668
##           82 |
##           83 |
##    5    84 | 8
##    4    85 | 18
##    2    86 | 1
##           87 |
##    1    88 | 4
```

- (a) scatter plot
- (b) bar chart
- (c) dot plot
- (d) stem and leaf display

25. Looking at the graph above concerning mountain heights, how tall is the 5th tallest mountain in the world? Hint: as a reminder from the previous question the tallest mountain is 8848 meters.

- (a) about 8480m
- (b) about 8120m
- (c) about 8020m
- (d) about 8710m

Key

Most questions required your knowledge of definitions and vocabulary discussed in class and in the notes or they required you to be able to make calculations or read excel output similar to examples done in class and required in the homework. A few questions required either a deeper understanding of what a p-value is or how to work backwards from a p-value to find the standard error.

1. c
2. a
3. d
4. c
5. c
6. a
7. a
8. b
9. b
10. d
11. c
12. d
13. b
14. b, no even if the p-value is extremely small it only tells us that the probability of committing a type I error is extremely small.
15. b
16. a, for all of the questions requiring reading the regression output you obviously need to know how to read the output in excel as shown in class.
17. d
18. c
19. d

20. c
21. e, we only know that *if* the assumptions are met then the OLS estimators will have certain properties.
22. a, with over 100,000 observations the t distribution is essentially the same as the z distribution. If $p = .005$ the you can look on the z table and find that the test statistic was 2.81 and then you back this out to find a standard error of $3.2/2.81$ is 1.13879.
23. a
24. d
25. a