UNIVERSITY OF REGINA
Department of Mathematics and Statistics

STATISTICS 100
Final Exam, Winter 2024

Time: 3 hours

Full Name: _____

Pages: 10

Student Number: _____

Instructor: (check one)

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INSTRUCTIONS

1. Do not open the exam until you are instructed to do so.

2. This exam consists of a section of multiple choice questions and a section of full answer questions.

a. **Multiple Choice Questions:**
Clearly indicate the correct answer (A) to (E) in the "Answer" spot. Only select ONE answer.
No work needs to be shown for multiple choice questions.
Each correct multiple choice question is worth 2 marks.
There is no penalty for incorrect answers.

b. **Full Answer Questions:**
To receive full credit for correct answers it is necessary to show all work.
The marks allocated for each question are indicated after each question.
All work and answers are to be placed on the right side pages of this exam in the space provided.

3. The left side pages are to be used as scrap paper. They are provided for rough work and checking only and will not be graded unless you expressly indicate there is work to be found there.

4. Probability tables are at the end of the exam. Do not remove staples or any pages from the exam.

For instructor use only:

Page:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Marks:	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**100**
Score:											

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PART A - MULTIPLE CHOICE QUESTIONS

Clearly indicate your answer (A)-(E) in the "Answer" spot. Each correct answer is worth 2 marks.

1. A farmer is recording the weights of 12 pumpkins harvested from their field. The weights (in pounds) of the pumpkins are as follow:

10.1, 12.5, 14.4, 10.5, 9.6, 8.4, 14.8, 12.8, 12.7, 12.8, 10.0, 20.1

i) Classify the variable "weight":
(A) Quantitative/Discrete
(B) Quantitative/Continuous
(C) Qualitative/Continuous
(D) Qualitative/Discrete
(E) Quantitative/Normal Answer: _____

(ii) State the mode and range of the data.
(A) Mode = 12.6 Range = 11.7
(B) Mode = 12.8 Range = 10
(C) Mode = 12.6 Range = 8.4
(D) Mode = 12.8 Range = 11.7
(E) Mode = 12.7 Range = 18.1 Answer: _____

(iii) State the median and the mean of the data.
(A) Median = 12.6 Mean = 12.10
(B) Median = 11.6 Mean = 12.10
(C) Median = 12.6 Mean = 12.39
(D) Median = 11.6 Mean = 12.39
(E) Median = 12.1 Mean = 12.60 Answer: _____

(iv) Calculate the interquartile range of this data. Then chose the *closest* of the five values below:
(A) 5.75
(B) 4.75
(C) 3.75
(D) 2.75
(E) 1.75 Answer: _____

(v) Using the interquartile range method, that is, fences with values Q1-(1.5)(IQR) and Q3+(1.5)(IQR), which of the following value(s) can be considered outliers?
(A) x=20.1.
(B) x=8.4
(C) x=8.4, 9.6
(D) x=8.4, 20.1
(E) There are no outliers as all data is between the fences. Answer: _____

The page is to be used as scrap paper only.

2. In 2023, there were two by-elections in the city of Regina: in Coronation Park and in Walsh Acres. The following table lists the votes cast in both areas for the New Democratic Party, the Saskatchewan Party, and Other Parties. Note that two sections of the table are blank.

	New Democratic Party	Saskatchewan Party	Other Parties	Total
Regina Coronation Park	2173	1155	446	3774
Regina Walsh Acres	2535	1842	???	4643
Total	4708	2997	???	8417

(I) How many votes were cast for Other Parties in the Regina Walsh Acres election?
(A) 712
(B) 446
(C) 262
(D) 266
(E) 978 Answer: _____

(ii) A random voter is selected. What is the probability that they voted in Regina Coronation Park OR that they voted for the New Democratic Party? Round to four decimals.
(A) 0.2582
(B) 0.5593
(C) 0.5758
(D) 0.7496
(E) 0.4616 Answer: _____

(iii) A random voter is selected. What is the probability that they voted in Regina Coronation Park GIVEN THAT they voted for the New Democratic Party? Round to four decimals.
(A) 0.2582
(B) 0.5593
(C) 0.5758
(D) 0.7496
(E) 0.4616 Answer: _____

(iv) Are events A: “voted in Regina Coronation Park” and B: “voted for the New Democratic Party” independent?
(A) Yes, because $P(A)=P(A|B)$
(B) Yes, because $P(A)=P(B|A)$
(C) Yes, because $P(A)=P(B)$
(D) No, because $P(A)\neq P(A|B)$
(E) No, becuase $P(A|B)\neq 0$ Answer: _____

(v) If we selected **two** random voters from the above 8417 voters, what is the probability that at least one voted for the Saskatchewan party?
(A) 0.3561
(B) 0.5853
(C) 0.6439
(D) 0.7122
(E) 0.1268 Answer: _____

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3. It is estimated that 80% of patients will recover from a stomach infection without the need for medical intervention.

(i) Suppose ten people contract a stomach infection. What is the probability that exactly eight will recover without need for medical intervention?
(A) 0.8
(B) 0.64.
(C) 0.1678
(D) 0.00067
(E) 0.3020 Answer: _____

(ii) Suppose ten people contract a stomach infection. What is the probability that at least one will recover without need for medical intervention?
(A) 0.9999
(B) 0.8926
(C) 0.6447
(D) 0.1600
(E) 0.1074 Answer: _____

(iii) What is the mean and standard deviation of people recovering from a stomach infection in a random sample of 250 individuals?
(A) mean = 200 standard deviation = 2.519
(B) mean = 200 standard deviation = 6.325
(C) mean = 250 standard deviation = 2.519
(D) mean = 250 standard deviation = 4.040
(E) mean = 50 standard deviation = 2.519 Answer: _____

(iv) Use the normal approximation to the binomial (with continuity correction) to estimate the probability that out of a random sample of 250 individuals, more than 210 will recover without medical intervention.
(A) 0.9515
(B) 0.9129
(C) 0.8742
(D) 0.1258
(E) 0.0485 Answer: _____

4. A multiple choice examination has five questions, each with five possible answers, only one of which is correct. A student didn't prepare for the exam and decides to make random and independent guesses for each of the five questions. The passing grade for the exam is 80%, i.e. the student must get at least four of the five questions correct in order to pass. What is the probability that the student passes this exam?
(A) 0.3277
(B) 0.1600
(C) 0.0400
(D) 0.0067
(E) 0.0031 Answer: _____

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5. The weight of Bengal Cats is normally distributed with mean 5.20 kg and standard deviation 0.78 kg.

(i) What is the probability that a randomly selected Bengal Cat weighs less than 5.00 kg?
(A) 0.2564
(B) 0.3974
(C) 0.7436
(D) 0.6026
(E) 0.2013 Answer: _____

(ii) What is the probability that a randomly selected Bengal Cat weighs between 5.00 kg and 6.00 kg?
(A) 0.2564
(B) 0.4001
(C) 0.8921
(D) 0.4511
(E) 0.3407 Answer: _____

(iii) How much would a Bengal Cat weigh if it was considered to be in the 90^{th} percentile in weight?
(A) 6.5 kg
(B) 6.0 kg
(C) 6.4 kg
(D) 6.2 kg
(E) 5.9 kg Answer: _____

(iv) What is the standard error of the sample mean for Bengal Cat weight, given samples of size n=60?
(A) 0.101
(B) 0.013
(C) 0.087
(D) 0.671
(E) 0.125 Answer: _____

(v) If we selected a sample of 60 Bengal Cats, what is the probability that their mean weight would be more than 5.25 kg?
(A) 0.5
(B) 0.6915
(C) 0.1666
(D) 0.3224
(E) 0.3085 Answer: _____

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6. A psychology study was conducted to investigate the relationship between the amount of time spent meditating each day (in minutes) and reported levels of stress (on a scale of 1 to 10). The data collected from participants is as follows:

x: time spent	10	15	20	25	30	35	40	45
y: stress level	7	6	6	5	4	3	2	3

Note that $\sum x = 220$ $\sum x^2 = 7100$ $\sum y = 36$ and $\sum y^2 = 184$

(i) Calculate the value of $\sum xy$.

(A) 845
(B) 1050
(C) 22
(D) 145
(E) 7920

Answer: _____

(ii) Calculate the value of r, the correlation coefficient.

(A) 0.95
(B)-0.95
(C) -0.15
(D) 0.87
(E) -0.87

Answer: _____

(iii) Based on the r-value, what best describes the relationship between the time spent meditating and stress level?

(A) They have a strong and positive correlation.
(B) They have a weak and positive correlation.
(C) They have a weak and negative correlation.
(D) They are not correlated at all.
(E) They have a strong and negative correlation.

Answer: _____

(iv) Calculate the slope of the regression line.

(A) 0.1381
(B) -0.1381
(C) 8.2978
(D) -8.2978
(E) 6.5900

Answer: _____

(v) If a participant meditates for 50 minutes per day, what do you predict their reported stress level would be (choose the closest value on a scale of one to ten)?

(A) 4
(B) 3
(C) 2
(D) 1
(E) 5

Answer: _____

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PART B - FULL ANSWER QUESTIONS

To receive full credit for correct answers it is necessary to show all work in the space provided.

7. Suppose we wish to estimate a population mean. If we want the sample estimate to be within 2.30 units of the true population mean, 9 out of 10 times, how large a sample should we select. We will assume that the population standard deviation is known to be 12.10. [4 marks]

8. To estimate the normal body temperature of a healthy human, a random sample of 130 healthy patients is selected. Their data yielded a sample mean of 36.79^{o}C with standard deviation 0.38^{o}C. Construct a 95% confidence interval for the true healthy human body temperature. [6 marks]

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9. A recent study on children's health claims that 17% of Canadian children are classified as obese. To test this claim, a sample of 100 randomly selected Canadian children is taken. In this sample, 8 children are classified as obese. Is this sufficient evidence to conclude that the claimed 17% rate is too high? Perform the appropriate hypothesis test, use á=0.05. [10 marks]

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10. A biologist believes that the average number of bird species in a particular forest has decreased compared to historical averages, which have typically been 10 species per location. To test this hypothesis, the biologist conducts a study and records the number of bird species observed in 10 randomly selected locations within the forest. The data collected is as follows:

Number of bird species observed: 12, 10, 8, 9, 7, 8, 6, 7, 8, 5

Note: $\sum x = 80$ and $\sum x^2 = 676$

At a significance level of á=0.05, can we conclude that the biologist is correct? [10 marks]

The page is to be used as scrap paper only.

11. To compare the lifespan of two different brands of 6W LED light bulbs, a sample of 100 bulbs is tested from each brand. The resulting data is shown below:

	Brand A	Brand B
Sample Size	100	100
Mean Lifespan (hours)	49,532	50,887
Standard Deviation (hours)	2,352	1,983

Use the given data to construct a 90% confidence interval for the difference in lifespan (in hours) for these two brands of light bulb. [10 marks]

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12. An IT-Support centre has five different support technicians for phone-in questions. The centre manager wants to determine if there is any significant difference in the speed with which these five technicians handle support calls. To do so, Technicians #1, #3 and #4 were observed for four support calls each. Technicians #2 and #5 were observed for five support calls each. For each observed support call, the time (in minutes) was recorded in the table below. [10 marks]

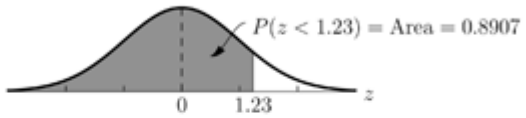
Technician #1	Technician #2	Technician #3	Technician #4	Technician #5
12.5	11.1	15.2	18.1	13.5
13.1	19.1	20.7	11.1	16.7
12.7	12.3	20.6	12.4	15.4
16.5	12.6	21.0	12.6	14.9
	12.9			15.2

a) Complete the ANOVA table (fill in the three missing degrees of freedom, the two missing Mean Squares, and the F-Score).

Source	d.f.	Sum of Squares	Mean Squares	F
Treatment		101.63		
Error		107.83		
Total		209.46		

b) At the á=0.05 level of significance, how would you respond to the claim that there is no difference in mean times for these five technicians? Clearly support your answer.

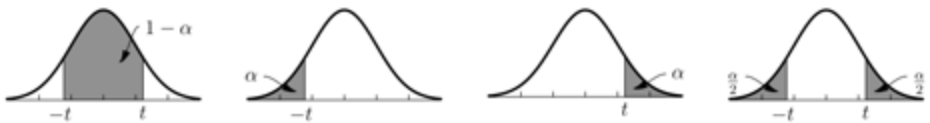
Normal Curve Areas



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
-0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	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	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	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	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Student's t Distribution (Critical Values)



Confidence Interval | Left-tailed Test | Right-tailed Test | Two-tailed Test

df	Confidence Coefficient, $1-\alpha$					
	0.80	0.90	0.95	0.98	0.99	0.999
	Level of Significance for One-Tailed Test, α					
	0.100	0.050	0.025	0.010	0.005	0.0005
	Level of Significance for Two-Tailed Test, α					
	0.20	0.10	0.05	0.02	0.01	0.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.599
3	1.638	2.353	3.182	4.541	5.841	12.924
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.869
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.408
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.768
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646

df	Confidence Coefficient, $1-\alpha$					
	0.80	0.90	0.95	0.98	0.99	0.999
	Level of Significance for One-Tailed Test, α					
	0.100	0.050	0.025	0.010	0.005	0.0005
	Level of Significance for Two-Tailed Test, α					
	0.20	0.10	0.05	0.02	0.01	0.001
31	1.309	1.696	2.040	2.453	2.744	3.633
32	1.309	1.694	2.037	2.449	2.738	3.622
33	1.308	1.692	2.035	2.445	2.733	3.611
34	1.307	1.691	2.032	2.441	2.728	3.601
35	1.306	1.690	2.030	2.438	2.724	3.591
36	1.306	1.688	2.028	2.434	2.719	3.582
37	1.305	1.687	2.026	2.431	2.715	3.574
38	1.304	1.686	2.024	2.429	2.712	3.566
39	1.304	1.685	2.023	2.426	2.708	3.558
40	1.303	1.684	2.021	2.423	2.704	3.551
41	1.303	1.683	2.020	2.421	2.701	3.544
42	1.302	1.682	2.018	2.418	2.698	3.538
43	1.302	1.681	2.017	2.416	2.695	3.532
44	1.301	1.680	2.015	2.414	2.692	3.526
45	1.301	1.679	2.014	2.412	2.690	3.520
46	1.300	1.679	2.013	2.410	2.687	3.515
47	1.300	1.678	2.012	2.408	2.685	3.510
48	1.299	1.677	2.011	2.407	2.682	3.505
49	1.299	1.677	2.010	2.405	2.680	3.500
50	1.299	1.676	2.009	2.403	2.678	3.496
51	1.298	1.675	2.008	2.402	2.676	3.492
52	1.298	1.675	2.007	2.400	2.674	3.488
53	1.298	1.674	2.006	2.399	2.672	3.484
54	1.297	1.674	2.005	2.397	2.670	3.480
55	1.297	1.673	2.004	2.396	2.668	3.476
60	1.296	1.671	2.000	2.390	2.660	3.460
80	1.292	1.664	1.990	2.374	2.639	3.416
100	1.290	1.660	1.984	2.364	2.626	3.390
200	1.286	1.653	1.972	2.345	2.601	3.340
∞	1.282	1.645	1.960	2.326	2.576	3.291

The F Distribution (Critical Values)

df_1

df_2	α	1	2	3	4	5
1	0.100	39.86	49.50	53.59	55.83	57.24
	0.050	161.4	199.5	215.7	224.6	230.2
	0.025	647.8	799.5	864.2	899.6	921.8
	0.010	4052	5000	5403	5625	5764
	0.005	16211	20000	21615	22500	23056
2	0.100	8.526	9.000	9.162	9.243	9.293
	0.050	18.51	19.00	19.16	19.25	19.30
	0.025	38.51	39.00	39.17	39.25	39.30
	0.010	98.50	99.00	99.17	99.25	99.30
	0.005	198.5	199.0	199.2	199.2	199.3
3	0.100	5.538	5.462	5.391	5.343	5.309
	0.050	10.13	9.552	9.277	9.117	9.013
	0.025	17.44	16.04	15.44	15.10	14.88
	0.010	34.12	30.82	29.46	28.71	28.24
	0.005	55.55	49.80	47.47	46.19	45.39
4	0.100	4.545	4.325	4.191	4.107	4.051
	0.050	7.709	6.944	6.591	6.388	6.256
	0.025	12.22	10.65	9.979	9.605	9.364
	0.010	21.20	18.00	16.69	15.98	15.52
	0.005	31.33	26.28	24.26	23.15	22.46
5	0.100	4.060	3.780	3.619	3.520	3.453
	0.050	6.608	5.786	5.409	5.192	5.050
	0.025	10.01	8.434	7.764	7.388	7.146
	0.010	16.26	13.27	12.06	11.39	10.97
	0.005	22.78	18.31	16.53	15.56	14.94
6	0.100	3.776	3.463	3.289	3.181	3.108
	0.050	5.987	5.143	4.757	4.534	4.387
	0.025	8.813	7.260	6.599	6.227	5.988
	0.010	13.75	10.92	9.780	9.148	8.746
	0.005	18.63	14.54	12.92	12.03	11.46
7	0.100	3.589	3.257	3.074	2.961	2.883
	0.050	5.591	4.737	4.347	4.120	3.972
	0.025	8.073	6.542	5.890	5.523	5.285
	0.010	12.25	9.547	8.451	7.847	7.460
	0.005	16.24	12.40	10.88	10.05	9.522
8	0.100	3.458	3.113	2.924	2.806	2.726
	0.050	5.318	4.459	4.066	3.838	3.687
	0.025	7.571	6.059	5.416	5.053	4.817
	0.010	11.26	8.649	7.591	7.006	6.632
	0.005	14.69	11.04	9.596	8.805	8.302
9	0.100	3.360	3.006	2.813	2.693	2.611
	0.050	5.117	4.256	3.863	3.633	3.482
	0.025	7.209	5.715	5.078	4.718	4.484
	0.010	10.56	8.022	6.992	6.422	6.057
	0.005	13.61	10.11	8.717	7.956	7.471
10	0.100	3.285	2.924	2.728	2.605	2.522
	0.050	4.965	4.103	3.708	3.478	3.326
	0.025	6.937	5.456	4.826	4.468	4.236
	0.010	10.04	7.559	6.552	5.994	5.636
	0.005	12.83	9.427	8.081	7.343	6.872
11	0.100	3.225	2.860	2.660	2.536	2.451
	0.050	4.844	3.982	3.587	3.357	3.204
	0.025	6.724	5.256	4.630	4.275	4.044
	0.010	9.646	7.206	6.217	5.668	5.316
	0.005	12.23	8.912	7.600	6.881	6.422
12	0.100	3.177	2.807	2.606	2.480	2.394
	0.050	4.747	3.885	3.490	3.259	3.106
	0.025	6.554	5.096	4.474	4.121	3.891
	0.010	9.330	6.927	5.953	5.412	5.064
	0.005	11.75	8.510	7.226	6.521	6.071
13	0.100	3.136	2.763	2.560	2.434	2.347
	0.050	4.667	3.806	3.411	3.179	3.025
	0.025	6.414	4.965	4.347	3.996	3.767
	0.010	9.074	6.701	5.739	5.205	4.862
	0.005	11.37	8.186	6.926	6.233	5.791
14	0.100	3.102	2.726	2.522	2.395	2.307
	0.050	4.600	3.739	3.344	3.112	2.958
	0.025	6.298	4.857	4.242	3.892	3.663
	0.010	8.862	6.515	5.564	5.035	4.695
	0.005	11.06	7.922	6.680	5.998	5.562
15	0.100	3.073	2.695	2.490	2.361	2.273
	0.050	4.543	3.682	3.287	3.056	2.901
	0.025	6.200	4.765	4.153	3.804	3.576
	0.010	8.683	6.359	5.417	4.893	4.556
	0.005	10.80	7.701	6.476	5.803	5.372
16	0.100	3.048	2.668	2.462	2.333	2.244
	0.050	4.494	3.634	3.239	3.007	2.852
	0.025	6.115	4.687	4.077	3.729	3.502
	0.010	8.531	6.226	5.292	4.773	4.437
	0.005	10.58	7.514	6.303	5.638	5.212
17	0.100	3.026	2.645	2.437	2.308	2.218
	0.050	4.451	3.592	3.197	2.965	2.810
	0.025	6.042	4.619	4.011	3.665	3.438
	0.010	8.400	6.112	5.185	4.669	4.336
	0.005	10.38	7.354	6.156	5.497	5.075
18	0.100	3.007	2.624	2.416	2.286	2.196
	0.050	4.414	3.555	3.160	2.928	2.773
	0.025	5.978	4.560	3.954	3.608	3.382
	0.010	8.285	6.013	5.092	4.579	4.248
	0.005	10.22	7.215	6.028	5.375	4.956
19	0.100	2.990	2.606	2.397	2.266	2.176
	0.050	4.381	3.522	3.127	2.895	2.740
	0.025	5.922	4.508	3.903	3.559	3.333
	0.010	8.185	5.926	5.010	4.500	4.171
	0.005	10.07	7.093	5.916	5.268	4.853
20	0.100	2.975	2.589	2.380	2.249	2.158
	0.050	4.351	3.493	3.098	2.866	2.711
	0.025	5.871	4.461	3.859	3.515	3.289
	0.010	8.096	5.849	4.938	4.431	4.103
	0.005	9.944	6.986	5.818	5.174	4.762
21	0.100	2.961	2.575	2.365	2.233	2.142
	0.050	4.325	3.467	3.072	2.840	2.685
	0.025	5.827	4.420	3.819	3.475	3.250
	0.010	8.017	5.780	4.874	4.369	4.042
	0.005	9.830	6.891	5.730	5.091	4.681
22	0.100	2.949	2.561	2.351	2.219	2.128
	0.050	4.301	3.443	3.049	2.817	2.661
	0.025	5.786	4.383	3.783	3.440	3.215
	0.010	7.945	5.719	4.817	4.313	3.988
	0.005	9.727	6.806	5.652	5.017	4.609
23	0.100	2.937	2.549	2.339	2.207	2.115
	0.050	4.279	3.422	3.028	2.796	2.640
	0.025	5.750	4.349	3.750	3.408	3.183
	0.010	7.881	5.664	4.765	4.264	3.939
	0.005	9.635	6.730	5.582	4.950	4.544
24	0.100	2.927	2.538	2.327	2.195	2.103
	0.050	4.260	3.403	3.009	2.776	2.621
	0.025	5.717	4.319	3.721	3.379	3.155
	0.010	7.823	5.614	4.718	4.218	3.895
	0.005	9.551	6.661	5.519	4.890	4.486
25	0.100	2.918	2.528	2.317	2.184	2.092
	0.050	4.242	3.385	2.991	2.759	2.603
	0.025	5.686	4.291	3.694	3.353	3.129
	0.010	7.770	5.568	4.675	4.177	3.855
	0.005	9.475	6.598	5.462	4.835	4.433
26	0.100	2.909	2.519	2.307	2.174	2.082
	0.050	4.225	3.369	2.975	2.743	2.587
	0.025	5.659	4.265	3.670	3.329	3.105
	0.010	7.721	5.526	4.637	4.140	3.818
	0.005	9.406	6.541	5.409	4.785	4.384
27	0.100	2.901	2.511	2.299	2.165	2.073
	0.050	4.210	3.354	2.960	2.728	2.572
	0.025	5.633	4.242	3.647	3.307	3.083
	0.010	7.677	5.488	4.601	4.106	3.785
	0.005	9.342	6.489	5.361	4.740	4.340
28	0.100	2.894	2.503	2.291	2.157	2.064
	0.050	4.196	3.340	2.947	2.714	2.558
	0.025	5.610	4.221	3.626	3.286	3.063
	0.010	7.636	5.453	4.568	4.074	3.754
	0.005	9.284	6.440	5.317	4.698	4.300
29	0.100	2.887	2.495	2.283	2.149	2.057
	0.050	4.183	3.328	2.934	2.701	2.545
	0.025	5.588	4.201	3.607	3.267	3.044
	0.010	7.598	5.420	4.538	4.045	3.725
	0.005	9.230	6.396	5.276	4.659	4.262
30	0.100	2.881	2.489	2.276	2.142	2.049
	0.050	4.171	3.316	2.922	2.690	2.534
	0.025	5.568	4.182	3.589	3.250	3.026
	0.010	7.562	5.390	4.510	4.018	3.699
	0.005	9.180	6.355	5.239	4.623	4.228
40	0.100	2.835	2.440	2.226	2.091	1.997
	0.050	4.085	3.232	2.839	2.606	2.449
	0.025	5.424	4.051	3.463	3.126	2.904
	0.010	7.314	5.179	4.313	3.828	3.514
	0.005	8.828	6.066	4.976	4.374	3.986
60	0.100	2.791	2.393	2.177	2.041	1.946
	0.050	4.001	3.150	2.758	2.525	2.368
	0.025	5.286	3.925	3.343	3.008	2.786
	0.010	7.077	4.977	4.126	3.649	3.339
	0.005	8.495	5.795	4.729	4.140	3.760
80	0.100	2.769	2.370	2.154	2.016	1.921
	0.050	3.960	3.111	2.719	2.486	2.329
	0.025	5.218	3.864	3.284	2.950	2.730
	0.010	6.963	4.881	4.036	3.563	3.255
	0.005	8.335	5.665	4.611	4.029	3.652
100	0.100	2.756	2.356	2.139	2.002	1.906
	0.050	3.936	3.087	2.696	2.463	2.305
	0.025	5.179	3.828	3.250	2.917	2.696
	0.010	6.895	4.824	3.984	3.513	3.206
	0.005	8.241	5.589	4.542	3.963	3.589
∞	0.100	2.706	2.303	2.084	1.945	1.847
	0.050	3.841	2.996	2.605	2.372	2.214
	0.025	5.024	3.689	3.116	2.786	2.567
	0.010	6.635	4.605	3.782	3.319	3.017
	0.005	7.879	5.298	4.279	3.715	3.350
	α	0.100	0.050	0.025	0.010	0.005