

1<sup>st</sup> SEM. 2014/2015



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**UNIVERSITY OF SWAZILAND**

**SUPPLEMENTARY EXAMINATION PAPER**

**PROGRAMME:** BSc. in Agricultural Economics and Agribusiness  
Management Year III  
BSc. in Agricultural Education Year III  
BSc. in Agronomy Year III  
BSc. in Animal Science Year III  
BSc. in Food Science, Nutrition and Technology Year III  
BSc. in Consumer sciences Year III  
BSc. in Consumer sciences Education Year III  
BSc. in Horticulture Year III  
BSc. in Agricultural & biosystems engineering Year III  
BSc. in Textiles Apparel Design and Management Year III

**COURSE CODE:** AEM 303

**TITLE OF PAPER:** Applied Agricultural statistics

**TIME ALLOWED:** Two (2) Hours

**INSTRUCTION:** ANSWER ALL QUESTIONS

**DO NOT OPEN THIS PAPER UNTIL PERMISSION HAS BEEN GRANTED BY  
THE CHIEF INVIGILATOR**

1.1 Define factorial experiments and explain the advantage and disadvantages of these experiments? ( 15 points)

1.2. Explain the layout of Latin square design and the advantage and disadvantages?

(15 Points)

1.3 Complete the following ANOVA table for LCD in which each treatment appeared once in each block. ( 10 points)

| Source of variation | df  | SS  | MS  | F   |
|---------------------|-----|-----|-----|-----|
| Treatments          | ___ | 14  | ___ | ___ |
| row                 | 4   | ___ | 8   | ___ |
| Column              | --- | 24  | ___ | ___ |
| Errors              | ___ | ___ | 0.2 | ___ |

Question 2 ( 20 points)

In a certain town, there are about one million eligible voters. A simple random sample size 10,000 was chosen ,to study the relationship between gender and participation in the last election. The results:

|             | Men   | Women |
|-------------|-------|-------|
| voted       | 2,792 | 3,591 |
| Didn't vote | 1,486 | 2,131 |

Make a chi square-test of the null hypothesis that gender and voting are independent?

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**Question 3 ( 40 points)**

An educator wants to see how strong the relationship is between a student's score on a test and his/her grade point average.

|              |     |     |     |     |     |     |     |     |
|--------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Test score x | 98  | 105 | 100 | 100 | 106 | 95  | 116 | 112 |
| GPA y        | 2.1 | 2.4 | 3.2 | 2.7 | 2.2 | 2.3 | 3.8 | 3.4 |

- 3.1 Compute the value of the linear correlation coefficient between x and y. (5 points)
- 3.2 State the hypotheses (5 points)
- 3.3 Find the critical value. (5 points)
- 3.4 Compute the test value. ( 10 points)
- 3.5 Summarize the result and find the regression line if r is Significant? (5 points)
- 3.6 Calculate the coefficient of determination? (5 points)
- 3.7 What is the best predicated value of GDA if the test score is 120? (5 points)

END OF PAPER

APPENDIX F Distribution of *t*

| df       | Level of significance for one-tailed test |       |        |        |        |         |
|----------|---|-------|--------|--------|--------|---------|
|          | .10                                       | .05   | .025   | .01    | .005   | .0005   |
|          | Level of significance for two-tailed test |       |        |        |        |         |
|          | .20                                       | .10   | .05    | .02    | .01    | .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  | 31.508  |
| 3        | 1.638                                     | 2.353 | 3.182  | 4.541  | 5.841  | 12.941  |
| 4        | 1.533                                     | 2.132 | 2.776  | 3.747  | 4.604  | 8.610   |
| 5        | 1.476                                     | 2.015 | 2.571  | 3.365  | 4.032  | 6.859   |
| 6        | 1.440                                     | 1.943 | 2.447  | 3.143  | 3.707  | 5.959   |
| 7        | 1.415                                     | 1.895 | 2.365  | 2.998  | 3.499  | 5.405   |
| 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  | 3.767   |
| 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   |
| 40       | 1.303                                     | 1.684 | 2.021  | 2.423  | 2.704  | 3.551   |
| 60       | 1.296                                     | 1.671 | 2.000  | 2.390  | 2.660  | 3.460   |
| 120      | 1.289                                     | 1.658 | 1.980  | 2.358  | 2.617  | 3.373   |
| $\infty$ | 1.282                                     | 1.645 | 1.960  | 2.326  | 2.576  | 3.291   |

Abridged from R. A. Fisher and F. Yates, *Statistical Tables for Biological, Agricultural and Medical Research*, 6th ed. (London: Longman, 1974), tab. III. Used by permission of the authors and Longman Group Ltd.

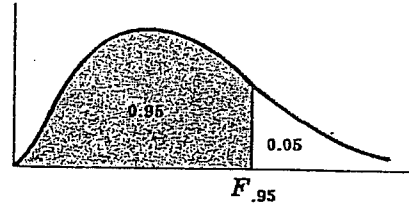
Chi-square Distribution Table

| d.f. | .995  | .99   | .975  | .95   | .9    | .1     | .05    | .025   | .01    |
|------|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| 1    | 0.00  | 0.00  | 0.00  | 0.00  | 0.02  | 2.71   | 3.84   | 5.02   | 6.63   |
| 2    | 0.01  | 0.02  | 0.05  | 0.10  | 0.21  | 4.61   | 5.99   | 7.38   | 9.21   |
| 3    | 0.07  | 0.11  | 0.22  | 0.35  | 0.58  | 6.25   | 7.81   | 9.35   | 11.34  |
| 4    | 0.21  | 0.30  | 0.48  | 0.71  | 1.06  | 7.78   | 9.49   | 11.14  | 13.28  |
| 5    | 0.41  | 0.55  | 0.83  | 1.15  | 1.61  | 9.24   | 11.07  | 12.83  | 15.09  |
| 6    | 0.68  | 0.87  | 1.24  | 1.64  | 2.20  | 10.64  | 12.59  | 14.45  | 16.81  |
| 7    | 0.99  | 1.24  | 1.69  | 2.17  | 2.83  | 12.02  | 14.07  | 16.01  | 18.48  |
| 8    | 1.34  | 1.65  | 2.18  | 2.73  | 3.49  | 13.36  | 15.51  | 17.53  | 20.09  |
| 9    | 1.73  | 2.09  | 2.70  | 3.33  | 4.17  | 14.68  | 16.92  | 19.02  | 21.67  |
| 10   | 2.16  | 2.56  | 3.25  | 3.94  | 4.87  | 15.99  | 18.31  | 20.48  | 23.21  |
| 11   | 2.60  | 3.05  | 3.82  | 4.57  | 5.58  | 17.28  | 19.68  | 21.92  | 24.72  |
| 12   | 3.07  | 3.57  | 4.40  | 5.23  | 6.30  | 18.55  | 21.03  | 23.34  | 26.22  |
| 13   | 3.57  | 4.11  | 5.01  | 5.89  | 7.04  | 19.81  | 22.36  | 24.74  | 27.69  |
| 14   | 4.07  | 4.66  | 5.63  | 6.57  | 7.79  | 21.06  | 23.68  | 26.12  | 29.14  |
| 15   | 4.60  | 5.23  | 6.26  | 7.26  | 8.55  | 22.31  | 25.00  | 27.49  | 30.58  |
| 16   | 5.14  | 5.81  | 6.91  | 7.96  | 9.31  | 23.54  | 26.30  | 28.85  | 32.00  |
| 17   | 5.70  | 6.41  | 7.56  | 8.67  | 10.09 | 24.77  | 27.59  | 30.19  | 33.41  |
| 18   | 6.26  | 7.01  | 8.23  | 9.39  | 10.86 | 25.99  | 28.87  | 31.53  | 34.81  |
| 19   | 6.84  | 7.63  | 8.91  | 10.12 | 11.65 | 27.20  | 30.14  | 32.85  | 36.19  |
| 20   | 7.43  | 8.26  | 9.59  | 10.85 | 12.44 | 28.41  | 31.41  | 34.17  | 37.57  |
| 22   | 8.64  | 9.54  | 10.98 | 12.34 | 14.04 | 30.81  | 33.92  | 36.78  | 40.29  |
| 24   | 9.89  | 10.86 | 12.40 | 13.85 | 15.66 | 33.20  | 36.42  | 39.36  | 42.98  |
| 26   | 11.16 | 12.20 | 13.84 | 15.38 | 17.29 | 35.56  | 38.89  | 41.92  | 45.64  |
| 28   | 12.46 | 13.56 | 15.31 | 16.93 | 18.94 | 37.92  | 41.34  | 44.46  | 48.28  |
| 30   | 13.79 | 14.95 | 16.79 | 18.49 | 20.60 | 40.26  | 43.77  | 46.98  | 50.89  |
| 32   | 15.13 | 16.36 | 18.29 | 20.07 | 22.27 | 42.58  | 46.19  | 49.48  | 53.49  |
| 34   | 16.50 | 17.79 | 19.81 | 21.66 | 23.95 | 44.90  | 48.60  | 51.97  | 56.06  |
| 38   | 19.29 | 20.69 | 22.88 | 24.88 | 27.34 | 49.51  | 53.38  | 56.90  | 61.16  |
| 42   | 22.14 | 23.65 | 26.00 | 28.14 | 30.77 | 54.09  | 58.12  | 61.78  | 66.21  |
| 46   | 25.04 | 26.66 | 29.16 | 31.44 | 34.22 | 58.64  | 62.83  | 66.62  | 71.20  |
| 50   | 27.99 | 29.71 | 32.36 | 34.76 | 37.69 | 63.17  | 67.50  | 71.42  | 76.15  |
| 55   | 31.73 | 33.57 | 36.40 | 38.96 | 42.06 | 68.80  | 73.31  | 77.38  | 82.29  |
| 60   | 35.53 | 37.48 | 40.48 | 43.19 | 46.46 | 74.40  | 79.08  | 83.30  | 88.38  |
| 65   | 39.38 | 41.44 | 44.60 | 47.45 | 50.88 | 79.97  | 84.82  | 89.18  | 94.42  |
| 70   | 43.28 | 45.44 | 48.76 | 51.74 | 55.33 | 85.53  | 90.53  | 95.02  | 100.43 |
| 75   | 47.21 | 49.48 | 52.94 | 56.05 | 59.79 | 91.06  | 96.22  | 100.84 | 106.39 |
| 80   | 51.17 | 53.54 | 57.15 | 60.39 | 64.28 | 96.58  | 101.88 | 106.63 | 112.33 |
| 85   | 55.17 | 57.63 | 61.39 | 64.75 | 68.78 | 102.08 | 107.52 | 112.39 | 118.24 |
| 90   | 59.20 | 61.75 | 65.65 | 69.13 | 73.29 | 107.57 | 113.15 | 118.14 | 124.12 |
| 95   | 63.25 | 65.90 | 69.92 | 73.52 | 77.82 | 113.04 | 118.75 | 123.86 | 129.97 |
| 100  | 67.33 | 70.06 | 74.22 | 77.93 | 82.36 | 118.50 | 124.34 | 129.56 | 135.81 |

# Appendix V

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95th Percentile Values  
for the F Distribution  
( $\nu_1$  degrees of freedom in numerator)  
( $\nu_2$  degrees of freedom in denominator)

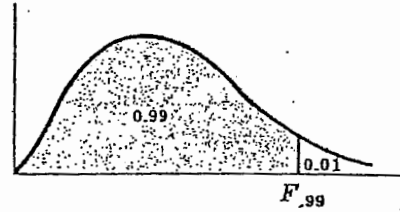


| $\nu_1 \backslash \nu_2$ | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 12   | 15   | 20   | 24   | 30   | 40   | 60   | 120  | $\infty$ |
|--------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|----------|
| 1                        | 161  | 200  | 216  | 225  | 230  | 234  | 237  | 239  | 241  | 242  | 244  | 246  | 248  | 249  | 250  | 251  | 252  | 253  | 254      |
| 2                        | 18.5 | 19.0 | 19.2 | 19.2 | 19.3 | 19.3 | 19.4 | 19.4 | 19.4 | 19.4 | 19.4 | 19.4 | 19.4 | 19.5 | 19.5 | 19.5 | 19.5 | 19.5 | 19.5     |
| 3                        | 10.1 | 9.55 | 9.28 | 9.12 | 9.01 | 8.94 | 8.89 | 8.85 | 8.81 | 8.79 | 8.74 | 8.70 | 8.66 | 8.64 | 8.62 | 8.59 | 8.57 | 8.55 | 8.53     |
| 4                        | 7.71 | 6.94 | 6.59 | 6.39 | 6.26 | 6.16 | 6.09 | 6.04 | 6.00 | 5.96 | 5.91 | 5.86 | 5.80 | 5.77 | 5.75 | 5.72 | 5.69 | 5.66 | 5.63     |
| 5                        | 6.61 | 5.79 | 5.41 | 5.19 | 5.05 | 4.95 | 4.88 | 4.82 | 4.77 | 4.74 | 4.68 | 4.62 | 4.56 | 4.53 | 4.50 | 4.46 | 4.43 | 4.40 | 4.37     |
| 6                        | 5.99 | 5.14 | 4.76 | 4.53 | 4.39 | 4.28 | 4.21 | 4.15 | 4.10 | 4.06 | 4.00 | 3.94 | 3.87 | 3.84 | 3.81 | 3.77 | 3.74 | 3.70 | 3.67     |
| 7                        | 5.59 | 4.74 | 4.35 | 4.12 | 3.97 | 3.87 | 3.79 | 3.73 | 3.68 | 3.64 | 3.57 | 3.51 | 3.44 | 3.41 | 3.38 | 3.34 | 3.30 | 3.27 | 3.23     |
| 8                        | 5.32 | 4.46 | 4.07 | 3.84 | 3.69 | 3.58 | 3.50 | 3.44 | 3.39 | 3.35 | 3.28 | 3.22 | 3.15 | 3.12 | 3.08 | 3.04 | 3.01 | 2.97 | 2.93     |
| 9                        | 5.12 | 4.26 | 3.86 | 3.63 | 3.48 | 3.37 | 3.29 | 3.23 | 3.18 | 3.14 | 3.07 | 3.01 | 2.94 | 2.90 | 2.86 | 2.83 | 2.79 | 2.75 | 2.71     |
| 10                       | 4.96 | 4.10 | 3.71 | 3.48 | 3.33 | 3.22 | 3.14 | 3.07 | 3.02 | 2.98 | 2.91 | 2.85 | 2.77 | 2.74 | 2.70 | 2.66 | 2.62 | 2.58 | 2.54     |
| 11                       | 4.84 | 3.98 | 3.59 | 3.36 | 3.20 | 3.09 | 3.01 | 2.95 | 2.90 | 2.85 | 2.79 | 2.72 | 2.65 | 2.61 | 2.57 | 2.53 | 2.49 | 2.45 | 2.40     |
| 12                       | 4.75 | 3.89 | 3.49 | 3.26 | 3.11 | 3.00 | 2.91 | 2.85 | 2.80 | 2.75 | 2.69 | 2.62 | 2.54 | 2.51 | 2.47 | 2.43 | 2.38 | 2.34 | 2.30     |
| 13                       | 4.67 | 3.81 | 3.41 | 3.18 | 3.03 | 2.92 | 2.83 | 2.77 | 2.71 | 2.67 | 2.60 | 2.53 | 2.46 | 2.42 | 2.38 | 2.34 | 2.30 | 2.25 | 2.21     |
| 14                       | 4.60 | 3.74 | 3.34 | 3.11 | 2.96 | 2.85 | 2.76 | 2.70 | 2.65 | 2.60 | 2.53 | 2.46 | 2.39 | 2.35 | 2.31 | 2.27 | 2.22 | 2.18 | 2.13     |
| 15                       | 4.54 | 3.68 | 3.29 | 3.06 | 2.90 | 2.79 | 2.71 | 2.64 | 2.59 | 2.54 | 2.48 | 2.40 | 2.33 | 2.29 | 2.25 | 2.20 | 2.16 | 2.11 | 2.07     |
| 16                       | 4.49 | 3.63 | 3.24 | 3.01 | 2.85 | 2.74 | 2.66 | 2.59 | 2.54 | 2.49 | 2.42 | 2.35 | 2.28 | 2.24 | 2.19 | 2.15 | 2.11 | 2.06 | 2.01     |
| 17                       | 4.45 | 3.59 | 3.20 | 2.96 | 2.81 | 2.70 | 2.61 | 2.55 | 2.49 | 2.45 | 2.38 | 2.31 | 2.23 | 2.19 | 2.15 | 2.10 | 2.06 | 2.01 | 1.96     |
| 18                       | 4.41 | 3.55 | 3.16 | 2.93 | 2.77 | 2.66 | 2.58 | 2.51 | 2.46 | 2.41 | 2.34 | 2.27 | 2.19 | 2.15 | 2.11 | 2.06 | 2.02 | 1.97 | 1.92     |
| 19                       | 4.38 | 3.52 | 3.13 | 2.90 | 2.74 | 2.63 | 2.54 | 2.48 | 2.42 | 2.38 | 2.31 | 2.23 | 2.16 | 2.11 | 2.07 | 2.03 | 1.98 | 1.93 | 1.88     |
| 20                       | 4.35 | 3.49 | 3.10 | 2.87 | 2.71 | 2.60 | 2.51 | 2.45 | 2.39 | 2.35 | 2.28 | 2.20 | 2.12 | 2.08 | 2.04 | 1.99 | 1.95 | 1.90 | 1.84     |
| 21                       | 4.32 | 3.47 | 3.07 | 2.84 | 2.68 | 2.57 | 2.49 | 2.42 | 2.37 | 2.32 | 2.25 | 2.18 | 2.10 | 2.05 | 2.01 | 1.96 | 1.92 | 1.87 | 1.81     |
| 22                       | 4.30 | 3.44 | 3.05 | 2.82 | 2.66 | 2.55 | 2.46 | 2.40 | 2.34 | 2.30 | 2.23 | 2.15 | 2.07 | 2.03 | 1.98 | 1.94 | 1.89 | 1.84 | 1.78     |
| 23                       | 4.28 | 3.42 | 3.03 | 2.80 | 2.64 | 2.53 | 2.44 | 2.37 | 2.32 | 2.27 | 2.20 | 2.13 | 2.05 | 2.01 | 1.96 | 1.91 | 1.86 | 1.81 | 1.76     |
| 24                       | 4.26 | 3.40 | 3.01 | 2.78 | 2.62 | 2.51 | 2.42 | 2.36 | 2.30 | 2.25 | 2.18 | 2.11 | 2.03 | 1.98 | 1.94 | 1.89 | 1.84 | 1.79 | 1.73     |
| 25                       | 4.24 | 3.39 | 2.99 | 2.76 | 2.60 | 2.49 | 2.40 | 2.34 | 2.28 | 2.24 | 2.16 | 2.09 | 2.01 | 1.96 | 1.92 | 1.87 | 1.82 | 1.77 | 1.71     |
| 26                       | 4.23 | 3.37 | 2.98 | 2.74 | 2.59 | 2.47 | 2.39 | 2.32 | 2.27 | 2.22 | 2.15 | 2.07 | 1.99 | 1.95 | 1.90 | 1.85 | 1.80 | 1.75 | 1.69     |
| 27                       | 4.21 | 3.35 | 2.96 | 2.73 | 2.57 | 2.46 | 2.37 | 2.31 | 2.25 | 2.20 | 2.13 | 2.06 | 1.97 | 1.93 | 1.88 | 1.84 | 1.79 | 1.73 | 1.67     |
| 28                       | 4.20 | 3.34 | 2.95 | 2.71 | 2.56 | 2.45 | 2.36 | 2.29 | 2.24 | 2.19 | 2.12 | 2.04 | 1.96 | 1.91 | 1.87 | 1.82 | 1.77 | 1.71 | 1.65     |
| 29                       | 4.18 | 3.33 | 2.93 | 2.70 | 2.55 | 2.43 | 2.35 | 2.28 | 2.22 | 2.18 | 2.10 | 2.03 | 1.94 | 1.90 | 1.85 | 1.81 | 1.75 | 1.70 | 1.64     |
| 30                       | 4.17 | 3.32 | 2.92 | 2.69 | 2.53 | 2.42 | 2.33 | 2.27 | 2.21 | 2.16 | 2.09 | 2.01 | 1.93 | 1.89 | 1.84 | 1.79 | 1.74 | 1.68 | 1.62     |
| 40                       | 4.08 | 3.23 | 2.84 | 2.61 | 2.45 | 2.34 | 2.25 | 2.18 | 2.12 | 2.08 | 2.00 | 1.92 | 1.84 | 1.79 | 1.74 | 1.69 | 1.64 | 1.58 | 1.51     |
| 60                       | 4.00 | 3.15 | 2.76 | 2.53 | 2.37 | 2.25 | 2.17 | 2.10 | 2.04 | 1.99 | 1.92 | 1.84 | 1.75 | 1.70 | 1.65 | 1.59 | 1.53 | 1.47 | 1.39     |
| 120                      | 3.92 | 3.07 | 2.68 | 2.45 | 2.29 | 2.18 | 2.09 | 2.02 | 1.96 | 1.91 | 1.83 | 1.75 | 1.66 | 1.61 | 1.55 | 1.50 | 1.43 | 1.35 | 1.25     |
| $\infty$                 | 3.84 | 3.00 | 2.60 | 2.37 | 2.21 | 2.10 | 2.01 | 1.94 | 1.88 | 1.83 | 1.75 | 1.67 | 1.57 | 1.52 | 1.46 | 1.39 | 1.32 | 1.22 | 1.00     |

Source: E. S. Pearson and H. O. Hartley, *Biometrika Tables for Statisticians*, Vol. 2 (1972), Table 5, page 178, by permission.

# Appendix VI

99th Percentile Values  
for the  $F$  Distribution  
( $\nu_1$  degrees of freedom in numerator)  
( $\nu_2$  degrees of freedom in denominator)



| $\nu_1 \backslash \nu_2$ | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 12   | 15   | 20   | 24   | 30   | 40   | 60   | 120  | $\infty$ |
|--------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|----------|
| 1                        | 4052 | 5000 | 5403 | 5625 | 5764 | 5859 | 5928 | 5981 | 6023 | 6056 | 6106 | 6157 | 6209 | 6235 | 6261 | 6287 | 6313 | 6339 | 6366     |
| 2                        | 98.5 | 99.0 | 99.2 | 99.2 | 99.3 | 99.3 | 99.4 | 99.4 | 99.4 | 99.4 | 99.4 | 99.4 | 99.4 | 99.5 | 99.5 | 99.5 | 99.5 | 99.5 | 99.5     |
| 3                        | 34.1 | 30.8 | 29.5 | 28.7 | 28.2 | 27.9 | 27.7 | 27.5 | 27.3 | 27.2 | 27.1 | 26.9 | 26.7 | 26.6 | 26.5 | 26.4 | 26.3 | 26.2 | 26.1     |
| 4                        | 21.2 | 18.0 | 16.7 | 16.0 | 15.5 | 15.2 | 15.0 | 14.8 | 14.7 | 14.5 | 14.4 | 14.2 | 14.0 | 13.9 | 13.8 | 13.7 | 13.7 | 13.6 | 13.5     |
| 5                        | 16.3 | 13.3 | 12.1 | 11.4 | 11.0 | 10.7 | 10.5 | 10.3 | 10.2 | 10.1 | 9.89 | 9.72 | 9.55 | 9.47 | 9.38 | 9.29 | 9.20 | 9.11 | 9.02     |
| 6                        | 13.7 | 10.9 | 9.78 | 9.15 | 8.75 | 8.47 | 8.26 | 8.10 | 7.98 | 7.87 | 7.72 | 7.56 | 7.40 | 7.31 | 7.23 | 7.14 | 7.06 | 6.97 | 6.88     |
| 7                        | 12.2 | 9.55 | 8.45 | 7.85 | 7.46 | 7.19 | 6.99 | 6.84 | 6.72 | 6.62 | 6.47 | 6.31 | 6.16 | 6.07 | 5.99 | 5.91 | 5.82 | 5.74 | 5.65     |
| 8                        | 11.3 | 8.65 | 7.59 | 7.01 | 6.63 | 6.37 | 6.18 | 6.03 | 5.91 | 5.81 | 5.67 | 5.52 | 5.36 | 5.28 | 5.20 | 5.12 | 5.03 | 4.95 | 4.86     |
| 9                        | 10.6 | 8.02 | 6.99 | 6.42 | 6.06 | 5.80 | 5.61 | 5.47 | 5.35 | 5.26 | 5.11 | 4.96 | 4.81 | 4.73 | 4.65 | 4.57 | 4.48 | 4.40 | 4.31     |
| 10                       | 10.0 | 7.56 | 6.55 | 5.99 | 5.64 | 5.39 | 5.20 | 5.06 | 4.94 | 4.85 | 4.71 | 4.56 | 4.41 | 4.33 | 4.25 | 4.17 | 4.08 | 4.00 | 3.91     |
| 11                       | 9.65 | 7.21 | 6.22 | 5.67 | 5.32 | 5.07 | 4.89 | 4.74 | 4.63 | 4.54 | 4.40 | 4.25 | 4.10 | 4.02 | 3.94 | 3.86 | 3.78 | 3.69 | 3.60     |
| 12                       | 9.33 | 6.93 | 5.95 | 5.41 | 5.06 | 4.82 | 4.64 | 4.50 | 4.39 | 4.30 | 4.16 | 4.01 | 3.86 | 3.78 | 3.70 | 3.62 | 3.54 | 3.45 | 3.36     |
| 13                       | 9.07 | 6.70 | 5.74 | 5.21 | 4.86 | 4.62 | 4.44 | 4.30 | 4.19 | 4.10 | 3.96 | 3.82 | 3.66 | 3.59 | 3.51 | 3.43 | 3.34 | 3.25 | 3.17     |
| 14                       | 8.86 | 6.51 | 5.56 | 5.04 | 4.70 | 4.46 | 4.28 | 4.14 | 4.03 | 3.94 | 3.80 | 3.66 | 3.51 | 3.43 | 3.35 | 3.27 | 3.18 | 3.09 | 3.00     |
| 15                       | 8.68 | 6.36 | 5.42 | 4.89 | 4.56 | 4.32 | 4.14 | 4.00 | 3.89 | 3.80 | 3.67 | 3.52 | 3.37 | 3.29 | 3.21 | 3.13 | 3.05 | 2.96 | 2.87     |
| 16                       | 8.53 | 6.23 | 5.29 | 4.77 | 4.44 | 4.20 | 4.03 | 3.89 | 3.78 | 3.69 | 3.55 | 3.41 | 3.26 | 3.18 | 3.10 | 3.02 | 2.93 | 2.84 | 2.75     |
| 17                       | 8.40 | 6.11 | 5.19 | 4.67 | 4.34 | 4.10 | 3.93 | 3.79 | 3.68 | 3.59 | 3.46 | 3.31 | 3.16 | 3.08 | 3.00 | 2.92 | 2.83 | 2.75 | 2.65     |
| 18                       | 8.29 | 6.01 | 5.09 | 4.58 | 4.25 | 4.01 | 3.84 | 3.71 | 3.60 | 3.51 | 3.37 | 3.23 | 3.08 | 3.00 | 2.92 | 2.84 | 2.75 | 2.66 | 2.57     |
| 19                       | 8.18 | 5.93 | 5.01 | 4.50 | 4.17 | 3.94 | 3.77 | 3.63 | 3.52 | 3.43 | 3.30 | 3.15 | 3.00 | 2.92 | 2.84 | 2.76 | 2.67 | 2.58 | 2.49     |
| 20                       | 8.10 | 5.85 | 4.94 | 4.43 | 4.10 | 3.87 | 3.70 | 3.56 | 3.46 | 3.37 | 3.23 | 3.09 | 2.94 | 2.86 | 2.78 | 2.69 | 2.61 | 2.52 | 2.42     |
| 21                       | 8.02 | 5.78 | 4.87 | 4.37 | 4.04 | 3.81 | 3.64 | 3.51 | 3.40 | 3.31 | 3.17 | 3.03 | 2.88 | 2.80 | 2.72 | 2.64 | 2.55 | 2.46 | 2.36     |
| 22                       | 7.95 | 5.72 | 4.82 | 4.31 | 3.99 | 3.76 | 3.59 | 3.45 | 3.35 | 3.26 | 3.12 | 2.98 | 2.83 | 2.75 | 2.67 | 2.58 | 2.50 | 2.40 | 2.31     |
| 23                       | 7.88 | 5.66 | 4.76 | 4.26 | 3.94 | 3.71 | 3.54 | 3.41 | 3.30 | 3.21 | 3.07 | 2.93 | 2.78 | 2.70 | 2.62 | 2.54 | 2.45 | 2.35 | 2.26     |
| 24                       | 7.82 | 5.61 | 4.72 | 4.22 | 3.90 | 3.67 | 3.50 | 3.36 | 3.26 | 3.17 | 3.03 | 2.89 | 2.74 | 2.66 | 2.58 | 2.49 | 2.40 | 2.31 | 2.21     |
| 25                       | 7.77 | 5.57 | 4.68 | 4.18 | 3.86 | 3.63 | 3.46 | 3.32 | 3.22 | 3.13 | 2.99 | 2.85 | 2.70 | 2.62 | 2.54 | 2.45 | 2.36 | 2.27 | 2.17     |
| 26                       | 7.72 | 5.53 | 4.64 | 4.14 | 3.82 | 3.59 | 3.42 | 3.29 | 3.18 | 3.09 | 2.96 | 2.82 | 2.66 | 2.58 | 2.50 | 2.42 | 2.33 | 2.23 | 2.13     |
| 27                       | 7.68 | 5.49 | 4.60 | 4.11 | 3.78 | 3.56 | 3.39 | 3.26 | 3.15 | 3.06 | 2.93 | 2.78 | 2.63 | 2.55 | 2.47 | 2.38 | 2.29 | 2.20 | 2.10     |
| 28                       | 7.64 | 5.45 | 4.57 | 4.07 | 3.75 | 3.53 | 3.36 | 3.23 | 3.12 | 3.03 | 2.90 | 2.75 | 2.60 | 2.52 | 2.44 | 2.35 | 2.26 | 2.17 | 2.06     |
| 29                       | 7.60 | 5.42 | 4.54 | 4.04 | 3.73 | 3.50 | 3.33 | 3.20 | 3.09 | 3.00 | 2.87 | 2.73 | 2.57 | 2.49 | 2.41 | 2.33 | 2.23 | 2.14 | 2.03     |
| 30                       | 7.56 | 5.39 | 4.51 | 4.02 | 3.70 | 3.47 | 3.30 | 3.17 | 3.07 | 2.98 | 2.84 | 2.70 | 2.55 | 2.47 | 2.39 | 2.30 | 2.21 | 2.11 | 2.01     |
| 40                       | 7.31 | 5.18 | 4.31 | 3.83 | 3.51 | 3.29 | 3.12 | 2.99 | 2.89 | 2.80 | 2.66 | 2.52 | 2.37 | 2.29 | 2.20 | 2.11 | 2.02 | 1.92 | 1.80     |
| 60                       | 7.08 | 4.98 | 4.13 | 3.65 | 3.34 | 3.12 | 2.95 | 2.82 | 2.72 | 2.63 | 2.50 | 2.35 | 2.20 | 2.12 | 2.03 | 1.94 | 1.84 | 1.73 | 1.60     |
| 120                      | 6.85 | 4.79 | 3.95 | 3.48 | 3.17 | 2.96 | 2.79 | 2.66 | 2.56 | 2.47 | 2.34 | 2.19 | 2.03 | 1.95 | 1.86 | 1.76 | 1.66 | 1.55 | 1.38     |
| $\infty$                 | 6.63 | 4.61 | 3.78 | 3.32 | 3.02 | 2.80 | 2.64 | 2.51 | 2.41 | 2.32 | 2.18 | 2.04 | 1.88 | 1.79 | 1.70 | 1.59 | 1.47 | 1.32 | 1.00     |

Source: E. S. Pearson and H. O. Hartley, *Biometrika Tables for Statisticians*, Vol. 2 (1972), Table 5, page 180, by permission.