

## Critical Values of F (F-Table)

table shows the critical values of F corresponding to X% upper tail area given a particular combination of numerator and denominator degrees of freedom

| Denominator<br>degrees of<br>freedom | Alpha | Numerator Degrees of Freedom |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
|--------------------------------------|-------|------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                                      |       | 1                            | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       | 10      | 12      | 15      | 20      | 24      | 30      | 40      | 60      | 120     |
| 1                                    | 0.1   | 39.86                        | 49.50   | 53.59   | 55.83   | 57.24   | 58.20   | 58.91   | 59.44   | 59.86   | 60.19   | 60.71   | 61.22   | 61.74   | 62.00   | 62.26   | 62.53   | 62.79   | 63.06   |
|                                      | 0.05  | 161.45                       | 199.50  | 215.71  | 224.58  | 230.16  | 233.99  | 236.77  | 238.88  | 240.54  | 241.88  | 243.91  | 245.95  | 248.01  | 249.05  | 250.10  | 251.14  | 252.20  | 253.25  |
|                                      | 0.025 | 647.79                       | 799.50  | 864.16  | 899.58  | 921.85  | 937.11  | 948.22  | 956.66  | 963.28  | 968.63  | 976.71  | 984.87  | 993.10  | 997.25  | 1001.41 | 1005.60 | 1009.80 | 1014.02 |
|                                      | 0.01  | 4052.18                      | 4999.50 | 5403.35 | 5624.58 | 5763.65 | 5858.99 | 5928.36 | 5981.07 | 6022.47 | 6055.85 | 6106.32 | 6157.28 | 6208.73 | 6234.63 | 6260.65 | 6286.78 | 6313.03 | 6339.39 |
| 2                                    | 0.1   | 8.53                         | 9.00    | 9.16    | 9.24    | 9.29    | 9.33    | 9.35    | 9.37    | 9.38    | 9.39    | 9.41    | 9.42    | 9.44    | 9.45    | 9.46    | 9.47    | 9.47    | 9.48    |
|                                      | 0.05  | 18.51                        | 19.00   | 19.16   | 19.25   | 19.30   | 19.33   | 19.35   | 19.37   | 19.38   | 19.40   | 19.41   | 19.43   | 19.45   | 19.45   | 19.46   | 19.47   | 19.48   | 19.49   |
|                                      | 0.025 | 38.51                        | 39.00   | 39.17   | 39.25   | 39.30   | 39.33   | 39.36   | 39.37   | 39.39   | 39.40   | 39.41   | 39.43   | 39.45   | 39.46   | 39.46   | 39.47   | 39.48   | 39.49   |
|                                      | 0.01  | 98.50                        | 99.00   | 99.17   | 99.25   | 99.30   | 99.33   | 99.36   | 99.37   | 99.39   | 99.40   | 99.42   | 99.43   | 99.45   | 99.46   | 99.47   | 99.47   | 99.48   | 99.49   |
| 3                                    | 0.1   | 5.54                         | 5.46    | 5.39    | 5.34    | 5.31    | 5.28    | 5.27    | 5.25    | 5.24    | 5.23    | 5.22    | 5.20    | 5.18    | 5.18    | 5.17    | 5.16    | 5.15    | 5.14    |
|                                      | 0.05  | 10.13                        | 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    |
|                                      | 0.025 | 17.44                        | 16.04   | 15.44   | 15.10   | 14.88   | 14.73   | 14.62   | 14.54   | 14.47   | 14.42   | 14.34   | 14.25   | 14.17   | 14.12   | 14.08   | 14.04   | 13.99   | 13.95   |
|                                      | 0.01  | 34.12                        | 30.82   | 29.46   | 28.71   | 28.24   | 27.91   | 27.67   | 27.49   | 27.35   | 27.23   | 27.05   | 26.87   | 26.69   | 26.60   | 26.50   | 26.41   | 26.32   | 26.22   |
| 4                                    | 0.1   | 4.54                         | 4.32    | 4.19    | 4.11    | 4.05    | 4.01    | 3.98    | 3.95    | 3.94    | 3.92    | 3.90    | 3.87    | 3.84    | 3.83    | 3.82    | 3.80    | 3.79    | 3.78    |
|                                      | 0.05  | 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    |
|                                      | 0.025 | 12.22                        | 10.65   | 9.98    | 9.60    | 9.36    | 9.20    | 9.07    | 8.98    | 8.90    | 8.84    | 8.75    | 8.66    | 8.56    | 8.51    | 8.46    | 8.41    | 8.36    | 8.31    |
|                                      | 0.01  | 21.20                        | 18.00   | 16.69   | 15.98   | 15.52   | 15.21   | 14.98   | 14.80   | 14.66   | 14.55   | 14.37   | 14.20   | 14.02   | 13.93   | 13.84   | 13.75   | 13.65   | 13.56   |
| 5                                    | 0.1   | 4.06                         | 3.78    | 3.62    | 3.52    | 3.45    | 3.40    | 3.37    | 3.34    | 3.32    | 3.30    | 3.27    | 3.24    | 3.21    | 3.19    | 3.17    | 3.16    | 3.14    | 3.12    |
|                                      | 0.05  | 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    |
|                                      | 0.025 | 10.01                        | 8.43    | 7.76    | 7.39    | 7.15    | 6.98    | 6.85    | 6.76    | 6.68    | 6.62    | 6.52    | 6.43    | 6.33    | 6.28    | 6.23    | 6.18    | 6.12    | 6.07    |
|                                      | 0.01  | 16.26                        | 13.27   | 12.06   | 11.39   | 10.97   | 10.67   | 10.46   | 10.29   | 10.16   | 10.05   | 9.89    | 9.72    | 9.55    | 9.47    | 9.38    | 9.29    | 9.20    | 9.11    |
| 6                                    | 0.1   | 3.78                         | 3.46    | 3.29    | 3.18    | 3.11    | 3.05    | 3.01    | 2.98    | 2.96    | 2.94    | 2.90    | 2.87    | 2.84    | 2.82    | 2.80    | 2.78    | 2.76    | 2.74    |
|                                      | 0.05  | 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    |
|                                      | 0.025 | 8.81                         | 7.26    | 6.60    | 6.23    | 5.99    | 5.82    | 5.70    | 5.60    | 5.52    | 5.46    | 5.37    | 5.27    | 5.17    | 5.12    | 5.07    | 5.01    | 4.96    | 4.90    |
|                                      | 0.01  | 13.75                        | 10.92   | 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    |
| 7                                    | 0.1   | 3.59                         | 3.26    | 3.07    | 2.96    | 2.88    | 2.83    | 2.78    | 2.75    | 2.72    | 2.70    | 2.67    | 2.63    | 2.59    | 2.58    | 2.56    | 2.54    | 2.51    | 2.49    |
|                                      | 0.05  | 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    |
|                                      | 0.025 | 8.07                         | 6.54    | 5.89    | 5.52    | 5.29    | 5.12    | 4.99    | 4.90    | 4.82    | 4.76    | 4.67    | 4.57    | 4.47    | 4.41    | 4.36    | 4.31    | 4.25    | 4.20    |
|                                      | 0.01  | 12.25                        | 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    |
| 8                                    | 0.1   | 3.46                         | 3.11    | 2.92    | 2.81    | 2.73    | 2.67    | 2.62    | 2.59    | 2.56    | 2.54    | 2.50    | 2.46    | 2.42    | 2.40    | 2.38    | 2.36    | 2.34    | 2.32    |
|                                      | 0.05  | 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    |
|                                      | 0.025 | 7.57                         | 6.06    | 5.42    | 5.05    | 4.82    | 4.65    | 4.53    | 4.43    | 4.36    | 4.30    | 4.20    | 4.10    | 4.00    | 3.95    | 3.89    | 3.84    | 3.78    | 3.73    |

| Denominator<br>degrees of<br>freedom | Alpha | Numerator Degrees of Freedom |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------------------------|-------|------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                                      |       | 1                            | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 12   | 15   | 20   | 24   | 30   | 40   | 60   | 120  |
| 9                                    | 0.01  | 11.26                        | 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 |
|                                      | 0.1   | 3.36                         | 3.01 | 2.81 | 2.69 | 2.61 | 2.55 | 2.51 | 2.47 | 2.44 | 2.42 | 2.38 | 2.34 | 2.30 | 2.28 | 2.25 | 2.23 | 2.21 | 2.18 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 7.21                         | 5.71 | 5.08 | 4.72 | 4.48 | 4.32 | 4.20 | 4.10 | 4.03 | 3.96 | 3.87 | 3.77 | 3.67 | 3.61 | 3.56 | 3.51 | 3.45 | 3.39 |
| 10                                   | 0.01  | 10.56                        | 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 |
|                                      | 0.1   | 3.29                         | 2.92 | 2.73 | 2.61 | 2.52 | 2.46 | 2.41 | 2.38 | 2.35 | 2.32 | 2.28 | 2.24 | 2.20 | 2.18 | 2.16 | 2.13 | 2.11 | 2.08 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 6.94                         | 5.46 | 4.83 | 4.47 | 4.24 | 4.07 | 3.95 | 3.85 | 3.78 | 3.72 | 3.62 | 3.52 | 3.42 | 3.37 | 3.31 | 3.26 | 3.20 | 3.14 |
| 11                                   | 0.01  | 10.04                        | 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 |
|                                      | 0.1   | 3.23                         | 2.86 | 2.66 | 2.54 | 2.45 | 2.39 | 2.34 | 2.30 | 2.27 | 2.25 | 2.21 | 2.17 | 2.12 | 2.10 | 2.08 | 2.05 | 2.03 | 2.00 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 6.72                         | 5.26 | 4.63 | 4.28 | 4.04 | 3.88 | 3.76 | 3.66 | 3.59 | 3.53 | 3.43 | 3.33 | 3.23 | 3.17 | 3.12 | 3.06 | 3.00 | 2.94 |
| 12                                   | 0.01  | 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 |
|                                      | 0.1   | 3.18                         | 2.81 | 2.61 | 2.48 | 2.39 | 2.33 | 2.28 | 2.24 | 2.21 | 2.19 | 2.15 | 2.10 | 2.06 | 2.04 | 2.01 | 1.99 | 1.96 | 1.93 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 6.55                         | 5.10 | 4.47 | 4.12 | 3.89 | 3.73 | 3.61 | 3.51 | 3.44 | 3.37 | 3.28 | 3.18 | 3.07 | 3.02 | 2.96 | 2.91 | 2.85 | 2.79 |
| 13                                   | 0.01  | 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 |
|                                      | 0.1   | 3.14                         | 2.76 | 2.56 | 2.43 | 2.35 | 2.28 | 2.23 | 2.20 | 2.16 | 2.14 | 2.10 | 2.05 | 2.01 | 1.98 | 1.96 | 1.93 | 1.90 | 1.88 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 6.41                         | 4.97 | 4.35 | 4.00 | 3.77 | 3.60 | 3.48 | 3.39 | 3.31 | 3.25 | 3.15 | 3.05 | 2.95 | 2.89 | 2.84 | 2.78 | 2.72 | 2.66 |
| 14                                   | 0.01  | 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 |
|                                      | 0.1   | 3.10                         | 2.73 | 2.52 | 2.39 | 2.31 | 2.24 | 2.19 | 2.15 | 2.12 | 2.10 | 2.05 | 2.01 | 1.96 | 1.94 | 1.91 | 1.89 | 1.86 | 1.83 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 6.30                         | 4.86 | 4.24 | 3.89 | 3.66 | 3.50 | 3.38 | 3.29 | 3.21 | 3.15 | 3.05 | 2.95 | 2.84 | 2.79 | 2.73 | 2.67 | 2.61 | 2.55 |
| 15                                   | 0.01  | 8.86                         | 6.51 | 5.56 | 5.04 | 4.69 | 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 |
|                                      | 0.1   | 3.07                         | 2.70 | 2.49 | 2.36 | 2.27 | 2.21 | 2.16 | 2.12 | 2.09 | 2.06 | 2.02 | 1.97 | 1.92 | 1.90 | 1.87 | 1.85 | 1.82 | 1.79 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 6.20                         | 4.77 | 4.15 | 3.80 | 3.58 | 3.41 | 3.29 | 3.20 | 3.12 | 3.06 | 2.96 | 2.86 | 2.76 | 2.70 | 2.64 | 2.59 | 2.52 | 2.46 |
| 16                                   | 0.01  | 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 |
|                                      | 0.1   | 3.05                         | 2.67 | 2.46 | 2.33 | 2.24 | 2.18 | 2.13 | 2.09 | 2.06 | 2.03 | 1.99 | 1.94 | 1.89 | 1.87 | 1.84 | 1.81 | 1.78 | 1.75 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 6.12                         | 4.69 | 4.08 | 3.73 | 3.50 | 3.34 | 3.22 | 3.12 | 3.05 | 2.99 | 2.89 | 2.79 | 2.68 | 2.63 | 2.57 | 2.51 | 2.45 | 2.38 |
| 17                                   | 0.01  | 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 |
|                                      | 0.1   | 3.03                         | 2.64 | 2.44 | 2.31 | 2.22 | 2.15 | 2.10 | 2.06 | 2.03 | 2.00 | 1.96 | 1.91 | 1.86 | 1.84 | 1.81 | 1.78 | 1.75 | 1.72 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 6.04                         | 4.62 | 4.01 | 3.66 | 3.44 | 3.28 | 3.16 | 3.06 | 2.98 | 2.92 | 2.82 | 2.72 | 2.62 | 2.56 | 2.50 | 2.44 | 2.38 | 2.32 |

| Denominator<br>degrees of<br>freedom | Alpha | Numerator Degrees of Freedom |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------------------------|-------|------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                                      |       | 1                            | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 12   | 15   | 20   | 24   | 30   | 40   | 60   | 120  |
| 18                                   | 0.01  | 8.40                         | 6.11 | 5.18 | 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 |
|                                      | 0.1   | 3.01                         | 2.62 | 2.42 | 2.29 | 2.20 | 2.13 | 2.08 | 2.04 | 2.00 | 1.98 | 1.93 | 1.89 | 1.84 | 1.81 | 1.78 | 1.75 | 1.72 | 1.69 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.98                         | 4.56 | 3.95 | 3.61 | 3.38 | 3.22 | 3.10 | 3.01 | 2.93 | 2.87 | 2.77 | 2.67 | 2.56 | 2.50 | 2.44 | 2.38 | 2.32 | 2.26 |
| 19                                   | 0.01  | 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 |
|                                      | 0.1   | 2.99                         | 2.61 | 2.40 | 2.27 | 2.18 | 2.11 | 2.06 | 2.02 | 1.98 | 1.96 | 1.91 | 1.86 | 1.81 | 1.79 | 1.76 | 1.73 | 1.70 | 1.67 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.92                         | 4.51 | 3.90 | 3.56 | 3.33 | 3.17 | 3.05 | 2.96 | 2.88 | 2.82 | 2.72 | 2.62 | 2.51 | 2.45 | 2.39 | 2.33 | 2.27 | 2.20 |
| 20                                   | 0.01  | 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 |
|                                      | 0.1   | 2.97                         | 2.59 | 2.38 | 2.25 | 2.16 | 2.09 | 2.04 | 2.00 | 1.96 | 1.94 | 1.89 | 1.84 | 1.79 | 1.77 | 1.74 | 1.71 | 1.68 | 1.64 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.87                         | 4.46 | 3.86 | 3.51 | 3.29 | 3.13 | 3.01 | 2.91 | 2.84 | 2.77 | 2.68 | 2.57 | 2.46 | 2.41 | 2.35 | 2.29 | 2.22 | 2.16 |
| 21                                   | 0.01  | 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 |
|                                      | 0.1   | 2.96                         | 2.57 | 2.36 | 2.23 | 2.14 | 2.08 | 2.02 | 1.98 | 1.95 | 1.92 | 1.87 | 1.83 | 1.78 | 1.75 | 1.72 | 1.69 | 1.66 | 1.62 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.83                         | 4.42 | 3.82 | 3.48 | 3.25 | 3.09 | 2.97 | 2.87 | 2.80 | 2.73 | 2.64 | 2.53 | 2.42 | 2.37 | 2.31 | 2.25 | 2.18 | 2.11 |
| 22                                   | 0.01  | 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 |
|                                      | 0.1   | 2.95                         | 2.56 | 2.35 | 2.22 | 2.13 | 2.06 | 2.01 | 1.97 | 1.93 | 1.90 | 1.86 | 1.81 | 1.76 | 1.73 | 1.70 | 1.67 | 1.64 | 1.60 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.79                         | 4.38 | 3.78 | 3.44 | 3.22 | 3.05 | 2.93 | 2.84 | 2.76 | 2.70 | 2.60 | 2.50 | 2.39 | 2.33 | 2.27 | 2.21 | 2.14 | 2.08 |
| 23                                   | 0.01  | 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 |
|                                      | 0.1   | 2.94                         | 2.55 | 2.34 | 2.21 | 2.11 | 2.05 | 1.99 | 1.95 | 1.92 | 1.89 | 1.84 | 1.80 | 1.74 | 1.72 | 1.69 | 1.66 | 1.62 | 1.59 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.75                         | 4.35 | 3.75 | 3.41 | 3.18 | 3.02 | 2.90 | 2.81 | 2.73 | 2.67 | 2.57 | 2.47 | 2.36 | 2.30 | 2.24 | 2.18 | 2.11 | 2.04 |
| 24                                   | 0.01  | 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 |
|                                      | 0.1   | 2.93                         | 2.54 | 2.33 | 2.19 | 2.10 | 2.04 | 1.98 | 1.94 | 1.91 | 1.88 | 1.83 | 1.78 | 1.73 | 1.70 | 1.67 | 1.64 | 1.61 | 1.57 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.72                         | 4.32 | 3.72 | 3.38 | 3.15 | 2.99 | 2.87 | 2.78 | 2.70 | 2.64 | 2.54 | 2.44 | 2.33 | 2.27 | 2.21 | 2.15 | 2.08 | 2.01 |
| 25                                   | 0.01  | 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 |
|                                      | 0.1   | 2.92                         | 2.53 | 2.32 | 2.18 | 2.09 | 2.02 | 1.97 | 1.93 | 1.89 | 1.87 | 1.82 | 1.77 | 1.72 | 1.69 | 1.66 | 1.63 | 1.59 | 1.56 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.69                         | 4.29 | 3.69 | 3.35 | 3.13 | 2.97 | 2.85 | 2.75 | 2.68 | 2.61 | 2.51 | 2.41 | 2.30 | 2.24 | 2.18 | 2.12 | 2.05 | 1.98 |
| 26                                   | 0.01  | 7.77                         | 5.57 | 4.68 | 4.18 | 3.85 | 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 |
|                                      | 0.1   | 2.91                         | 2.52 | 2.31 | 2.17 | 2.08 | 2.01 | 1.96 | 1.92 | 1.88 | 1.86 | 1.81 | 1.76 | 1.71 | 1.68 | 1.65 | 1.61 | 1.58 | 1.54 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.66                         | 4.27 | 3.67 | 3.33 | 3.10 | 2.94 | 2.82 | 2.73 | 2.65 | 2.59 | 2.49 | 2.39 | 2.28 | 2.22 | 2.16 | 2.09 | 2.03 | 1.95 |

| Denominator<br>degrees of<br>freedom | Alpha | Numerator Degrees of Freedom |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------------------------|-------|------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                                      |       | 1                            | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 12   | 15   | 20   | 24   | 30   | 40   | 60   | 120  |
| 27                                   | 0.01  | 7.72                         | 5.53 | 4.64 | 4.14 | 3.82 | 3.59 | 3.42 | 3.29 | 3.18 | 3.09 | 2.96 | 2.81 | 2.66 | 2.58 | 2.50 | 2.42 | 2.33 | 2.23 |
|                                      | 0.1   | 2.90                         | 2.51 | 2.30 | 2.17 | 2.07 | 2.00 | 1.95 | 1.91 | 1.87 | 1.85 | 1.80 | 1.75 | 1.70 | 1.67 | 1.64 | 1.60 | 1.57 | 1.53 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.63                         | 4.24 | 3.65 | 3.31 | 3.08 | 2.92 | 2.80 | 2.71 | 2.63 | 2.57 | 2.47 | 2.36 | 2.25 | 2.19 | 2.13 | 2.07 | 2.00 | 1.93 |
| 28                                   | 0.01  | 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 |
|                                      | 0.1   | 2.89                         | 2.50 | 2.29 | 2.16 | 2.06 | 2.00 | 1.94 | 1.90 | 1.87 | 1.84 | 1.79 | 1.74 | 1.69 | 1.66 | 1.63 | 1.59 | 1.56 | 1.52 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.61                         | 4.22 | 3.63 | 3.29 | 3.06 | 2.90 | 2.78 | 2.69 | 2.61 | 2.55 | 2.45 | 2.34 | 2.23 | 2.17 | 2.11 | 2.05 | 1.98 | 1.91 |
| 29                                   | 0.01  | 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 |
|                                      | 0.1   | 2.89                         | 2.50 | 2.28 | 2.15 | 2.06 | 1.99 | 1.93 | 1.89 | 1.86 | 1.83 | 1.78 | 1.73 | 1.68 | 1.65 | 1.62 | 1.58 | 1.55 | 1.51 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.59                         | 4.20 | 3.61 | 3.27 | 3.04 | 2.88 | 2.76 | 2.67 | 2.59 | 2.53 | 2.43 | 2.32 | 2.21 | 2.15 | 2.09 | 2.03 | 1.96 | 1.89 |
| 30                                   | 0.01  | 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 |
|                                      | 0.1   | 2.88                         | 2.49 | 2.28 | 2.14 | 2.05 | 1.98 | 1.93 | 1.88 | 1.85 | 1.82 | 1.77 | 1.72 | 1.67 | 1.64 | 1.61 | 1.57 | 1.54 | 1.50 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.57                         | 4.18 | 3.59 | 3.25 | 3.03 | 2.87 | 2.75 | 2.65 | 2.57 | 2.51 | 2.41 | 2.31 | 2.20 | 2.14 | 2.07 | 2.01 | 1.94 | 1.87 |
| 40                                   | 0.01  | 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 |
|                                      | 0.1   | 2.84                         | 2.44 | 2.23 | 2.09 | 2.00 | 1.93 | 1.87 | 1.83 | 1.79 | 1.76 | 1.71 | 1.66 | 1.61 | 1.57 | 1.54 | 1.51 | 1.47 | 1.42 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.42                         | 4.05 | 3.46 | 3.13 | 2.90 | 2.74 | 2.62 | 2.53 | 2.45 | 2.39 | 2.29 | 2.18 | 2.07 | 2.01 | 1.94 | 1.88 | 1.80 | 1.72 |
| 60                                   | 0.01  | 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 |
|                                      | 0.1   | 2.79                         | 2.39 | 2.18 | 2.04 | 1.95 | 1.87 | 1.82 | 1.77 | 1.74 | 1.71 | 1.66 | 1.60 | 1.54 | 1.51 | 1.48 | 1.44 | 1.40 | 1.35 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.29                         | 3.93 | 3.34 | 3.01 | 2.79 | 2.63 | 2.51 | 2.41 | 2.33 | 2.27 | 2.17 | 2.06 | 1.94 | 1.88 | 1.82 | 1.74 | 1.67 | 1.58 |
| 120                                  | 0.01  | 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 |
|                                      | 0.1   | 2.75                         | 2.35 | 2.13 | 1.99 | 1.90 | 1.82 | 1.77 | 1.72 | 1.68 | 1.65 | 1.60 | 1.55 | 1.48 | 1.45 | 1.41 | 1.37 | 1.32 | 1.26 |
|                                      | 0.05  | 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 |
|                                      | 0.025 | 5.15                         | 3.80 | 3.23 | 2.89 | 2.67 | 2.52 | 2.39 | 2.30 | 2.22 | 2.16 | 2.05 | 1.94 | 1.82 | 1.76 | 1.69 | 1.61 | 1.53 | 1.43 |
|                                      | 0.01  | 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 | 1.53 |