

FAKULTET TEHNIČKIH NAUKA
GEODEZIJA I GEOINFORMATIKA

RAČUN IZRAVNANJA
VEŽBA 3

NOVI SAD, 2025.

TESTIRANJE HIPOTEZA

Procedura testiranja validnosti statistike naziva se **testiranjem hipoteze**. Osnovni elementi test hipoteza jesu:

- **Nulta hipoteza, H_0 - tvrdnja kojom se porede statistika populacije i statistika uzorka**
- **Alternativna hipoteza, H_a – šta se prihvata ako se donese odluka o odbacivanju H_0**
- **Test statistika – vrednost koja se računa na osnovu uzorka i koja se koristi prilikom donošenja odluke da li H_0 treba odbaciti**
- **Reon odbacivanja – vrednost test statistike za koju se odbacuje nulta hipoteza.**

TESTIRANJE HIPOTEZA

Kada se god donosi odluka vezano za nultu hipotezu, postoji mogućnost donošenja pogrešne odluke. Prilikom donošenja odluke moguća je pojava dva osnovna tipa grešaka, i to:

- **odbacivanje validne statistike** (odbacivanje H_0 , iako je korektna, greška **Tip I**)
- **prihvatanje nevalidne statistike** (prihvatanja H_0 iako nije korektna, greška **Tip II**)

Dakle, može se konstatovati, prilikom testiranja hipoteza moguće su dve vrste grešaka, i to:

TESTIRANJE HIPOTEZA

Greška tip 1: odbacivanje nulte hipoteze ukoliko je ona zaista tačna (što se simbolino označava kao α),

Greška tip 2: ne odbacivanje nulte hipoteze kada je ona zaista netačna (što se simbolično označava kao β)

| STANJE | Odluka | |
|----------------|--|--|
| | Prihvata se H_0 | Odbacuje se H_0 |
| H_0 istinito | Dobra odluka: $P=1-\alpha$ (nivo poverenja) | Greška tip I: $P=\alpha$ (nivo značajnosti) |
| H_a istinito | Greška tip II: $P=\beta$ | Dobra odluka: $P=1-\beta$ (moć testa) |

Zadatak 1

TESTIRANJE HIPOTEZA O SREDNJOJ VREDNOSTI POPULACIJE/UZORKA

Testovi mogu biti dvostrani i jednostrani

Jednostrani:

$$H_0: M[\bar{y}] = \mu = \bar{y}$$

$$H_a: M[\bar{y}] = \mu > \bar{y} (\mu < \bar{y})$$

Test statistika:

$$t = \frac{\bar{y} - \mu}{s/\sqrt{n}}$$

Reon odbacivanja nulte hipoteze definiše se kao:

$$t > t_\alpha$$

t_α i $t_{\alpha/2}$ - kvantili jednostranog i dvostranog studentovog „t“ rasporeda, respektivno.

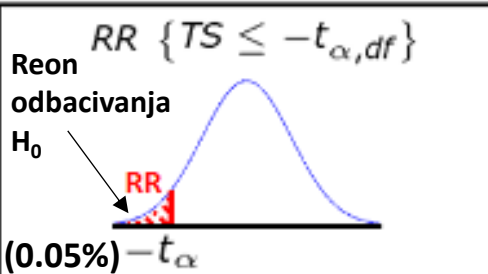
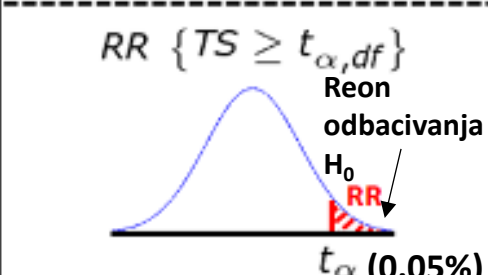
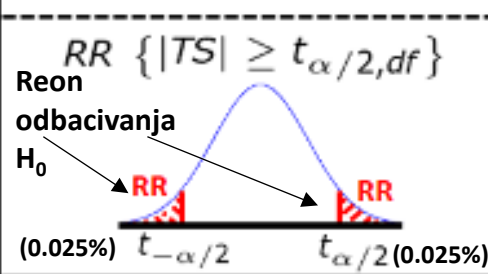
Napomene:

- Za uzorke sa $n > 30$, umesto studentovog „t“ rasporeda koristi se normalan raspored.
- Za poznato σ , umesto studentovog „t“ rasporeda koristi se normalan raspored. Odnosno, umesto t_α , koriste se kvantili normalnog rasporeda.

Dvostrani:

$$H_0: M[\bar{y}] = \mu = \bar{y}$$

$$H_a: M[\bar{y}] = \mu \neq \bar{y}$$

| H_0 | H_a | REJECTION REGION |
|---|--------------------|--|
| Jednostrani test Levo ograničenje $\mu_1 \geq \mu_2$ | $\mu_1 < \mu_2$ | $RR \{TS \leq -t_{\alpha,df}\}$ Reon odbacivanja H_0  (0.05%) $-t_\alpha$ |
| Jednostrani test Desno ograničenje $\mu_1 \leq \mu_2$ | $\mu_1 > \mu_2$ | $RR \{TS \geq t_{\alpha,df}\}$ Reon odbacivanja H_0  t_α (0.05%) |
| Dvostrani test $\mu_1 = \mu_2$ | $\mu_1 \neq \mu_2$ | $RR \{ TS \geq t_{\alpha/2,df}\}$ Reon odbacivanja H_0  (0.025%) $t_{-\alpha/2}$ $t_{\alpha/2}$ (0.025%) |

Zadatak 2

TESTIRANJE HIPOTEZA O VARIJANSI POPULACIJE/UZORKA

Ponekad je važno proveriti da li instrument meri sa specificiranim preciznošću. Prilikom kontrole varijanse uzorka, u odnosu na varijansu populacije, koristi se χ^2 raspored.

Testovi mogu biti dvostrani i jednostrani

Jednostrani:

$$H_0: M[s^2] = s^2 = \sigma^2$$

$$H_a: M[s^2] = s^2 > \sigma^2 \quad (s^2 < \sigma^2)$$

Test statistika:

$$\chi^2 = \frac{f * s^2}{\sigma^2}$$

Dvostrani:

$$H_0: M[s^2] = s^2 = \sigma^2$$

$$H_a: M[s^2] = s^2 \neq \sigma^2$$

Reon odbacivanja nulte hipoteze definiše se kao:

$$\chi^2 > \chi_{\alpha, f}^2$$

$$\chi^2 > \chi_{\alpha/2, f}^2$$

$\chi_{\alpha, f}^2$ i $\chi_{\alpha/2, f}^2$ - kvantili jednostranog i dvostranog hi na kvadrat (χ^2) rasporeda, respektivno.

FIŠEROV „F“ RASPORED

F raspored se koristi pri poređenju sračunatih varijansi dva uzorka. Ukoliko su χ_1^2 i χ_2^2 dve hi-kvadrat promenljive sa f_1 i f_2 , tada je po definiciji

$$F = \frac{\chi_1^2/f_1}{\chi_2^2/f_2}$$

F raspored u brojiocu ima f_1 stepeni slobode i odnosi se na jednu populaciju, a u imeniocu f_2 stepeni slobode i odnosi se na drugu populaciju. Za razliku od χ^2 ili t rasporeda, kod F rasporeda procentne tačke su prikazane u više tabela.

F raspored se koristi pri testiranju uzoraka na pripadnost istoj populaciji. Na primer, ako imamo dve varijanse, s_1^2 i s_2^2 . Da bi dve varijanse pripadale istoj populaciji, odnos varijansi treba biti jednak 1 (tj. $\sigma_1^2 = \sigma_2^2$).

FIŠEROV „F“ RASPORED

Verovatnoće za Fišerov „F“ raspored prikazane su u tabelama 1-7.

U navedenim tabelama za usvojeni nivo značajnosti $\alpha = 1 - p$ i odgovarajuće brojeve stepeni slobode f_1 i f_2 određuje kvantil Fišerovog „F“ rasporeda F_{α, f_1, f_2} .

Takođe, kvantil Fišerovog „F“ rasporeda se može odrediti i u programu Excel pomoću sledeće funkcije:

Excel: $F_{\alpha, f_1, f_2} \rightarrow \text{FINV}(1 - p, f_1, f_2)$

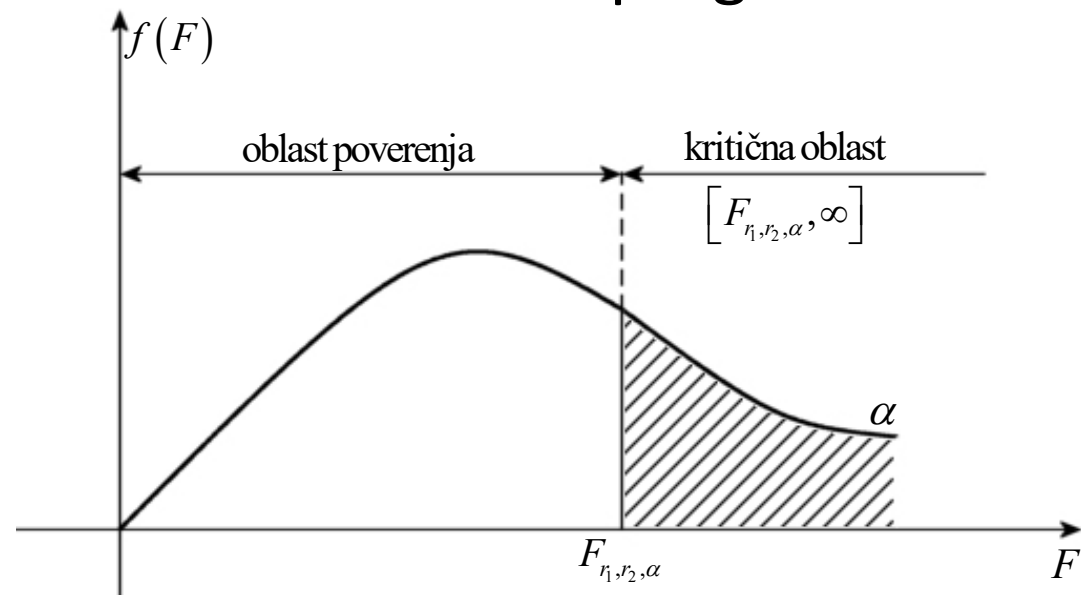


Table D.4 Critical values for F distribution
 $\alpha = 0.20$

Tabela 1

| $v_1 \backslash v_2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 |
|----------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1 | 9.47 | 12.00 | 13.06 | 13.64 | 14.01 | 14.26 | 14.44 | 14.58 | 14.68 | 14.77 | 14.90 | 15.04 | 15.17 | 15.24 | 15.31 | 15.37 | 15.44 | 15.51 |
| 2 | 3.56 | 4.00 | 4.16 | 4.24 | 4.28 | 4.32 | 4.34 | 4.36 | 4.37 | 4.38 | 4.40 | 4.42 | 4.43 | 4.44 | 4.45 | 4.46 | 4.46 | 4.47 |
| 3 | 2.68 | 2.89 | 2.94 | 2.96 | 2.97 | 2.97 | 2.97 | 2.98 | 2.98 | 2.98 | 2.98 | 2.98 | 2.98 | 2.98 | 2.98 | 2.98 | 2.98 | 2.98 |
| 4 | 2.35 | 2.47 | 2.48 | 2.48 | 2.48 | 2.47 | 2.47 | 2.47 | 2.46 | 2.46 | 2.46 | 2.46 | 2.45 | 2.44 | 2.44 | 2.44 | 2.43 | 2.43 |
| 5 | 2.18 | 2.26 | 2.25 | 2.24 | 2.23 | 2.22 | 2.21 | 2.20 | 2.20 | 2.19 | 2.18 | 2.18 | 2.17 | 2.16 | 2.16 | 2.15 | 2.15 | 2.14 |
| 6 | 2.07 | 2.13 | 2.11 | 2.09 | 2.08 | 2.06 | 2.05 | 2.04 | 2.03 | 2.03 | 2.02 | 2.01 | 2.00 | 1.99 | 1.98 | 1.98 | 1.97 | 1.96 |
| 7 | 2.00 | 2.04 | 2.02 | 1.99 | 1.97 | 1.96 | 1.94 | 1.93 | 1.93 | 1.92 | 1.91 | 1.89 | 1.88 | 1.87 | 1.86 | 1.86 | 1.85 | 1.84 |
| 8 | 1.95 | 1.98 | 1.95 | 1.92 | 1.90 | 1.88 | 1.87 | 1.86 | 1.85 | 1.84 | 1.83 | 1.81 | 1.80 | 1.79 | 1.78 | 1.77 | 1.76 | 1.75 |
| 9 | 1.91 | 1.93 | 1.90 | 1.87 | 1.85 | 1.83 | 1.81 | 1.80 | 1.79 | 1.78 | 1.76 | 1.75 | 1.73 | 1.72 | 1.71 | 1.70 | 1.69 | 1.68 |
| 10 | 1.88 | 1.90 | 1.86 | 1.83 | 1.80 | 1.78 | 1.77 | 1.75 | 1.74 | 1.73 | 1.72 | 1.70 | 1.68 | 1.67 | 1.66 | 1.65 | 1.64 | 1.63 |
| 11 | 1.86 | 1.87 | 1.83 | 1.80 | 1.77 | 1.75 | 1.73 | 1.72 | 1.70 | 1.69 | 1.67 | 1.66 | 1.64 | 1.63 | 1.62 | 1.61 | 1.60 | 1.59 |
| 12 | 1.84 | 1.85 | 1.80 | 1.77 | 1.74 | 1.72 | 1.70 | 1.69 | 1.67 | 1.66 | 1.65 | 1.64 | 1.62 | 1.60 | 1.59 | 1.58 | 1.56 | 1.55 |
| 13 | 1.82 | 1.83 | 1.78 | 1.75 | 1.72 | 1.69 | 1.68 | 1.66 | 1.65 | 1.64 | 1.62 | 1.60 | 1.58 | 1.56 | 1.55 | 1.53 | 1.52 | 1.51 |
| 14 | 1.81 | 1.81 | 1.76 | 1.73 | 1.70 | 1.67 | 1.65 | 1.64 | 1.63 | 1.62 | 1.60 | 1.58 | 1.56 | 1.54 | 1.53 | 1.51 | 1.50 | 1.49 |
| 15 | 1.80 | 1.80 | 1.75 | 1.71 | 1.68 | 1.66 | 1.64 | 1.62 | 1.61 | 1.60 | 1.58 | 1.56 | 1.54 | 1.52 | 1.51 | 1.49 | 1.48 | 1.47 |
| 16 | 1.79 | 1.78 | 1.74 | 1.70 | 1.67 | 1.64 | 1.62 | 1.61 | 1.59 | 1.58 | 1.56 | 1.54 | 1.52 | 1.50 | 1.49 | 1.48 | 1.46 | 1.45 |
| 17 | 1.78 | 1.77 | 1.72 | 1.68 | 1.65 | 1.63 | 1.61 | 1.59 | 1.58 | 1.57 | 1.55 | 1.53 | 1.51 | 1.49 | 1.48 | 1.46 | 1.45 | 1.43 |
| 18 | 1.77 | 1.76 | 1.71 | 1.67 | 1.64 | 1.62 | 1.60 | 1.58 | 1.56 | 1.55 | 1.53 | 1.51 | 1.49 | 1.48 | 1.46 | 1.45 | 1.44 | 1.42 |
| 19 | 1.76 | 1.75 | 1.70 | 1.66 | 1.63 | 1.61 | 1.58 | 1.57 | 1.55 | 1.54 | 1.52 | 1.50 | 1.48 | 1.46 | 1.45 | 1.44 | 1.42 | 1.41 |
| 20 | 1.76 | 1.75 | 1.70 | 1.65 | 1.62 | 1.60 | 1.58 | 1.56 | 1.54 | 1.53 | 1.51 | 1.49 | 1.47 | 1.45 | 1.44 | 1.43 | 1.41 | 1.40 |
| 21 | 1.75 | 1.74 | 1.69 | 1.65 | 1.61 | 1.59 | 1.57 | 1.55 | 1.53 | 1.52 | 1.50 | 1.48 | 1.46 | 1.44 | 1.43 | 1.41 | 1.40 | 1.38 |
| 22 | 1.75 | 1.73 | 1.68 | 1.64 | 1.61 | 1.58 | 1.56 | 1.54 | 1.53 | 1.51 | 1.49 | 1.47 | 1.45 | 1.43 | 1.42 | 1.40 | 1.39 | 1.37 |
| 23 | 1.74 | 1.73 | 1.68 | 1.63 | 1.60 | 1.57 | 1.55 | 1.53 | 1.52 | 1.50 | 1.48 | 1.46 | 1.44 | 1.42 | 1.41 | 1.39 | 1.38 | 1.36 |
| 24 | 1.74 | 1.72 | 1.67 | 1.63 | 1.59 | 1.57 | 1.55 | 1.53 | 1.51 | 1.50 | 1.48 | 1.46 | 1.43 | 1.42 | 1.40 | 1.39 | 1.37 | 1.35 |
| 25 | 1.73 | 1.72 | 1.66 | 1.62 | 1.59 | 1.56 | 1.54 | 1.52 | 1.51 | 1.49 | 1.47 | 1.45 | 1.42 | 1.41 | 1.39 | 1.38 | 1.36 | 1.34 |
| 26 | 1.73 | 1.71 | 1.66 | 1.62 | 1.58 | 1.56 | 1.53 | 1.52 | 1.50 | 1.49 | 1.47 | 1.44 | 1.42 | 1.40 | 1.39 | 1.37 | 1.35 | 1.33 |
| 27 | 1.73 | 1.71 | 1.66 | 1.61 | 1.58 | 1.55 | 1.53 | 1.51 | 1.49 | 1.48 | 1.46 | 1.44 | 1.41 | 1.40 | 1.38 | 1.36 | 1.34 | 1.32 |
| 28 | 1.72 | 1.71 | 1.65 | 1.61 | 1.57 | 1.55 | 1.52 | 1.51 | 1.49 | 1.48 | 1.46 | 1.43 | 1.41 | 1.39 | 1.37 | 1.36 | 1.34 | 1.31 |
| 29 | 1.72 | 1.70 | 1.65 | 1.60 | 1.57 | 1.54 | 1.52 | 1.50 | 1.49 | 1.47 | 1.45 | 1.43 | 1.40 | 1.39 | 1.37 | 1.35 | 1.33 | 1.31 |
| 30 | 1.72 | 1.70 | 1.64 | 1.60 | 1.57 | 1.54 | 1.52 | 1.50 | 1.48 | 1.47 | 1.45 | 1.42 | 1.39 | 1.38 | 1.36 | 1.35 | 1.33 | 1.31 |
| 50 | 1.69 | 1.66 | 1.60 | 1.56 | 1.52 | 1.49 | 1.47 | 1.45 | 1.43 | 1.42 | 1.39 | 1.37 | 1.34 | 1.32 | 1.30 | 1.28 | 1.26 | 1.24 |
| 60 | 1.68 | 1.65 | 1.59 | 1.55 | 1.51 | 1.48 | 1.46 | 1.44 | 1.42 | 1.41 | 1.38 | 1.35 | 1.32 | 1.31 | 1.29 | 1.27 | 1.24 | 1.22 |
| 80 | 1.67 | 1.64 | 1.58 | 1.53 | 1.50 | 1.47 | 1.44 | 1.42 | 1.41 | 1.39 | 1.37 | 1.34 | 1.31 | 1.29 | 1.27 | 1.25 | 1.22 | 1.19 |
| 120 | 1.66 | 1.63 | 1.57 | 1.52 | 1.48 | 1.45 | 1.43 | 1.41 | 1.39 | 1.37 | 1.35 | 1.32 | 1.29 | 1.27 | 1.25 | 1.23 | 1.20 | 1.17 |

(continued)

Table D.4 (Continued)

 $\alpha = 0.10$

Tabela 2

| $v_1 \backslash v_2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 |
|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1 | 39.85 | 49.49 | 53.59 | 55.83 | 57.23 | 58.20 | 58.90 | 59.43 | 59.85 | 60.19 | 60.70 | 61.21 | 61.73 | 61.99 | 62.26 | 62.52 | 62.79 | 63.05 |
| 2 | 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 |
| 3 | 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 |
| 4 | 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 |
| 5 | 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 |
| 6 | 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 |
| 7 | 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 |
| 8 | 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 |
| 9 | 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 |
| 10 | 3.28 | 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 |
| 11 | 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 |
| 12 | 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 |
| 13 | 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 |
| 14 | 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 |
| 15 | 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 |
| 16 | 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 |
| 17 | 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 |
| 18 | 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 |
| 19 | 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 |
| 20 | 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 |
| 21 | 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 |
| 22 | 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 |
| 23 | 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 |
| 24 | 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 |
| 25 | 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 |
| 26 | 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 |
| 27 | 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 |
| 28 | 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 |
| 29 | 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 |
| 30 | 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 |
| 50 | 2.81 | 2.41 | 2.20 | 2.06 | 1.97 | 1.90 | 1.84 | 1.80 | 1.76 | 1.73 | 1.68 | 1.63 | 1.57 | 1.54 | 1.50 | 1.46 | 1.42 | 1.38 |
| 60 | 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 |
| 80 | 2.77 | 2.37 | 2.15 | 2.02 | 1.92 | 1.85 | 1.79 | 1.75 | 1.71 | 1.66 | 1.63 | 1.57 | 1.51 | 1.48 | 1.44 | 1.40 | 1.36 | 1.31 |
| 120 | 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 |

Table D.4 (Continued)

 $\alpha = 0.05$

Tabela 3

| $v_1 \backslash v_2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 |
|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1 | 161.4 | 199.4 | 215.6 | 224.5 | 230.1 | 233.9 | 236.7 | 238.8 | 240.5 | 241.8 | 243.8 | 245.9 | 247.9 | 249 | 250 | 251.1 | 252.1 | 253.2 |
| 2 | 18.51 | 19.00 | 19.16 | 19.25 | 19.30 | 19.33 | 19.35 | 19.37 | 19.38 | 19.39 | 19.41 | 19.43 | 19.44 | 19.45 | 19.46 | 19.47 | 19.48 | 19.49 |
| 3 | 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 |
| 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 | 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 26 | 4.22 | 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 50 | 4.03 | 3.18 | 2.79 | 2.56 | 2.40 | 2.29 | 2.20 | 2.13 | 2.07 | 2.03 | 1.95 | 1.87 | 1.78 | 1.74 | 1.69 | 1.63 | 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 |
| 80 | 3.96 | 3.11 | 2.72 | 2.49 | 2.33 | 2.21 | 2.13 | 2.06 | 2.00 | 1.95 | 1.88 | 1.79 | 1.70 | 1.65 | 1.60 | 1.54 | 1.48 | 1.41 |
| 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 |

Table D.4 (Continued)
 $\alpha = 0.01$

Tabela 4

| $v_1 \backslash v_2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 |
|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|------|------|------|------|------|------|
| 1 | 4052 | 5000 | 5403 | 5625 | 5764 | 5859 | 5928 | 5982 | 6022 | 6056 | 6106 | 6157 | 6209 | 6235 | 6261 | 6287 | 6313 | 6339 |
| 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 |
| 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 |
| 4 | 21.2 | 18.0 | 16.7 | 16.0 | 15.5 | 15.2 | 15.0 | 14.8 | 14.7 | 14.6 | 14.4 | 14.2 | 14.0 | 13.9 | 13.8 | 13.7 | 13.7 | 13.6 |
| 5 | 16.25 | 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 | 13.74 | 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 | 12.24 | 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 | 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 |
| 9 | 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 |
| 10 | 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 |
| 11 | 9.64 | 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 |
| 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 |
| 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 |
| 14 | 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 |
| 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 |
| 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 |
| 17 | 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 | 2.84 | 2.75 |
| 18 | 8.28 | 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 | 2.76 | 2.67 |
| 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 |
| 20 | 8.09 | 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 |
| 21 | 8.01 | 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 |
| 22 | 7.94 | 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 |
| 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 |
| 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 |
| 25 | 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 |
| 26 | 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 |
| 27 | 7.67 | 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 |
| 28 | 7.63 | 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 |
| 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 |
| 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 |
| 50 | 7.17 | 5.06 | 4.20 | 3.72 | 3.41 | 3.19 | 3.02 | 2.89 | 2.78 | 2.70 | 2.56 | 2.42 | 2.27 | 2.18 | 2.10 | 2.01 | 1.91 | 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 |
| 80 | 6.96 | 4.88 | 4.04 | 3.56 | 3.26 | 3.04 | 2.87 | 2.74 | 2.64 | 2.55 | 2.42 | 2.27 | 2.12 | 2.03 | 1.94 | 1.85 | 1.75 | 1.63 |
| 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 | 1.53 |

(continued)

Table D.4 (Continued)

 $\alpha = 0.025$

Tabela 5

| $\nu_1 \backslash \nu_2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 |
|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1 | 647.8 | 799.5 | 864.2 | 899.6 | 921.8 | 937.1 | 948.2 | 956.7 | 963.3 | 968.6 | 976.7 | 984.9 | 993.1 | 997.2 | 1001 | 1006 | 1010 | 1014 |
| 2 | 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 | 39.48 |
| 3 | 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 |
| 4 | 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 |
| 5 | 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 |
| 6 | 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 |
| 7 | 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 |
| 8 | 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 |
| 9 | 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 | 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 | 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 | 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 | 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 | 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 | 6.20 | 4.76 | 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 | 6.11 | 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 | 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 |
| 18 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 |
| 27 | 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 | 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 | 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 | 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 |
| 50 | 5.34 | 3.97 | 3.39 | 3.05 | 2.83 | 2.67 | 2.55 | 2.46 | 2.38 | 2.32 | 2.22 | 2.11 | 1.99 | 1.93 | 1.87 | 1.80 | 1.72 | 1.64 |
| 60 | 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 |
| 80 | 5.22 | 3.86 | 3.28 | 2.95 | 2.73 | 2.57 | 2.45 | 2.35 | 2.28 | 2.21 | 2.11 | 2.00 | 1.88 | 1.82 | 1.75 | 1.68 | 1.60 | 1.51 |
| 120 | 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 |

Table D.4 (Continued)

 $\alpha = 0.005$

Tabela 6

| $v_1 \backslash v_2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 |
|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| 1 | 16211 | 20000 | 21615 | 22500 | 23056 | 23437 | 23715 | 23925 | 24091 | 24224 | 24426 | 24630 | 24836 | 24940 | 25044 | 25148 | 25253 | 253591 |
| 2 | 198.5 | 199.0 | 199.2 | 199.2 | 199.3 | 199.4 | 199.4 | 199.4 | 199.4 | 199.4 | 199.4 | 199.4 | 199.4 | 199.5 | 199.5 | 199.5 | 199.5 | 199.5 |
| 3 | 55.55 | 49.80 | 47.47 | 46.19 | 45.39 | 44.84 | 44.43 | 44.13 | 43.88 | 43.69 | 43.39 | 43.06 | 42.78 | 42.62 | 42.47 | 42.31 | 42.15 | 41.99 |
| 4 | 31.33 | 26.28 | 24.26 | 23.15 | 22.46 | 21.97 | 21.62 | 21.35 | 21.14 | 20.97 | 20.70 | 20.44 | 20.17 | 20.03 | 19.89 | 19.75 | 19.61 | 19.47 |
| 5 | 22.77 | 18.31 | 16.53 | 15.55 | 14.94 | 14.51 | 14.20 | 13.96 | 13.77 | 13.62 | 13.38 | 13.15 | 12.90 | 12.78 | 12.66 | 12.53 | 12.40 | 12.27 |
| 6 | 18.62 | 14.54 | 12.91 | 12.03 | 11.46 | 11.07 | 10.79 | 10.57 | 10.39 | 10.25 | 10.03 | 9.81 | 9.59 | 9.47 | 9.36 | 9.24 | 9.12 | 9.00 |
| 7 | 16.23 | 12.40 | 10.88 | 10.05 | 9.52 | 9.16 | 8.89 | 8.68 | 8.51 | 8.38 | 8.18 | 7.97 | 7.75 | 7.64 | 7.53 | 7.42 | 7.31 | 7.19 |
| 8 | 14.68 | 11.04 | 9.60 | 8.80 | 8.30 | 7.95 | 7.69 | 7.50 | 7.34 | 7.21 | 7.01 | 6.81 | 6.61 | 6.50 | 6.40 | 6.29 | 6.18 | 6.06 |
| 9 | 13.61 | 10.10 | 8.72 | 7.96 | 7.47 | 7.13 | 6.88 | 6.69 | 6.54 | 6.42 | 6.23 | 6.03 | 5.83 | 5.73 | 5.62 | 5.52 | 5.41 | 5.30 |
| 10 | 12.82 | 9.43 | 8.08 | 7.34 | 6.87 | 6.54 | 6.30 | 6.12 | 5.97 | 5.85 | 5.66 | 5.47 | 5.27 | 5.17 | 5.07 | 4.97 | 4.86 | 4.75 |
| 11 | 12.22 | 8.91 | 7.60 | 6.88 | 6.42 | 6.10 | 5.86 | 5.68 | 5.54 | 5.42 | 5.24 | 5.05 | 4.86 | 4.76 | 4.65 | 4.55 | 4.44 | 4.34 |
| 12 | 11.75 | 8.51 | 7.23 | 6.52 | 6.07 | 5.76 | 5.52 | 5.35 | 5.20 | 5.09 | 4.91 | 4.72 | 4.53 | 4.43 | 4.33 | 4.23 | 4.12 | 4.01 |
| 13 | 11.37 | 8.19 | 6.93 | 6.23 | 5.79 | 5.48 | 5.25 | 5.08 | 4.94 | 4.82 | 4.64 | 4.46 | 4.27 | 4.17 | 4.07 | 3.97 | 3.87 | 3.76 |
| 14 | 11.06 | 7.92 | 6.68 | 6.00 | 5.56 | 5.26 | 5.03 | 4.86 | 4.72 | 4.60 | 4.43 | 4.25 | 4.06 | 3.96 | 3.86 | 3.76 | 3.66 | 2.55 |
| 15 | 10.79 | 7.70 | 6.48 | 5.80 | 5.37 | 5.07 | 4.85 | 4.67 | 4.54 | 4.42 | 4.25 | 4.07 | 3.88 | 3.79 | 3.69 | 3.58 | 3.48 | 3.37 |
| 16 | 10.57 | 7.51 | 6.30 | 5.64 | 5.21 | 4.91 | 4.69 | 4.52 | 4.38 | 4.27 | 4.10 | 3.92 | 3.73 | 3.64 | 3.54 | 3.44 | 3.33 | 3.22 |
| 17 | 10.38 | 7.35 | 6.16 | 5.50 | 5.07 | 4.78 | 4.56 | 4.39 | 4.25 | 4.14 | 3.97 | 3.79 | 3.61 | 3.51 | 3.41 | 3.31 | 3.21 | 3.10 |
| 18 | 10.21 | 7.21 | 6.03 | 5.37 | 4.96 | 4.66 | 4.44 | 4.28 | 4.14 | 4.03 | 3.86 | 3.68 | 3.50 | 3.40 | 3.30 | 3.20 | 3.10 | 2.99 |
| 19 | 10.07 | 7.09 | 5.92 | 5.27 | 4.85 | 4.56 | 4.34 | 4.18 | 4.04 | 3.93 | 3.76 | 3.59 | 3.40 | 3.31 | 3.21 | 3.11 | 3.00 | 2.89 |
| 20 | 9.94 | 6.99 | 5.82 | 5.17 | 4.76 | 4.47 | 4.26 | 4.09 | 3.96 | 3.85 | 3.68 | 3.50 | 3.32 | 3.22 | 3.12 | 3.02 | 2.92 | 2.81 |
| 21 | 9.83 | 6.89 | 5.73 | 5.09 | 4.68 | 4.39 | 4.18 | 4.01 | 3.88 | 3.77 | 3.60 | 3.43 | 3.24 | 3.15 | 3.05 | 2.95 | 2.84 | 2.73 |
| 22 | 9.72 | 6.81 | 5.65 | 5.02 | 4.61 | 4.32 | 4.11 | 3.94 | 3.81 | 3.70 | 3.54 | 3.36 | 3.18 | 3.08 | 2.98 | 2.88 | 2.77 | 2.66 |
| 23 | 9.63 | 6.73 | 5.58 | 4.95 | 4.54 | 4.26 | 4.05 | 3.88 | 3.75 | 3.64 | 3.47 | 3.30 | 3.12 | 3.02 | 2.92 | 2.82 | 2.71 | 2.60 |
| 24 | 9.55 | 6.66 | 5.52 | 4.89 | 4.49 | 4.20 | 3.99 | 3.83 | 3.69 | 3.59 | 3.42 | 3.25 | 3.06 | 2.97 | 2.87 | 2.77 | 2.66 | 2.55 |
| 25 | 9.47 | 6.60 | 5.46 | 4.83 | 4.43 | 4.15 | 3.94 | 3.78 | 3.64 | 3.54 | 3.37 | 3.20 | 3.01 | 2.92 | 2.82 | 2.72 | 2.61 | 2.50 |
| 26 | 9.40 | 6.54 | 5.41 | 4.79 | 4.38 | 4.10 | 3.89 | 3.73 | 3.60 | 3.49 | 3.33 | 3.15 | 2.97 | 2.87 | 2.77 | 2.67 | 2.56 | 2.45 |
| 27 | 9.34 | 6.49 | 5.36 | 4.74 | 4.34 | 4.06 | 3.85 | 3.69 | 3.56 | 3.45 | 3.28 | 3.11 | 2.93 | 2.83 | 2.73 | 2.63 | 2.52 | 2.41 |
| 28 | 9.28 | 6.44 | 5.32 | 4.70 | 4.30 | 4.02 | 3.81 | 3.65 | 3.52 | 3.41 | 3.25 | 3.07 | 2.89 | 2.79 | 2.69 | 2.59 | 2.48 | 2.37 |
| 29 | 9.23 | 6.39 | 5.28 | 4.66 | 4.26 | 3.98 | 3.77 | 3.61 | 3.48 | 3.38 | 3.21 | 3.04 | 2.86 | 2.76 | 2.66 | 2.56 | 2.45 | 2.33 |
| 30 | 9.18 | 6.35 | 5.24 | 4.62 | 4.23 | 3.95 | 3.74 | 3.58 | 3.45 | 3.34 | 3.18 | 3.01 | 2.82 | 2.73 | 2.63 | 2.52 | 2.42 | 2.30 |
| 50 | 8.62 | 5.90 | 4.83 | 4.23 | 3.85 | 3.58 | 3.38 | 3.22 | 3.09 | 2.99 | 2.82 | 2.65 | 2.47 | 2.37 | 2.27 | 2.16 | 2.05 | 1.93 |
| 60 | 8.49 | 5.79 | 4.73 | 4.14 | 3.76 | 3.49 | 3.29 | 3.13 | 3.01 | 2.90 | 2.74 | 2.57 | 2.39 | 2.29 | 2.19 | 2.08 | 1.96 | 1.83 |
| 80 | 8.33 | 5.66 | 4.61 | 4.03 | 3.65 | 3.39 | 3.19 | 3.03 | 2.91 | 2.80 | 2.64 | 2.47 | 2.29 | 2.19 | 2.08 | 1.97 | 1.85 | 1.72 |
| 120 | 8.18 | 5.54 | 4.50 | 3.92 | 3.55 | 3.28 | 3.09 | 2.93 | 2.81 | 2.71 | 2.54 | 2.37 | 2.19 | 2.09 | 1.98 | 1.87 | 1.75 | 1.61 |

Table D.4 (Continued)
 $\alpha = 0.001$

Tabela 7

| $\nu_1 \backslash \nu_2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 |
|--------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1 | 405269 | 500004 | 540387 | 562506 | 576412 | 585943 | 592881 | 598151 | 602292 | 605625 | 610676 | 615772 | 620913 | 623504 | 626107 | 628720 | 631345 | 633980 |
| 2 | 998.5 | 999.0 | 999.1 | 999.2 | 999.3 | 999.3 | 999.4 | 999.4 | 999.4 | 999.4 | 999.4 | 999.4 | 999.5 | 999.5 | 999.5 | 999.5 | 999.5 | 999.5 |
| 3 | 167.0 | 148.5 | 141.1 | 137.1 | 134.6 | 132.9 | 131.6 | 130.6 | 129.9 | 129.3 | 128.3 | 127.4 | 126.4 | 125.9 | 125.5 | 125.0 | 124.5 | 124.0 |
| 4 | 74.14 | 61.25 | 56.18 | 53.44 | 51.71 | 50.53 | 49.66 | 49.00 | 48.47 | 48.05 | 47.41 | 46.76 | 46.10 | 45.77 | 45.43 | 45.09 | 44.75 | 44.40 |
| 5 | 47.18 | 37.12 | 33.20 | 31.09 | 29.75 | 28.83 | 28.16 | 27.65 | 27.24 | 26.92 | 26.42 | 25.91 | 25.39 | 25.13 | 24.87 | 24.60 | 24.33 | 24.06 |
| 6 | 35.51 | 27.00 | 23.70 | 21.92 | 20.80 | 20.03 | 19.46 | 19.03 | 18.69 | 18.41 | 17.99 | 17.56 | 17.12 | 16.90 | 16.67 | 16.44 | 16.21 | 15.98 |
| 7 | 29.25 | 21.69 | 18.77 | 17.20 | 16.21 | 15.52 | 15.02 | 14.63 | 14.33 | 14.08 | 13.71 | 13.32 | 12.93 | 12.73 | 12.53 | 12.33 | 12.12 | 11.91 |
| 8 | 25.41 | 18.49 | 15.83 | 14.39 | 13.48 | 12.86 | 12.40 | 12.05 | 11.77 | 11.54 | 11.91 | 10.84 | 10.48 | 10.30 | 10.11 | 9.92 | 9.73 | 9.53 |
| 9 | 22.86 | 16.39 | 13.90 | 12.56 | 11.71 | 11.13 | 10.70 | 10.37 | 10.11 | 9.89 | 9.57 | 9.24 | 8.90 | 8.72 | 8.55 | 8.37 | 8.19 | 8.00 |
| 10 | 21.04 | 14.91 | 12.55 | 11.28 | 10.48 | 9.93 | 9.52 | 9.20 | 8.96 | 8.75 | 8.45 | 8.13 | 7.80 | 7.64 | 7.47 | 7.30 | 7.12 | 6.94 |
| 11 | 19.69 | 13.81 | 11.56 | 10.35 | 9.58 | 9.05 | 8.66 | 8.35 | 8.12 | 7.92 | 7.63 | 7.32 | 7.01 | 6.85 | 6.68 | 6.52 | 6.35 | 6.18 |
| 12 | 18.64 | 12.97 | 10.80 | 9.63 | 8.89 | 8.38 | 8.00 | 7.71 | 7.48 | 7.29 | 7.00 | 6.71 | 6.40 | 6.25 | 6.09 | 5.93 | 5.76 | 5.59 |
| 13 | 17.82 | 12.31 | 10.21 | 9.07 | 8.35 | 7.86 | 7.49 | 7.21 | 6.98 | 6.80 | 6.52 | 6.23 | 5.93 | 5.78 | 5.63 | 5.47 | 5.30 | 5.14 |
| 14 | 17.14 | 11.78 | 9.73 | 8.62 | 7.92 | 7.44 | 7.08 | 6.80 | 6.58 | 6.40 | 6.13 | 5.85 | 5.56 | 5.41 | 5.25 | 5.10 | 4.94 | 4.77 |
| 15 | 16.59 | 11.34 | 9.34 | 8.25 | 7.57 | 7.09 | 6.74 | 6.47 | 6.26 | 6.08 | 5.81 | 5.54 | 5.25 | 5.10 | 4.95 | 4.80 | 4.64 | 4.47 |
| 16 | 16.12 | 10.97 | 9.01 | 7.94 | 7.27 | 6.80 | 6.46 | 6.19 | 5.98 | 5.81 | 5.55 | 5.27 | 4.99 | 4.85 | 4.70 | 4.54 | 4.39 | 4.23 |
| 17 | 15.72 | 10.66 | 8.73 | 7.68 | 7.02 | 6.56 | 6.22 | 5.96 | 5.75 | 5.58 | 5.32 | 5.05 | 4.78 | 4.63 | 4.48 | 4.33 | 4.18 | 4.02 |
| 18 | 15.38 | 10.39 | 8.49 | 7.46 | 6.81 | 6.35 | 6.02 | 5.76 | 5.56 | 5.39 | 5.13 | 4.87 | 4.59 | 4.45 | 4.30 | 4.15 | 4.00 | 3.84 |
| 19 | 15.08 | 10.16 | 8.28 | 7.27 | 6.62 | 6.18 | 5.85 | 5.59 | 5.39 | 5.22 | 4.97 | 4.70 | 4.43 | 4.29 | 4.14 | 3.99 | 3.84 | 3.68 |
| 20 | 14.82 | 9.95 | 8.10 | 7.10 | 6.46 | 6.02 | 5.69 | 5.44 | 5.24 | 5.08 | 4.82 | 4.56 | 4.29 | 4.15 | 4.00 | 3.86 | 3.70 | 3.54 |
| 21 | 14.59 | 9.77 | 7.94 | 6.95 | 6.32 | 5.88 | 5.56 | 5.31 | 5.11 | 4.95 | 4.70 | 4.44 | 4.17 | 4.03 | 3.88 | 3.74 | 3.58 | 3.42 |
| 22 | 14.38 | 9.61 | 7.80 | 6.81 | 6.19 | 5.76 | 5.44 | 5.19 | 4.99 | 4.83 | 4.58 | 4.33 | 4.06 | 3.92 | 3.78 | 3.63 | 3.48 | 3.32 |
| 23 | 14.20 | 9.47 | 7.67 | 6.70 | 6.08 | 5.65 | 5.33 | 5.09 | 4.89 | 4.73 | 4.48 | 4.23 | 3.96 | 3.82 | 3.68 | 3.53 | 3.38 | 3.22 |
| 24 | 14.03 | 9.34 | 7.55 | 6.59 | 5.98 | 5.55 | 5.23 | 4.99 | 4.80 | 4.64 | 4.39 | 4.14 | 3.87 | 3.74 | 3.59 | 3.45 | 3.29 | 3.14 |
| 25 | 13.88 | 9.22 | 7.45 | 6.49 | 5.89 | 5.46 | 5.15 | 4.91 | 4.71 | 4.56 | 4.31 | 4.06 | 3.79 | 3.66 | 3.52 | 3.37 | 3.22 | 3.06 |
| 26 | 13.74 | 9.12 | 7.36 | 6.41 | 5.80 | 5.38 | 5.07 | 4.83 | 4.64 | 4.48 | 4.24 | 3.99 | 3.72 | 3.59 | 3.44 | 3.30 | 3.15 | 2.99 |
| 27 | 13.61 | 9.02 | 7.27 | 6.33 | 5.73 | 5.31 | 5.00 | 4.76 | 4.57 | 4.41 | 4.17 | 3.92 | 3.66 | 3.52 | 3.38 | 3.23 | 3.08 | 2.92 |
| 28 | 13.50 | 8.93 | 7.19 | 6.25 | 5.66 | 5.24 | 4.93 | 4.69 | 4.50 | 4.35 | 4.11 | 3.86 | 3.60 | 3.46 | 3.32 | 3.18 | 3.02 | 2.86 |
| 29 | 13.39 | 8.85 | 7.12 | 6.19 | 5.59 | 5.18 | 4.87 | 4.64 | 4.45 | 4.29 | 4.05 | 3.80 | 3.54 | 3.41 | 3.27 | 3.12 | 2.97 | 2.81 |
| 30 | 13.29 | 8.77 | 7.05 | 6.12 | 5.53 | 5.12 | 4.82 | 4.58 | 4.39 | 4.24 | 4.00 | 3.75 | 3.49 | 3.36 | 3.22 | 3.07 | 2.92 | 2.76 |
| 40 | 12.61 | 8.25 | 6.59 | 5.70 | 5.13 | 4.73 | 4.44 | 4.21 | 4.02 | 3.87 | 3.64 | 3.40 | 3.14 | 3.01 | 2.87 | 2.73 | 2.57 | 2.41 |
| 50 | 12.22 | 7.96 | 6.34 | 5.46 | 4.90 | 4.51 | 4.22 | 4.00 | 3.82 | 3.67 | 3.44 | 3.20 | 2.95 | 2.82 | 2.68 | 2.53 | 2.38 | 2.21 |
| 60 | 11.97 | 7.77 | 6.17 | 5.31 | 4.76 | 4.37 | 4.09 | 3.86 | 3.69 | 3.54 | 3.32 | 3.08 | 2.83 | 2.69 | 2.55 | 2.41 | 2.25 | 2.08 |
| 120 | 11.38 | 7.32 | 5.78 | 4.95 | 4.42 | 4.04 | 3.77 | 3.55 | 3.38 | 3.24 | 3.02 | 2.78 | 2.53 | 2.40 | 2.26 | 2.11 | 1.95 | 1.77 |

Zadatak 3 i Zadatak 5

TESTIRANJE HIPOTEZA O JEDNAKOSTI DVE DISPERZIJE

Testovi mogu biti dvostrani i jednostrani

Jednostrani:

$$H_0: \frac{\sigma_1^2}{\sigma_2^2} = 1 \quad (\sigma_1^2 = \sigma_2^2)$$

$$H_a: \frac{\sigma_1^2}{\sigma_2^2} > 1 \quad (\sigma_1^2 > \sigma_2^2)$$

$$H_a: \frac{\sigma_1^2}{\sigma_2^2} < 1 \quad (\sigma_1^2 < \sigma_2^2)$$

Dvostrani:

$$H_0: \frac{\sigma_1^2}{\sigma_2^2} = 1 \quad (\sigma_1^2 = \sigma_2^2)$$

$$H_a: \frac{\sigma_1^2}{\sigma_2^2} \neq 1 \quad (\sigma_1^2 \neq \sigma_2^2)$$

Test statistika:

$$F = \frac{\sigma_1^2}{\sigma_2^2} \text{ ili } F = \frac{\sigma_2^2}{\sigma_1^2}, \text{ uvek primenjivati sledeće: } F = \frac{\text{veća varijansa}}{\text{manja varijansa}}$$

Reon odbacivanja nulte hipoteze definiše se kao:

$$F > F_{\alpha, f_1, f_2}$$

$$F > F_{\alpha/2, f_1, f_2}$$

F_{α, f_1, f_2} i $F_{\alpha/2, f_1, f_2}$ - kvantili jednostranog i dvostranog Fišerovog „F“ rasporeda, respektivno.

Zadatak 4

TESTIRANJE HOMOGENOSTI TAČNOSTI MERENJA

Bartletov test: Vrši se testiranje hipoteze o jednakosti k disperzija

$$H_0: \sigma_1^2 = \sigma_2^2 = \dots = \sigma_k^2 = \sigma^2$$

$$H_a: \text{da je bar jedno } \sigma_j^2 \neq \sigma^2$$

Test statistika:

$$\chi^2 = \frac{1}{c} * (f_m * \ln s^2 - \sum_{i=1}^n f_i * \ln s_i^2); c = 1 + \frac{1}{3*(k-1)} * \left(\sum_{i=1}^n \frac{1}{f_i} - \frac{1}{f_m} \right);$$

$$f_i - \text{ broj stepeni slobode; } f_m = \sum_{j=1}^k f_j; s^2 = \frac{1}{f_m} * \sum_{i=1}^n f_i * s_i^2$$

Reon odbacivanja nulte hipoteze definiše se kao:

$$\chi^2 > \chi_{\alpha, f}^2$$

Zadatak 4

EKSPERIMENTALNO STANDARDNO ODSUPANJE MERENJA UGLOVA

$$s^2 = \frac{1}{f_m} * \sum_{i=1}^n f_i * s_i^2$$

$$s_{\bar{x}} = \frac{s}{\sqrt{n}}, \text{ gde je } n \text{ broj girusa}$$