[This question paper contains 16 printed pages.]

Your Roll No......

Sr. No. of Question Paper : 780

Unique Paper Code : 12271201

Name of the Paper : Introductory Macroeconomics

Name of the Course : **B.A. (H) Economics**

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Answers may be written either in English or Hindi; but the same medium should be used throughout the paper.

छात्रों के लिए निर्देश

1. इस प्रश्न-पत्र के मिलते ही ऊपर दिए गए निर्धारित स्थान पर अपना अनुक्रमांक लिखिए।
2. इस प्रश्न-पत्र का उत्तर अंग्रेजी या हिंदी किसी एक भाषा में दीजिए, लेकिन सभी उत्तरों का माध्यम एक ही होना चाहिए।

P.T.O.

1. (a) Briefly explain the "uses of private savings" in the economy. (4)

(b) A bond promises to pay 600 in one year

(i) What is the interest rate on the bond if its price today is 400?

(ii) If interest rate is 10%, what would be the price of bond today? (4)

(c) Using IS-LM model, show the impact of investment subsidy to the economy. How will it affect interest rate, income & investment in the economy? How is it different from expansionary fiscal policy? (7)

(अ) अर्थव्यवस्था में "निजी बचत के उपयोग" को संक्षेप में समझाएं।

(ब) एक बांड एक वर्ष में 600 का भुगतान करने का वादा करता है

(i) बांड पर ब्याज दर क्या है यदि इसकी कीमत आज 400 है?

(ii) यदि ब्याज दर 40% है, तो आज बांड की कीमत क्या होगी?

(स) IS-LM मॉडल का प्रयोग करते हुए, अर्थव्यवस्था पर निवेश सब्सिडी के प्रभाव को दिखाएं। यह अर्थव्यवस्था में ब्याज दर, आय और निवेश को कैसे प्रभावित करेगा? यह विस्तारवादी राजकोषीय नीति से किस प्रकार भिन्न है?

2. (a) Given the following information : (5)

Investment (I)	=	50
Government Purchases (G)	=	40
GNP	=	500
CA Balance	=	–20
Tax (T)	=	100
Transfer Payment (TR)	=	30
Interest Payment on government debt	=	20
Net Factor payments from abroad	=	–5

Compute :

(i) GDP

(ii) Net Export

(iii) Consumption

(iv) Private Savings

(v) Government Savings

(b) "Seigniorage is first an increasing function then a decreasing function of nominal money growth". Do you agree? Explain. (4)

(c) What is full employment budget surplus? How is it different from actual employment budget surplus? How does a decrease in MPC affect the budget surplus? (4)

(d) "An increase in Government spending by $10 leads to fall in the budget surplus exactly by $10", is this statement is true or false. Explain. (2)

(अ) निम्नलिखित जानकारी को देखते हुए :

निवेश (I)	=	50
सरकारी खरीद (G)	=	40
जीएनपी (GNP)	=	500
चालू खाता शेष	=	-20
कर (T)	=	100
स्थानांतरण भुगतान (TR)	=	30
सरकारी ऋण पर ब्याज भुगतान	=	20
विदेश से शुद्ध कारक भुगतान	=	-5

गणना कीजिये :

(i) सकल घरेलू उत्पाद

(ii) शुद्ध निर्यात

(iii) उपभोग

(iv) निजी बचत

(v) सरकारी बचत

(ब) "Seigniorage पहले एक बढ़ता हुआ कार्य है फिर नाममात्र धन वृद्धि का घटता कार्य"। क्या आप सहमत हैं? समझाइये।

(स) पूर्ण रोजगार बजट अधिशेष क्या है? यह वास्तविक रोजगार बजट अधिशेष से किस प्रकार भिन्न है? एमपीसी में कमी बजट अधिशेष को कैसे प्रभावित करती है?

(द) "सरकारी खर्च में $10 की वृद्धि से बजट अधिशेष में $10 की कमी आती है", यह कथन सही है या गलत है। समझाइये।

3. (a) India issues 10,000 cr. debt forgiveness to one of its neighbouring country. How is this transaction accounted for in the balance of payments of India. (3)

(b) How does hyperinflation affect economic activity of a country? (5)

(c) What do you understand by Policy mix? In an economy, illustrate the effects of a policy mix on equilibrium output and interest rate. How the monetary accommodation of fiscal expansion leaves the interest rate unchanged as the level of output rises? Explain. (7)

(अ) भारत 10,000 करोड़ जारी करता है। अपने पड़ोसी देश में से एक को कर्ज माफी। भारत के भुगतान संतुलन में इस लेन-देन का लेखा-जोखा कैसे किया जाता है।

(ब) अति मुद्रास्फीति किसी देश की आर्थिक गतिविधि को कैसे प्रभावित करती है?

(स) नीति मिश्रण से आप क्या समझते हैं? एक अर्थव्यवस्था में, संतुलन उत्पादन और ब्याज दर पर नीति मिश्रण के प्रभावों का वर्णन करें। जैसे-जैसे उत्पादन का स्तर बढ़ता है, राजकोषीय विस्तार का मौद्रिक समायोजन ब्याज दर को अपरिवर्तित कैसे छोड़ता है? समझाइये।

4. (a) What is GDP deflator? How is it different from CPI deflator? How does CPI inflation overstate the cost of living? (4)

(b) What is the demand for Central bank money? Using appropriate diagram explain the equilibrium in the market for central bank money. How does a decrease in the supply of central bank money affect its equilibrium? (5)

P.T.O.

(c) Given : $C = 0.8(1-t)\ Y$

$t = 0.25$

$I = 900 - 20i$

$G = 800$

$L = 0.25Y - 50i$

$M/P = 500$

Find

(i) Find equilibrium level of income & Consumption.

(ii) Calculate budget surplus at equilibrium.

(iii) If govt. spending increases by 200 how much would be the new level of private spending. (6)

(अ) GDP डिफ्लेटर क्या है? यह CPI डिफ्लेटर से किस प्रकार भिन्न है? सीपीआई मुद्रास्फीति जीवन यापन की लागत को कैसे बढ़ा देती है?

(ब) केंद्रीय बैंक के पैसे की मांग क्या है? उपयुक्त आरेख का प्रयोग करते हुए केंद्रीय बैंक मुद्रा के लिए बाजार में संतुलत की व्याख्या कीजिए। केंद्रीय बैंक के पैसे की आपूर्ति में कमी उसके संतुलन को कैसे प्रभावित करती है?

(स) दिया गया है :

$$C = 0.8(1-t)\ Y$$

$$t = 0.25$$

$$I = 900 - 20i$$

$$G = 800$$

$$L = 0.25Y - 50i$$

$$M/P = 500$$

गणना कीजिये :

(i) आय और उपभोग का संतुलन स्तर ज्ञात कीजिए।

(ii) संतुलन पर बजट अधिशेष की गणना करें।

(iii) अगर सरकार। खर्च 200 से बढ़ता है, निजी खर्च का नया स्तर कितना होगा।

P.T.O.

5. (a) Consider an economy whose real GDP is 5000 in time period 1 and 6000 in time period 2. The GDP deflator for the same economy is 105 in time period 1 and 120 in time period 2.

(i) What is the nominal GDP in time period 1 and 2?

(ii) What is the rate of inflation in time period 2?

(iii) If the real rate of interest in time period 2 is 4%, what is the nominal rate of interest in time period 2? (3)

(b) Why is central Bank money is also called High Powered Money? Explain using the concept of multiplier. Assuming that money multiplier is 7 and overall supply of money is 35000, what will be the central bank money? (5)

(c) Explain the relationship between effectiveness of monetary policy & interest elasticity of money demand using diagram. (4)

(d) Assume a model of the expenditure sector with no govt sector. If the savings function is defined as $S = -400 + 0.2y$, and the autonomous investment increases by 200, by how much will consumption increases? (3)

(अ) एक ऐसी अर्थव्यवस्था पर विचार करें जिसकी वास्तविक जीडीपी समय अवधि 1 में 5000 और समय अवधि 2 में 6000 है। उसी अर्थव्यवस्था के लिए जीडीपी डिफ्लेटर समय अवधि 1 में 105 और समय अवधि 2 में 120 है।

(i) समय अवधि 1 और 2 में नाममात्र सकल घरेलू उत्पाद कया है?

(ii) समय अवधि 2 में मुद्रास्फीति की दर क्या है?

(iii) यदि समय अवधि 2 में वास्तविक ब्याज दर 4% है, तो समय अवधि 2 में ब्याज की नाममात्र दर क्या है?

(ब) केंद्रीय बैंक के पैसे को हाई पावर्ड मनी क्यों कहा जाता है? गुणक की अवधारणा का प्रयोग करते हुए समझाइए। यह मानते हुए कि मुद्रा गुणक 7 है और मुद्रा की कुल आपूर्ति 35000 है, केंद्रीय बैंक की मुद्रा क्या होगी?

(स) मौद्रिक नीति की प्रभावशीलता और मुद्रा की मांग की ब्याज लोच के बीच संबंध को आरेख का उपयोग करके स्पष्ट करें।

(द) बिना सरकारी क्षेत्र वाले व्यय क्षेत्र का एक मॉडल मान लें। यदि बचत फलन को $S = -400 + 0.2y$ के रूप में परिभाषित किया जाता है, और स्वायत्त निवेश में 200 की वृद्धि होती है, तो खपत में कितनी वृद्धि होगी?

6. (a) Differentiate between intermediate and final goods. Under which category are Capital Goods and inventory investment included and why? (3)

(b) Suppose that money demand is given by $M^d = Y(0.25-i)$ where income is 100 cr. And supply of

money is 20 cr. Assume equilibrium in money market

(i) What is the interest rate?

(ii) If central bank increases interest rate by 5%, what should be the level of money supply for the money market to be in equilibrium. (5)

(c) Examine the impact of a contractionary fiscal policy on output & interest rate under two assumptions :

(i) Interest rates are kept constant

(ii) Money stock is kept constant (7)

(अ) मध्यवर्ती और अंतिम माल के बीच अंतर। कैपिटल गुड्स और इन्वेंट्री निवेश को किस श्रेणी में शामिल किया गया है और क्यों?

(ब) मान लीजिए कि पैसे की मांग एमडी = वाई (0.25-i) द्वारा दी गई है जहां आय 100 करोड़ है। और पैसे की आपूर्ति 20 करोड़ है। मुद्रा बाजार में संतुलन मानिए

(i) ब्याज दर क्या है?

(ii) यदि केंद्रीय बैंक ब्याज दर में 5% की वृद्धि करता है, तो मुद्रा बाजार के संतुलन में रहने के लिए मुद्रा आपूर्ति का स्तर क्या होना चाहिए।

(स) दो मान्यताओं के तहत उत्पादन और ब्याज दर पर एक संकुचन राजकोषीय नीति के प्रभाव की जांच करें :

(i) ब्याज दरों को स्थिर रखा जाता है

(ii) मनी स्टॉक स्थिर रखा जाता है

7. (a) A factory owner purchased 5 new machines at Rs. 30,000 each. He sold his old ones for Rs. 60,000. What is the net impact of these transaction on GDP? (2)

(b) What determine output and employment in the classical system? What role does the aggregate demand have in determining output, employment and price level? (7)

(c) Explain how each of the following events affect monetary base, money multiplier and money supply.

(i) Central bank follows expansionary open market operations.

(ii) If there is an increase in the amount of money that people hold as currency rather than deposits. (6)

(अ) एक कारखाने के मालिक ने 30,000 रुपये प्रत्येक पर 5 नई मशीनें खरीदीं। उसने अपने पुराने लोगों को 60,000 रुपये में बेच दिया। सकल घरेलू उत्पाद पर इन लेनदेन का शुद्ध प्रभाव क्या है?

(ब) शास्त्रीय प्रणाली में उत्पादन और रोजगार क्या निर्धारित करते हैं? उत्पादन, रोजगार और मूल्य स्तर निर्धारित करते में कुल मांग की क्या भूमिका है?

(स) बताएं कि निम्नलिखित में से प्रत्येक घटना मौद्रिक आधार, धन गुणक और मुद्रा आपूर्ति को कैसे प्रभावित करती है।

(i) सेंट्रल बैंक विस्तारवादी खुले बाजार के संचालन का अनुसरण करता है।

(ii) यदि लोगों के पास जमा राशि के बजाय मुद्रा के रूप में रखी गई राशि में वृद्धि होती है।

B.A (H) Eco 1st Sem Aug 2022

(5)

[This question paper contains 20 printed pages.]

Your Roll No.....

B

Sr. No. of Question Paper : 806

Unique Paper Code : 12271202

Name of the Paper : Mathematical Methods for Economics II

Name of the Course : **BA (Hons.) Economics**

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. There are **4** questions in all. **All** questions are compulsory.
3. All parts of a question must be answered together.
4. Use of a simple calculator is allowed.
5. Answers may be written either in English or Hindi; but the same medium should be used throughout the paper.

P.T.O.

छात्रों के लिए निर्देश

1. इस प्रश्न-पत्र के मिलते ही ऊपर दिए गए निर्धारित स्थान पर अपना अनुक्रमांक लिखिए।

2. कुल चार प्रश्न हैं। सभी प्रश्न अनिवार्य हैं।

3. प्रत्येक प्रश्न के सभी भागों को एक ही स्थान पर हल कीजिये।

4. साधारण कैलकुलेटर का उपयोग किया जा सकता है।

5. इस प्रश्न-पत्र का उत्तर अंग्रेजी या हिंदी किसी एक भाषा में दीजिए, लेकिन सभी उत्तरों का माध्यम एक ही होना चाहिए।

1. Attempt any **four** of the following : (6×4=24)

(a) (i) Let $Y = 10KL - \sqrt{K} - \sqrt{L}$ and $K = 0.2t + 5$ and $L = 5e^{0.1t}$. Express the rate of change of Y as a weighted sum of the relative rates of change of K and L. Can you attach any economic significance to the weights?

(ii) Let $r = r(x,y)$, $x = x(s, t)$ and $y = y(s, t)$. Given that

$$x(1,0) = 2, \quad x_1'(1,0) = -1, \quad x_2'(1,0) = 7,$$

$$y(0) = 3, \quad y(1) = 0, \quad y'(0) = 4$$

$$r(2,3) = -1, \quad r_1'(2,3) = 3, \quad r_2'(2,3) = 5$$

$$r_1'(1,0) = 6, \quad r_2'(1,0) = -2$$

Calculate $\frac{\partial r}{\partial t}$ at $s = 1,\ t = 0$.

(b) Given $f(x,y) = \ln\sqrt{x^2 + y^2}$.

(i) At (1,0), in what direction does f increase most rapidly? What is the rate of change in f in that direction?

(ii) Find an approximate value for f(1.01,0.02). How large is the error caused by this approximation?

(c) (i) Given $f(x_1, x_2, \ldots, x_n) = x_1 . x_2 . x_3 \ldots . x_n$. Is f homogenous? Is it homothetic? Are the first order partial derivatives of the function homogenous and if yes of what degree? Show that $\nabla f = f(x_1, x_2, \ldots, x_n)\left(\frac{1}{x_1}, \frac{1}{x_2} \cdots, \frac{1}{x_n}\right)$.

(ii) Suppose that f(x, y) is homogenous of degree 2 with $f_1'(2,3) = 4$ and $f_2'(4,6) = 12$. Find f(6,9).

P.T.O.

(d) The following system of equations defines $u = u(x,y)$ and $v = v(x,y)$ as differentiable functions of x and y around the point $P = (x, y, u, v) = (1,1,1,0)$:

$$(u + 2v)^5 + xy^2 = 2u - yv$$

$$(1 + u^2)^3 - z^2v = 8x + y^5w^2$$

Differentiate the system and find the values of u'_x, u'_y, v'_x and v'_y.

(e) (i) For the function, $f(x,y,z) = \dfrac{zx}{\left(x+y^2\right)}$,

determine whether the function f increases or decreases at a specified point $P_0 = (1,1,1)$ when one variable increases, while the others are fixed.

(ii) Assume that the equation $e^{xy^2} - 2x - 4y = c$ implicitly defines y as a differentiable function of x. Find a value of the constant c such that $f(0) = 1$ and find the slope and the equation of the tangent at the point $(x, y) = (0,1)$.

निम्नलिखित में से किन्हीं **चार** के उत्तर दीजिये :

(क) (i) मान लीजिये $Y = 10KL - \sqrt{K} - \sqrt{L}$ तथा $K = 0.2t + 5$ और $L = 5e^{0.1t}$. Y में परिवर्तन की दर को K और L की परिवर्तन की सापेक्ष दरों के भारित योग के रूप में व्यक्त करें। क्या आप इसके लिए कोई आर्थिक महत्त्व दिखा सकते हैं?

(ii) माना कि $r = r(x,y)$, $x = x(s,t)$ तथा $y = y(t)$ । दिया हुआ है :

$$x(1,0) = 2, \quad x'_1(1,0) = -1, \quad x'_2(1,0) = 7,$$

$$y(0) = 3, \quad y(1) = 0, \quad y'(0) = 4$$

$$r(2,3) = -1, \quad r'_1(2,3) = 3, \quad r'_2(2,3) = 5$$

$$r'_1(1,0) = 6, \quad r'_2(1,0) = -2$$

$\frac{\partial r}{\partial t}$ at $s = 1$, $t = 0$ की गणना कीजिये ।

(ख) आपको दिया गया फलन : $f(x,y) = \ln\sqrt{x^2 + y^2}$ ।

(i) फलन f सबसे तेजी से (1,0) पर किस दिशा में बढ़ता है? उस दिशा में f में परिवर्तन की दर क्या है?

P.T.O.

(ii) $f(1.01, 0.02)$ के लिए अनुमानित मान ज्ञात कीजिये। इस समीकरण के कारण हुई त्रुटि कितनी बड़ी है?

(ग) (i) दिया गया $f(x_1, x_2, \ldots, x_n) = x_1 \cdot x_2 \cdot x_3 \ldots x_n$ क्या f समरूप (होमोजीनियस) है? क्या ये समरूप (होमोथेटिक) है? क्या f के प्रथम कोटि आंशिक अवकलज (पार्शियल डेरिवेटिव्स) सजातीय फलन (होमोजीनियस फंक्शन) हैं और यदि हाँ तो किस अंश (डिग्री) के हैं?

$$\nabla f = f(x_1, x_2, \ldots, x_n)\left(\frac{1}{x_1}, \frac{1}{x_2} \ldots, \frac{1}{x_n}\right)$$ दिखाएँ।

(ii) मान लीजिये कि $f(x, y)$ डिग्री 2 का समरूप है तथा $f'_1(2,3) = 4$ और $f'_2(4,6) = 12$ तो $f(6,9)$ ज्ञात करें।

(घ) निम्नलिखित समीकरणों की प्रणाली $u = u(x,y)$ और $v = v(x,y)$ जो कि बिंदु $P = (x, y, u, v) = (1,1,1,0)$ के आसपास x और y के अवकलनीय (डिफ्रेंशियेबल) फलन के रूप में परिभाषित करती है।

$$(u + 2v)^5 + xy^2 = 2u - yv$$
$$(1 + u^2)^3 - z^2v = 8x + y^5w^2$$

प्रणाली को डिफ्रेंशियेट करें तथा u'_x, u'_y, v'_x तथा v'_y का मान ज्ञात करें।

(ङ) (i) दिए गए फलन $f(x,y,z) = \frac{zx}{(x+y^2)}$, के लिए निर्धारित करें कि फलन एक निर्दिष्ट बिंदु $P_0 = (1,1,1)$ पर बढ़ता है या घटता है, जब एक चर बढ़ता है, जबकि अन्य स्थिर होते हैं।

(ii) माना कि समीकरण $e^{xy^2} - 2x - 4y = c$ परोक्ष (इम्प्लिसिटली) रूप से y को x के एक अवकलनीय (डिफ्रेंशियेबल) फलन के रूप में परिभाषित करता है। जब $f(0) = 1$ दिया हुआ है तो स्थिरांक c का मान ज्ञात कीजिये तथा बिंदु $(x, y) = (0,1)$ पर स्पर्शरेखा (टेनजेंट) का ढलान (स्लोप) और समीकरण ज्ञात कीजिये।

2. Attempt **any four** of the following : (7×4=28)

(a) Consider the function $f(x,y) = x^2 - y^2 - xy - x^3$. Find and classify its critical points. Find the domain S where f is concave and find the largest value of f in S.

(b) State the necessary conditions for the solution of the utility maximization problem, $U(x,y)=\left(\sqrt{x}+\sqrt{y}\right)^2$ for general values of p_x, p_y and M. Find the optimal values of x, y and the corresponding value of λ (the langrange multiplier). What are the consumer's demand functions for x and y? Find the indirect utility function $U^*(p_x, p_y, M)$ and verify that

$$\lambda=\frac{\partial U^*}{\partial M}.$$

(c) Find the extreme points and extreme values for $f(x, y) = xe^y - x^2 - e^y$ on the domain defined by $0 \le x \le 2$ and $0 \le y \le 1$.

(d) The function f(x, y) is such that

Firstly, $f'_x > 0$, $f'_y > 0$;

Secondly, $f''_{xx} < 0$, $f''_{yy} < 0$; and

Thirdly the level curve $y = g(x)$ is defined implicitly by $f(x, y) = c$ where c is a constant. The function f is such that all level curves are strictly convex.

Let F be a differentiable and strictly increasing function of one variable. Which of the above mentioned three properties are preserved for the function $W(x,y) = F(f(x,y))$?

(e) Let $f(x,y) = (x^2 - \alpha xy)e^y$ be a function of two variables with α as a constant and $\alpha \neq 0$.

(i) Find the critical points of f and decide for each of them if it is a local maximum point, local minimum point or a saddle point.

(ii) Let (x^*,y^*) be the critical point where $x^* \neq 0$ and let $f^*(\alpha) = f(x^*,y^*)$. Find $\frac{df^*(\alpha)}{d\alpha}$ and show that if we define $\hat{f}(x,y,\alpha) = (x^2 - \alpha xy)e^y$ then $\frac{\partial \hat{f}(x^*,y^*,\alpha)}{\partial \alpha} = \frac{df^*(\alpha)}{d\alpha}$.

P.T.O.

निम्नलिखित में से किन्हीं चार के उत्तर दीजिये :

(क) दिए गए फलन (फंक्शन) $f(x,y) = x^2 - y^2 - xy - x^3$ के महत्वपूर्ण बिन्दुओं को खोजें और वर्गीकृत करें। डोमेन S ज्ञात कीजिये जहाँ f अवतल है। S डोमेन में f का सबसे बड़ा मान ज्ञात कीजिये।

(ख) उपयोगिता अधिकतमकरण समस्या (मैक्सीमाइज प्रॉब्लम)

$U(x,y) = \left(\sqrt{x} + \sqrt{y}\right)^2$ के समाधान के लिए आवश्यक शर्तें बताएं, p_x, p_y और M के सामान्य मूल्यों के लिए। x, y के अधिकतम मान और λ (लैंगरेंज मल्टीप्लायर) के संगत मान का पता लगाएं। x और y के लिए उपभोक्ता की मांग का फलन क्या है? अप्रत्यक्ष उपयोगिता फलन $U^*(p_x, p_y, M)$ ज्ञात कीजिये

तथा सत्यापित कीजिये कि $\lambda = \dfrac{\partial U^*}{\partial M}$।

(ग) दिए गए फलन $f(x, y) = xe^y - x^2 - e^y$ के लिए चरम बिंदु और चरम मान खोजें जब पारस (डोमेन) $0 \le x \le 2$ और $0 \le y \le 1$ दिया गया है।

(घ) दिया गया फलन $f(x, y)$ इस प्रकार है :

प्रथमत: $f'_x > 0$, $f'_y > 0$;

उसके बाद, $f''_{xx} < 0$, $f''_{yy} < 0$; तथा

अंतत: $y = g(x)$ को $f(x, y) = c$ द्वारा परोक्ष रूप से परिभाषित किया गया है जहाँ c एक स्थिरांक हैं। दिए गए फलन f के सभी वक्र स्तर पूर्णरूप से उत्तर हैं।

मान लीजिए F एक अवकलनीय और एक चर का पूर्णरूप से बढ़ता हुआ फलन है। उपरोक्त तीनों गुणों में से कौन-सा गुण दिए गए फलन $W(x, y) = F(f(x, y))$ के लिए संरक्षित हैं ?

(ङ) मान लीजिए दो चर का एक फलन $f(x, y) = (x^2 - \alpha xy)e^y$ दिया गया है जिसमें α स्थिर है तथा $\alpha \neq 0$:

(i) दिए गए फलन f के क्रिटिकल बिंदु ज्ञात कीजिए और उसमें से प्रत्येक के लिए निर्णय कीजिए कि क्या यह बिंदु स्थानीय अधिकतम बिंदु, स्थानीय न्यूनतम बिंदु या सैडल बिंदु है।

(ii) मान लीजिये (x^*, y^*) क्रिटिकल बिंदु हैं जहाँ $x^* \neq 0$

और माना कि $f^*(\alpha) = f(x^*, y^*)$ है। $\dfrac{df^*(\alpha)}{d\alpha}$

P.T.O.

ज्ञात कीजिए और दिखाएँ यदि हम

$\hat{f}(x,y,\alpha)=(x^2-\alpha xy)e^y$ को परिभाषित करते हैं

तो $\frac{\partial \hat{f}(x^*,y^*,\alpha)}{\partial \alpha}=\frac{df^*(\alpha)}{d\alpha}$ दिखायें।

3. Attempt **any one** of the following : (7×1=7)

(a) To feed his stock a farmer can purchase two kinds of feed. The farmer has determined that the herd requires 60, 84, and 72 units of the nutritional elements A, B, and C, respectively, per day. The contents and cost of a kilogram of each of the two feeds are given in the following table :

	Nutritional Elements (units per kg)			
	A	B	C	Cost (Rs. per kg)
Feed 1	3	7	3	100
Feed 2	2	2	6	40

(i) The farmer wants to determine the least expensive way of providing an adequate diet by combining the two feeds. Set this up as a linear programming problem and find the minimal-cost diet.

(ii) Does the optimal solution change if the price of Feed 1 increases from 100 Rs per kg to 140 Rs per kg, with all other data unchanged?

(b) (i) Solve the following problem :

$$\max\ 3x + 4y \text{ subject to } \begin{cases} 3x + 2y \le 6 \\ x + 4y \le 4 \end{cases}$$

$$x \ge 0,\ y \ge 0$$

(ii) Compute the increase in the criterion function if the first constraint changes to $3x + 2y \le 7$.

(iii) Compute the increase in the criterion function if the second constraint changes to $x + 4y \le 5$.

(iv) Prove using (ii) and (iii) that if (x, y) is feasible in the original problem then the criterion function can never be larger than the optimal value of the criterion function obtained in (i).

निम्नलिखित में से किन्हीं **एक** का उत्तर दीजिए :

(क) एक किसान अपने स्टॉक को भरने के लिए दो प्रकार का चारा (**फीड**) खरीद सकता है। किसान ने निर्धारित किया है कि पशु समूह को प्रतिदिन क्रमशः पोषक तत्वों A की 60 यूनिट, B की 84 यूनिट और C की 72 यूनिट की आवश्यकता होती है। दो प्रकार के चारे की प्रति किलोग्राम लागत और सामग्री निम्नलिखित तालिका में दी गई है :

	पोषक तत्व (यूनिट प्रति किलो)			
	A	B	C	लागत (रुपये प्रति किलो)
चारा 1	3	7	3	100
चारा 2	2	2	6	40

(i) किसान दो चारे को मिलाकर पर्याप्त आहार प्रदान करने का सबसे कम खर्चीला तरीका निर्धारित करना चाहता है। इसे एक रैखिक प्रोग्रामिंग (लीनियर प्रोग्रामिंग) समस्या के रूप में दिखाएँ और न्यूनतम लागत वाला आहार (डाइट) ज्ञात करें।

(ii) यदि चारा 1 की कीमत 100 रुपये प्रति किलोग्राम से बढ़कर 140 रूपये प्रति किलोग्राम हो जाती है और अन्य सभी डेटा अपरिवर्तित रहते हैं, तो क्या इष्टतम समाधान (ऑप्टीमल सोल्यूशन) बदलता है?

(ख) (i) निम्नलिखित समस्या (प्रॉब्लम) का समाधान करें :

अधिकतम (मैक्स) $3x + 4y$ यदि $\begin{cases} 3x + 2y \leq 6 \\ x + 4y \leq 4 \end{cases}$

$x \geq 0,\ y \geq 0$

(ii) यदि पहली बाधा (कंस्ट्रेंट्स) $3x + 2y \leq 7$ में बदल जाती है तो मानदंड (क्राइटेरियन) फलन में वृद्धि की गणना करें।

(iii) यदि दूसरी बाधा (कंस्ट्रेंट्स) $x + 4y \leq 5$ में बदल जाती है तो मानदंड (क्राइटेरियन) फलन में वृद्धि की गणना करें।

P.T.O.

(iv) यदि (x, y) मूल समस्या में संभव है तो मानदंड फलन (क्राइटेरियन फंक्शन) कभी भी (i) में प्राप्त मानदंड फलन (क्राईटेरियन फंक्शन) के इष्टतम मान से बड़ा नहीं हो सकता है, इसे (ii) और (iii) का उपयोग करके सिद्ध करें।

4. Attempt **any two** of the following : (8×2=16)

(a) (i) Find the area of the region between the curves: $y_1 = 3x^2 - 6x + 8$ and $y_2 = -2x^2 + 4x + 1$ from $x = 0$ to $x = 2$.

(ii) Show that $y(t) = 2e^{6t} + 1$ is the solution to the differential equation $\frac{dy}{dt} = 6y - 6$ where $y(0) = 3$. Does $y(t)$ converge to a steady state? (4,4)

(b) (i) Let the rate of investment be given by the function, $I(t) = 12t^{1/3}$. If $K(0) = 25$, find the time path of capital stock. Find the amount of capital accumulation during the time interval [1,3].

(ii) The demand and supply functions in the market for a commodity are given by :

$$Q_{dt} = 4 - P_t$$

$$Q_{st} = 1 + 0.5P_{t-1}$$

Q_{dt} and Q_{st} are the quantity demanded and quantity supplied of the commodity at time t, and P_t represents the price in time period t. Find the expression for P_t in terms of P_{t-1} in the equilibrium. Solve the corresponding difference equation. Is the time path of price oscillatory/non-oscillatory and convergent/ divergent? Illustrate using a graph. Consider $P_0 = 1$. (4,4)

(c) (i) Find the general solution of the differential equation $\dot{P} = \delta[D(P) - S(P)]$ where $\delta > 0$ and $D(P) = a - bP$ gives the demand of a commodity and $S(P) = \alpha + \beta P$ gives the supply. a, b, α and β are positive constants. Determine the equilibrium state and examine whether it is stable.

(ii) Given that :

$$C_t = 90 + 0.8y_{t-1}$$

$$I_t = 50$$

$$Y_0 = 1200$$

Y_t, C_t and I_t are the national income, consumption and investment at time t. Find the time path of national income, Y_t. Comment on the stability of the time path. (4,4)

निम्नलिखित में से किन्हीं दो के उत्तर दीजिये :

(क) (i) वक्रों : $y_1 = 3x^2 - 6x + 8$ और $y_2 = -2x^2 + 4x + 1$ के बीच, $x = 0$ से $x = 2$, तक के क्षेत्र का क्षेत्रफल ज्ञात कीजिए।

(ii) सिद्ध करें कि $y(t) = 2e^{6t} + 1$ अंतर समीकरण (डिफरेंशियल इकवेशन) $\frac{dy}{dt} = 6y - 6$ जहाँ $y(0) = 3$ का समाधान है। क्या $y(t)$ स्थिर (स्टडी) अवस्था में परिवर्तित (कन्वर्ज) होता है?

(ख) (i) मान लीजिये निवेश की दर फलन (फंक्शन) $I(t)=12t^{1/3}$ द्वारा दी गई है। यदि $K(0) = 25$ है तो पूंजी स्टॉक का समय पथ (टाइम पाथ) ज्ञात कीजिए। टाइम इंटरवल [1,3] के दौरान पूंजी संचय की मात्रा ज्ञात कीजिए।

(ii) किसी वस्तु के लिए बाजार में मांग (डिमांड) और आपूर्ति (सप्लाई) फलन दिए गए हैं :

$$Q_{dt} = 4 - P_t$$

$$Q_{st} = 1 + 0.5P_{t-1}$$

Q_{dt} और Q_{st} समय t पर वस्तु की मांग और आपूर्ति की मात्रा है, तथा P_t, वस्तु की कीमत समयावधि t में है। संतुलन में P_t के लिए व्यंजक P_{t-1} के पदों (टर्म्स) में ज्ञात कीजिए। सम्बन्धित (कोरस्पोंडिंग) अंतर समीकरण (डिफरेंस इकवेशन) को हल कीजिए। क्या कीमत का समय पथ (टाइम पाथ) मूल्य दोलन (ओस्लेट्री) / गैर दोलन (नॉन ओस्लेट्री) और अभिसरण (कन्वेर्जेंट) / अपसारी (डाईवर्जेंट) है? एक ग्राफ का उपयोग करके चित्रण करें। $P_0 = 1$ पर विचार करें।

P.T.O.

(ग) (i) अंतर समीकरण (डिफरेंशियल इकवेशन) $\dot{P} = \delta[D(P) - S(P)]$ का सामान्य समाधान ज्ञात करें जहाँ $\delta > 0$ तथा एक वस्तु की मांग (डिमांड) $D(P) = a - bP$ और $S(P) = \alpha + \beta P$ आपूर्ति है. a, b, α और β सकारात्मक स्थिरांक (कानस्टंट्स) हैं। संतुलित स्थिति निर्धारित करें और जांचें कि क्या वह स्थिर है।

(ii) दिया गया है :

$$C_t = 90 + 0.8y_{t-1}$$

$$I_t = 50$$

$$Y_0 = 1200$$

Y_t, C_t और I_t समय t पर राष्ट्रीय आय, खपत और निवेश हैं। राष्ट्रीय आय Y_t का समय पथ ज्ञात कीजिये। समय पथ (टाइम पथ) की स्थिरता पर टिप्पणी कीजिए।

4108

SET A

Sr. No. of Question Paper: 5293

Unique Paper Code : 12277613

Name of the Course : B. A. (H) Economics

Name of the Paper : Economics of Health and Education

Semester : VI

Duration: 3 Hours Maximum Marks: 75

Any graphs/figures/diagrams in the question paper have been taken from the prescribed readings.

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **five** questions in all.
3. Use of scientific calculator is allowed.

1. Suppose there is a population of individuals whose number is normalized to one. Let be the fraction of individuals who are immunized. The probability of contracting an infectious disease is given by $p(n) = p_o(1-n)^2$, where p_o is the probability of contracting the disease when none in the population is immunized. Assume that the vaccination provided is fully effective. Individuals are identical in all respects and the cost of illness is assumed to be the same across all individuals and is equal to one. The marginal cost of the vaccination is constant, denoted by c.
   a. Derive the private and social marginal benefit. What is the relationship between the two? (6)
   b. Show diagrammatically the private optimum and the social optimum. (4)
   c. What are the possible reasons that make the government pursue full immunization? (5)

2. Answer the following questions:
   a. Different people obtain different levels of direct utility from smoking – for some it is high, for some others it is low and even it is zero or negative for some others. However, both smokers and non-smokers suffer from second hand smoke. Show the social costs and benefits functions graphically and find the socially optimum number of smokers. (8)

b. What are the effects of varying quality of medical care services on the demand for these services? (7)

3. Answer the following questions:
   a. Discuss how the changes in food habits over time can bring about changes in per capita calorie intake. (8)
   b. Suresh is considering a 1-year training program, which charges Rs 40,000 in tuition, to learn how to install computer equipments. If he enrolls in the program, his opportunity cost in terms of forgone income is Rs 250,000. After completing the program, he is promised a job for 5 years, with a yearly salary of Rs 800,000. (After 5 years, the equipment is expected to be obsolete, but Suresh plans to retire by that time anyway.) Assume Suresh's personal discount rate is 5 percent. Should Suresh enroll in the program? Justify your answer. (7)
4. Answer the following questions:
   a. "The most significant problem faced in evaluating the net impact on social welfare of health projects is the valuation of benefits." In the light of the above statement, explain various methods of measuring benefits under cost-benefit analysis (CBA). (12)
   b. Calculate the Index of Dissimilarity for males and females, given the information below. (3)

Occupation	Males	Females
A	80	40
B	80	50
C	40	50
Total	200	140

5. Answer the following questions:
   a. Can price indices of food be considered as price indices of calories? Justify your answer. (8)
      i. With the help of diagrams, explain what will happen to the acquisition of human capital if: (3.5+3.5=7)
      ii. Cost of getting education for an additional year decrease
      iii. Benefit derived from spending an additional year on education increases.

6. Answer the following question:
   a. Suppose that the supply curve for doctors is given by $Ls = -6 + 0.6W$ while the demand curve is given by $L_o = 50-W$, where W = annual earnings and L = number of doctors.
      i. Find the equilibrium wage and employment levels.

ii. Now, suppose that the demand for doctors increases and the new demand curve is . Assume that this market is subject to cobweb adjustments as it takes about four years to produce people who specialize in medicine. While this adjustment is taking place, the short-run supply of doctors is fixed.

A. Calculate the new long run equilibrium wage and employment levels.
B. Calculate the wage and employment levels in each of the first three rounds of adjustments.
C. Draw a graph to show these events. (2.5*4 = 10)

b. Consider a situation where three drugs are available to treat a particular disease. The probability of avoiding death changes as follows:

i. For Drug1, from 0.3 to 0.34, and it costs Rs 10 per treatment;
ii. For Drug 2, from 0.2 to 0.27, and it costs Rs 7 per treatment;
iii. For Drug 3, from 0.4 to 0.48, and it costs Rs 5 per treatment.
iv. For Drug 4, from 0.5 to 0.6, and it costs Rs 8 per treatment
v. For Drug 5, from 0.7 to 0.9, and it costs Rs 30 per treatment

Calculate the cost-effectiveness (C/E) of each drug. Which drug is the most cost-effective? (5)

7. Answer the following questions:
   a. Discuss the initiatives taken by government in improving the teaching and learning outcomes in India. (7)
   b. Discuss India's educational achievements from an international perspective. Do you think that India's educational achievement is one of the mixed successes? (8)

8. a. Consider five occupations in which workers can be employed. Depending upon the educational qualifications required, each occupation is given a number (N). The higher the number, higher is the level of education, and hence higher will be the salary (S). The following table gives these numbers for the five occupations and the monthly salary of females corresponding to each of these five occupations.

Occupations	Number (N)	Average Salary of Females (S)
A	2	900
B	5	965
C	9	1012
D	10	1065
E	15	1155

A least squares regression applied to a similar data set for *males* yielded the following relationship: $S_i = 1100 + 20N_i - 0.5N_i^2$. Using this equation, estimate the salaries that the females would have earned based on the numbers (N_i) given to each occupation. Analyze whether discrimination exists. Do you notice any relationship between skill level and the discrimination in the salary earned? (10)

b. Explain the non-competitive model of discrimination wherein employers exhibit collusive behavior. (5)

SNO - 5354

14/08
(M)

Name of Course: Ba (Hons) Economics
Scheme/Mode of Examination: CBCS-DSE
Semester : VI
Name of the Paper: Money and Financial Markets
UPC/Subject Code: 12277606
Medium of Instruction: English and Hindi
Max Marks: 75

All Questions Carry Equal Marks. Answer Any Five (5) Questions.
सभी प्रश्नों के बराबर अंक हैं। किन्हीं पाँच (5) प्रश्नों के उत्तर दीजिए।

Q1. (a) Describe a fairly general model of money multiplier incorporating adjustment on account of
(i) Required reserve ratio changes;
(ii) Excess Reserves held by the banks and
(iii) Discretionary finance provided by the Central Bank.
Explain the reason for each adjustment. 9
(b) Derive the money multiplier where money is defined as broad money. 6

Q1. (a) मुद्रा गुणक के एक सामान्य मॉडल का समायोजन को शामिल करते हुए वर्णन करें जिसका कारण है
(i) आवश्यक आरक्षित अनुपात में परिवर्तन;
(ii) बैंकों द्वारा रखे गए अतिरिक्त भंडार और
(iii) सेंट्रल बैंक द्वारा प्रदान किया गया विवेकाधीन वित्त।
प्रत्येक समायोजन का कारण स्पष्ट कीजिए।
9
(b) मुद्रा गुणक को व्युत्पन्न करें जहाँ मुद्रा को व्यापक मुद्रा के रूप में परिभाषित किया जाता है। 6

Q2. (a) Briefly describe the various reform measures undertaken to deepen and widen the Indian Money Market. 7
(b) Discuss the causes and consequences of a financial crisis. 8

Q2. (a) भारतीय मुद्रा बाजार को मजबूत और प्रभावी बनाने के लिए किए गए विभिन्न सुधार उपायों का संक्षेप में वर्णन करें। 7
(b) वित्तीय संकट के कारणों और परिणामों की विवेचना कीजिए। 8

Q3. (a) Why are options and futures labelled derivative securities? What are the main ways in which an option differs from a future contract? 7
(b) Explain the risk and return characteristics of options when the option price is Rs. 3 in the following two cases:-
(i) In the case where investor has long a put option
(ii) In the case where investor has short a call option. 8

Q3. (a) विकल्प और वायदा को व्युत्पन्न प्रतिभूति क्यों कहा जाता है? वे मुख्य तरीके क्या हैं जिनसे एक विकल्प, वायदा अनुबंध से भिन्न होता है? 7

(b) निम्नवर्णित 3 मामलों में विकल्पों के जोखिम और लाभ विशेषताओं की व्याख्या कीजिए जब विकल्प मूल्य 3 रुपये हों

(i) उस मामले में जहां निवेशक के पास लंबे समय तक पुट ऑप्शन है

(ii) उस मामले में जहां निवेशक के पास कॉल ऑप्शन कम है। 8

Q4. (a) Using demand and supply analysis illustrate and explain the impact of the following changes on the interest rate a firm pays for loanable funds:

(i) An increased uncertainty about the future tax treatment of interest income

(ii) An increase in firm's default risk

(iii) A decrease in the liquidity risk of the firm's bond

(iv) An increase in inflationary expectations. 8

(b) Explain briefly the expectations hypothesis. How could future interest rate be forecast using expectations hypothesis? 7

Q4. (a) मांग और आपूर्ति विश्लेषण का उपयोग करते हुए एक फर्म द्वारा ऋण योग्य निधियों के लिए भुगतान की जाने वाली ब्याज दर पर निम्नलिखित परिवर्तनों के प्रभाव को उदाहरण के साथ स्पष्ट और व्याख्या कीजिए :

(i) ब्याज आय के फ्यूचर टैक्स ट्रीटमेंट के बारे में बढ़ी हुई अनिश्चितता

(ii) फर्म के डिफ़ॉल्ट जोखिम में वृद्धि

(iii) फर्म के बांड की तरलता जोखिम में कमी

(iv) मुद्रास्फीतिकारी प्रत्याशा में वृद्धि।

8

(b) संक्षेप में प्रत्याशा की परिकल्पना की व्याख्या करें। प्रत्याशा की परिकल्पना का उपयोग करके भविष्य की ब्याज दर का पूर्वानुमान कैसे लगाया जा सकता है?

7

Q5. a) Briefly discuss the various interest rate methodologies which have been prescribed by the RBI for Indian banks since 1994. 8

b) What are the implications of BASEL-III for Indian Banks? 7

Q5. (a) भारतीय बैंकों के लिए भारतीय रिजर्व बैंक द्वारा 1994 से निर्धारित विभिन्न ब्याज दर पद्धतियों पर संक्षेप में चर्चा करें। 8

(b) भारतीय बैंकों के लिए BASEL-III के क्या निहितार्थ हैं? 7

Q6. a) Discuss the role that RBI plays in the Indian banking and financial system. 9

b) What properties should a variable have to serve as an intermediate target of monetary policy? 6

Q6. (a) भारतीय बैंकिंग और वित्तीय प्रणाली में आरबीआई की भूमिका की चर्चा करें। 9

(b) मौद्रिक नीति के मध्यवर्ती लक्ष्य के रूप में एक चर में कौन से गुण मौजूद होने चाहिए। 6

Q7. a) Discuss the recent developments and reforms in the government securities market. 7

b) Examine the impact of asymmetric imperfect information on bank loan decisions. 8

Q7. (a) सरकारी प्रतिभूति बाजार में हाल के घटनाक्रमों और सुधारों की विवेचना कीजिए। 7

(b) बैंक ऋण निर्णयों पर असममित अपूर्ण जानकारी के प्रभाव की जांच करें। 8

Q8. Write short notes on any two: 7.5+7.5

(i) Market Stabilization Scheme

(ii) Central Bank's Balance Sheet

(iii) Instrument Instability

Q8. किन्हीं दो पर संक्षिप्त टिप्पणी लिखिए : 7.5+7.5

(i) बाजार स्थिरीकरण योजना

(ii) सेंट्रल बैंक की बैलेंस शीट

(iii) साधन अस्थिरता

SNO- 5411

17/09
CM

Unique Paper Code: 12271602

Name of Paper: Development Economics- II

Name of the Course: CBCS LOCF Core- B.A (Hons.) Economics

Semester: VI

Maximum Marks: 75
Time Duration: 3 hours

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper
2. Answers may be written either in English or in Hindi, but the same medium should be used throughout the paper.
3. This paper consists of 8 questions. Answer **any five** questions.
4. The marks for each question are written along with the questions.

छात्रों के लिए निर्देश

1. इस प्रश्न-पत्र के मिलते ही ऊपर दिए गए निर्धारित स्थान पर अपना अनुक्रमांक लिखिए।
2. इस प्रश्न-पत्र का उत्तर अंग्रेजी या हिन्दी किसी एक भाषा में दीजिए; लेकिन सभी उत्तरों का माध्यम एक ही होना चाहिए।
3. इस प्रश्न-पत्र में 8 प्रश्न हैं। किन्हीं पाँच प्रश्नों के उत्तर दीजिए।
4. प्रत्येक प्रश्न के अंक प्रश्न के सामने दिए गए हैं।

1. (a) In a society where the prime responsibility of child-rearing activities falls on women, what will be the effect of a rise in (i) male wage and (ii) female wage on the fertility choices made by the household? Explain with the help of suitable diagrams. (8)

   (b) A couple has a ninety-five percent threshold probability that it can receive support from at least one child at the old age. There is fifty percent chance that a child will look after the parents when they are old. Given this information, calculate how many children this couple would choose to have. Also, explain the factors that determine the overall probability of having the child grow up to look after the parents. (3,4)

(a) एक ऐसे समाज में, जहां बच्चों के पालन-पोषण की गतिविधियों की जिम्मेदारी महिलाओं की होती है, (i) पुरुष मजदूरी और (ii) महिला मजदूरी में वृद्धि का घर के प्रजनन विकल्पों पर क्या प्रभाव पड़ेगा? अपने तर्क के समर्थन में उपयुक्त आरेखों का प्रयोग कीजिए। (8)

(b) एक दंपति की 95 प्रतिशत सीमा प्रायिकता है कि उसे बुढ़ापे में कम से कम एक बच्चे से सहायता प्राप्त हो सकती है। इस बात की 50 प्रतिशत संभावना है कि बच्चा अपने माता-पिता की देखभाल तब करेगा जब वे बूढ़े हो जाएंगे। इस सूचना के आधार पर, गणना करें कि इस दंपति के कितने बच्चे होंगे। साथ ही, उन कारकों की व्याख्या करें जो माता-पिता की देखभाल करने के लिए बच्चे के बड़े होने की समग्र संभावना को निर्धारित करते हैं।

(3,4)

2. Using the Harris-Todaro model, explain that migration is a response to the significant wage gap that prevails between the rural and the urban sectors. Explain this process of migration and the creation of the urban informal sector. (15)

हैरिस-टोडारो मॉडल का उपयोग करते हुए दिखाएँ कि प्रवास ग्रामीण और शहरी क्षेत्रों के बीच व्याप्त महत्वपूर्ण मजदूरी अंतर की वजह से है। प्रवासन की इस प्रक्रिया और शहरी अनौपचारिक क्षेत्र के निर्माण की व्याख्या करें। (15)

3. (a) Under the conditions of uncertainty in agricultural production, sharecropping arrangement is a way to share, not just the output, but also the associated risk. Discuss this statement with suitable arguments. (10)

(b) Is sharecropping also a preferred contract when input costs are shared between the landlord and the tenant? (5)

(a) कृषि उत्पादन में अनिश्चितता की स्थिति के तहत, बटाईदार व्यवस्था न केवल उत्पादन, बल्कि संबंधित जोखिम को साझा करने का एक तरीका है। उपयुक्त तर्कों के साथ इस कथन की विवेचना कीजिए । (10)

(b) क्या बटाईदारी भी एक पसंदीदा अनुबंध है जब मकान-मालिक और किरायेदार के बीच इनपुट लागत साझा की जाती है? (5)

4. Derive the supply curve of the rural labour market when labour is the only asset, using the concepts of capacity curve and piece rate. Show the possibility that the equilibrium involves existence of involuntary unemployment. (10,5)

क्षमता वक्र और टुकड़ा दर की अवधारणाओं का उपयोग करते हुए, ग्रामीण श्रम बाजार की आपूर्ति वक्र प्राप्त करें जब श्रम ही एकमात्र संपत्ति है। संभावना दिखाएँ कि संतुलन में अनैच्छिक बेरोजगारी का अस्तित्व शामिल है। (10,5)

5. Show that an interlinked transaction generates efficient surplus if a loan is partially repaid in the form of labour, where the rate of interest charged by the lender is higher and the wage rate is lower than the respective market rates. Will it be a preferred contract if the wage rates are further lowered while the rate of interest continues to be the same as in the market? (8,7)

दिखाएं कि एक इंटरलिंक्ड लेनदेन कुशल अधिशेष उत्पन्न करता है यदि ऋण आंशिक रूप से श्रम के रूप में चुकाया जाता है, जहां ऋणदाता द्वारा ब्याज की दर अधिक होती है और मजदूरी दर संबंधित बाजार दरों से कम होती है। क्या यह एक पसंदीदा अनुबंध होगा यदि मजदूरी दरों को और कम किया जाता है जबकि ब्याज दर बाजार में समान रहती है? (8,7)

6. Explain the concept of sustainable development and its estimation using productive base. Are the movements in Human Development Index and sustainable development related? Discuss. (10,5)

सतत विकास की अवधारणा और उत्पादक आधार का उपयोग करके इसके आकलन की व्याख्या करें। क्या मानव विकास सूचकांक और सतत विकास में गतिविधियां संबंधित हैं? विवेचन करें । (10,5)

7. How is the global integration of the WTO regime different from the globalisation of the Bretton Woods System in the formulation of domestic policies in the developing world? (15)

बताएं कि विकासशील देशों में घरेलू नीतियों के निर्माण में विश्व व्यापार संगठन के शासन का वैश्विक एकीकरण ब्रेटन वुड्स सिस्टम के वैश्वीकरण से कैसे भिन्न है? (15)

8. Write short note on *any* two: (7.5 each)
   (a) Characteristics of rural credit markets
   (b) Political economy model of environmental regulation
   (c) Model of nutritional status
   (d) Centrality of reputation in trade theory

किन्हीं दो पर संक्षिप्त टिप्पणी लिखिए: (प्रत्येक 7.5)
(a) ग्रामीण सांख बाजारों की विशेषताएं
(b) पर्यावरण विनियमन का राजनीतिक अर्थव्यवस्था मॉडल
(c) पोषण की स्थिति का मॉडल
(d) व्यापार सिद्धांत में प्रतिष्ठा की केंद्रीयता

Photo

8/08/22

(M)

S.No. of Question Paper: 5423

Unique Paper Code : 12271403

Name of the Paper : Introductory Econometrics

Name of the Course : CBCS Core

Semester : IV

Duration: 3 hours

Maximum Marks: 75

(Write Your Roll No. on the top immediately on receipt of this question paper.)
Note: Answers may be written either in English or in Hindi; but the same medium should be used throughout the paper.
(इस प्रश्न पत्र की प्राप्ति के तुरंत बाद शीर्ष पर अपना रोल नंबर लिखिए।)

नोट: उत्तर अंग्रेजी या हिंदी में लिखे जा सकते हैं; लेकिन पूरे पेपर में एक ही माध्यम का इस्तेमाल किया जाना चाहिए।

Answer any Five questions out of Seven.

All questions carry equal marks.

Use of simple non-programmable calculator is allowed. Statistical tables are attached for your reference.

सात में से किन्हीं पाँच प्रश्नों के उत्तर दीजिए।

सभी प्रश्नों पर समान अंक हैं।

साधारण गैर-प्रोग्राम योग्य कैलकुलेटर के उपयोग की अनुमति है। आपके संदर्भ के लिए सांख्यिकीय सारणियां संलग्न हैं। सभी गणनाओं के लिए दो दशमलव स्थानों पर संख्याओं को गोल किया जा सकता है।

1. State whether the following statements are True or False. Give reasons for your answer.

   (i) In a two variable log-log regression model, the slope coefficient and measure of elasticity are always same.
   (ii) In a simple regression, the r^2 of log-log and semi-log models can be compared to find which is a better fit.
   (iii) In a simple regression model estimated using OLS, the residuals (e_i) are such that $\bar{e} = 0$ *and* $\bar{e}^2 = 0$.

(iv) A researcher is analyzing the effect of income (X, in thousands of Rupees) on consumption (Y, in thousands of Rupees) with regression:

$$lnY_i = \beta_1 + \beta_2 X_i + u_i$$
$$\widehat{\beta_2} = 0.7$$

It means that an increase in Income by 1000 Rupees leads to an average increase in Consumption by 70%.

(v) If X and Y are related to each other by the equation: Y = 2 + 0.5 X, the correlation coefficient between them is 0.5.

(5×3=15)

1. बताएं कि निम्नलिखित कथन सही हैं या गलत। अपने जवाब के लिए कारण दीजिये।

(i) दो चर लॉग-लॉग रिग्रेशन मॉडल में, ढलान गुणांक और लोच का माप हमेशा समान होता है।

(ii) एक साधारण प्रतिगमन में, लॉग-लॉग और सेमी-लॉग मॉडल के r^2 की तुलना यह पता लगाने के लिए की जा सकती है कि कौन सा बेहतर फिट है।

(iii) ओएलएस (OLS) का उपयोग करके अनुमानित एक साधारण प्रतिगमन मॉडल में, अवशिष्ट (e_i) ऐसे हैं कि $\bar{e} = 0$ और $\bar{e}^2 = 0$.

(iv) एक कंपनी प्रतिगमन के साथ उपभोग (Y, हजारों रुपये में) पर आय (X, हजारों रुपये में) के प्रभाव का विश्लेषण कर रही है:

$$lnY_i = \beta_1 + \beta_2 X_i + u_i$$
$$\widehat{\beta_2} = 0.7$$

इसका मतलब है कि आय में 1000 रुपये की वृद्धि से उपभोग में औसतन 70% की वृद्धि होती है।

(v) यदि X और Y समीकरण Y = 2 + 0.5 X द्वारा एक दूसरे से संबंधित हैं, उनके बीच सहसंबंध गुणांक 0.5 है।

(5×3=15)

2. Using data on annual disposal income (DY) and consumption (C), both measured in '000 Rs, from 250 Indian households, the following regression equation has been estimated:

$$C_i = 0.567 + 1.045\ DY_i$$
$$(se)\quad 0.33 \qquad 0.066$$

i) Provide the interpretation of constant is this equation and discuss its sign and magnitude.

ii) Derive a 95% confidence for both slope and intercept coefficients.

iii) Are these coefficients statistically significant?

iv) Test the hypothesis that slope coefficient is statistically less than one.

v) Calculate the predicted consumption of hypothetical household with an annual income of Rs 40,000. (2+5+3+3+ 2)

2. 250 भारतीय परिवारों से वार्षिक निपटान आय (DY) और खपत (C) पर डेटा का उपयोग करते हुए, दोनों को '000 रुपये में मापा गया, निम्नलिखित प्रतिगमन समीकरण का अनुमान लगाया गया है:

$$C_i = 0.567 + 1.045\ DY_i$$
$$(se) \quad 0.33 \quad 0.066$$

i) यह समीकरण स्थिरांक की व्याख्या प्रदान कीजिये और इसके चिह्न और परिमाण पर चर्चा कीजिये।

ii) ढलान और अवरोधन गुणांक दोनों के लिए 95% विश्वास प्राप्त कीजिये।

iii) क्या ये गुणांक सांख्यिकीय रूप से महत्वपूर्ण हैं?

iv) इस परिकल्पना का परीक्षण कीजिये कि ढलान गुणांक सांख्यिकीय रूप से एक से कम है।

v) 40,000 रुपये की वार्षिक आय वाले काल्पनिक परिवार की अनुमानित खपत की गणना कीजिये। (2+5+3+3+ 2)

3. Based on the data of 75 observations, a sales manager of a company estimated the following sales models:

Model 1: $sales_i = \beta_1 + \beta_2 price + \beta_3 advert + \beta_4 advert^2 + \mu_i$

Model 2: $sales_i = \beta_1 + \beta_2 price + \mu_i$

Model 3: $sales_i = \beta_1 + \beta_3 advert + \beta_4 advert^2 + \mu_i$

Residual sum of squares and Total sum of squares from the three models are as follow

RSS_1 =1532:084, TSS_1 = 3115.482, RSS_2 =1896.391, RSS_3 = 2683.411

a) Test the overall significance of the regression model 1 using α=5%.

b) How would you test (use α=1%)

(i) Whether it is significant to add advertising and advertising square to the model

(ii) Whether it is significant to add price to the model.

Clearly state the Null and alternative hypothesis and show the necessary calculations.

c) The estimated regression equation using Model 1 is as follows:

Sales = 109.72 -7.640 Price + 12.151 Adver - 2.768 $Adver^2$

(se) (6.80) (1.046) (3.556) (0.941)

(i) Test the slope coefficient of Price is statistically different from zero (Use α=5%)

(ii) Interpret the relationship between advertisement and sales.

(d) Suppose the true model is 1 and model 3 suffers from some specification error. What could be the possible error and what will be its impact on the estimated coefficients?

(3+5+4+3)

3. 75 अवलोकनों के आंकड़ों के आधार पर, एक कंपनी के बिक्री प्रबंधक ने निम्नलिखित बिक्री मॉडल का अनुमान लगाया:

मॉडल 1: $\text{sales}_i = \beta_1 + \beta_2 price + \beta_3 advert + \beta_4 advert^2 + \mu_i$

मॉडल 2: $\text{sales}_i = \beta_1 + \beta_2 price + \mu_i$

मॉडल 3: $\text{sales}_i = \beta_1 + \beta_3 advert + \beta_4 advert^2 + \mu_i$

तीनों मॉडलों से वर्गों का अवशिष्ट योग और वर्गों का कुल योग इस प्रकार है

RSS_1 =1532:084, TSS_1 = 3115.482, RSS_2 =1896.391, RSS_3 = 2683.411

क) α=5% का उपयोग करके प्रतिगमन मॉडल 1 के समग्र महत्व का परीक्षण कीजिये।

ख) आप कैसे परीक्षण करेंगे (α=1% का प्रयोग कीजिये)

(i) क्या मॉडल में विज्ञापन और विज्ञापन वर्ग जोड़ना महत्वपूर्ण है?

(ii) क्या मॉडल में कीमत जोड़ना महत्वपूर्ण है।

शून्य और वैकल्पिक परिकल्पना को स्पष्ट रूप से बताएं और आवश्यक गणनाएं दिखाएं।

ग) मॉडल 1 का उपयोग करते हुए अनुमानित प्रतिगमन समीकरण इस प्रकार है:

$$\text{Sales} = 109.72 - 7.640\ \text{Price} + 12.151\ \text{Adver} - 2.768\ \text{Adver}^2$$
$$\text{(se)} \quad (6.80) \quad (1.046) \quad (3.556) \quad (0.941)$$

(i) परीक्षण कीजिये कि मूल्य का ढलान गुणांक शून्य से सांख्यिकीय रूप से भिन्न है (α=5% का उपयोग कीजिये)।

(ii) विज्ञापन और बिक्री के बीच संबंध की व्याख्या कीजिये।

(डी) मान लीजिए कि सही मॉडल 1 है और मॉडल 3 कुछ विनिर्देश त्रुटि से ग्रस्त है। संभावित त्रुटि क्या हो सकती है और अनुमानित गुणांक पर इसका क्या प्रभाव पड़ेगा?

(3+5+4+3)

4. a) In a regression of expenditure on public transport (Y) on number of days worked in a year (W) and number of days not worked (NW=365-W) for a random sample of 100 residents in a city, the following results were obtained:

Regression 1:

$$\widehat{logY} = 2.81 + 0.91\, logW + 0.53 logNW$$

se = (1.38) (0.34) (0.14) R^2=0.97

Using the same data, the following regression was also obtained

Regression 2: $$log(\frac{\widehat{Y}}{NW}) = -0.11 + 0.34 \log (W/NW)$$

se = (0.03) (0.15) $R^2 = 0.85$

(i) How would you interpret the slope coefficients of logW in Regression 1?
(ii) Do you suspect multicollinearity in Regression 1? How do you know? Has it been removed in regression 2?
(iii)What remedial measures are employed to remove multicollinearity in the regression?
(iv)Can you compare the R^2 of the two regressions? Give reasons. (1+2+2+1)

(b) A real estate company used monthly housing sales data to estimate the effect that the pandemic lockdown had on demand for sub-urban real estate

$$\widehat{lnY_t} = -1.83 + 0.08D_t - 0.91lnX_t + 0.55(D_t lnX_t)$$

Where Y= Share of sub-urban housing deals during a month, X= price per square meter of sub-urban real estate,

D_t=1, if it is a lockdown month

= 0, if it is not a lockdown month

All parameters are significantly different from zero at α= 5%

(i) Write the regression functions for a lockdown and a non-lockdown month.
(ii) What was the change in the price-elasticity for sub-urban housing during the lockdown?
(iii) Can the above equation be rewritten if Dummy assignment is switched as below?

D_t=0, if it is a lockdown month
= 1 if it is not a lockdown month (2+3+4)

4. क) एक शहर में 100 निवासियों के यादृच्छिक नमूने के लिए एक वर्ष में काम किए गए दिनों की संख्या (W) और काम नहीं किए गए दिनों की संख्या (NW = 365-W) पर सार्वजनिक परिवहन (Y) पर खर्च के प्रतिगमन में, अग्रांकित परिणाम प्राप्त किए गए:

समाश्रयण 1:

$$\widehat{logY} = 2.81 + 0.91\, logW + 0.53 logNW$$

se = (1.38) (0.34) (0.14) R^2=0.97

उसी डेटा का उपयोग करके, निम्न प्रतिगमन भी प्राप्त किया गया:

समाश्रयण 2: $$\widehat{log(\frac{Y}{NW})} = -0.11 + 0.34 \log (W/NW)$$

se = (0.03) (0.15) $R^2 = 0.85$

(i) आप प्रतिगमन 1 में logW के ढलान गुणांक की व्याख्या कैसे करेंगे?

(ii) क्या आपको प्रतिगमन 1 में बहुसंकेतिकता (Multicollinearity) का संदेह है? आपको कैसे मालूम? क्या इसे प्रतिगमन 2 में हटा दिया गया है?

(iii) समाश्रयण में बहुसंरेखण (Multicollinearity) को दूर करने के लिए कौन से उपचारात्मक उपाय किए जाते हैं?

(iv) क्या आप दोनों मॉडलों के R^2 की तुलना कर सकते हैं? कारण दीजिये। (1+2+2+1)

(ख) एक रियल एस्टेट कंपनी ने उप-शहरी अचल संपत्ति की मांग पर महामारी लॉकडाउन के प्रभाव का अनुमान लगाने के लिए मासिक आवास बिक्री डेटा का उपयोग किया

$$\widehat{lnY_t} = -1.83 + 0.08D_t - 0.91lnX_t + 0.55(D_t lnX_t)$$

जहां Y = एक महीने के दौरान उप-शहरी आवास सौदों का हिस्सा,

X = उप-शहरी अचल संपत्ति के प्रति वर्ग मीटर की कीमत,

D_t=1, अगर यह लॉकडाउन का महीना है

= 0, अगर यह लॉकडाउन का महीना नहीं है

सभी पैरामीटर α= 5% पर शून्य से काफी भिन्न हैं।

(i) लॉकडाउन और नॉन-लॉकडाउन महीने के लिए रिग्रेशन फंक्शन लिखिए।

(ii) लॉकडाउन के दौरान उपनगरीय आवास के लिए मूल्य-लोच में क्या बदलाव आया?

(iii) क्या उपरोक्त समीकरण को फिर से लिखा जा सकता है यदि मूक चर का निर्धारण बदल दिया जाए:

D_t=0, अगर यह लॉकडाउन का महीना है

= 1 अगर यह लॉकडाउन का महीना नहीं है (2+3+4)

5. a) The following population regression function (PRF) was estimated, using time-series data on real fixed investment (I) and an appropriate rate of interest (r):

$$I_t = \alpha + \beta r_t + u_t$$

(i) What are the expected signs of the coefficients in this equation? Explain the reasoning.

(ii) How can you use this equation to estimate average interest elasticity of investment?

(iii) Suppose the above equation is re-estimated in log-linear version of PRF:

$$lnI_t = \alpha + \beta lnr_t + u_t$$

How would you test whether interest elasticity of investment is significant or not?

(iv) Explain clearly, how would you test a hypothesis of whether investment is interest-elastic. Write the null and alternative hypotheses. (2+2+2+2)

b) Suppose that aggregate private consumption expenditure (measured in billion rupees) in year t (C) is dependent on gross national product (GNP) (measured in billion rupees) in year t and national defense expenditure (D) (measured in billion rupees) in year t.

$$C_t = \beta_1 + \beta_2 GNP_t + \beta_3 D_t + u_t$$

(i) Suppose it is postulated that $\sigma_t^2 = \sigma^2\sqrt{(GNP_t)}$, what is the nature of problem suspected in the regression. What are the sources of such a problem?

(ii) Outline the steps of a test suggested to detect the problem.

(iii) How can regression be transformed to correct for the problem postulated in the regression? (2+2+3)

5. क) वास्तविक निश्चित निवेश (I) और उचित ब्याज दर (r) पर समय-श्रृंखला डेटा का उपयोग करके निम्नलिखित जनसंख्या प्रतिगमन फ़ंक्शन (PRF) का अनुमान लगाया गया था:

$$I_t = \alpha + \beta r_t + u_t$$

(i) इस समीकरण में गुणांकों के अपेक्षित चिह्न क्या हैं? तर्क स्पष्ट कीजिए।

(ii) निवेश की औसत ब्याज लोच का अनुमान लगाने के लिए आप इस समीकरण का उपयोग कैसे कर सकते हैं?

(iii) मान लीजिए कि उपरोक्त समीकरण को PRF के लॉग-लीनियर संस्करण में पुन: अनुमानित किया गया है:

$$lnI_t = \alpha + \beta lnr_t + u_t$$

आप कैसे जांचेंगे कि निवेश की ब्याज लोच महत्वपूर्ण है या नहीं?

(iv) स्पष्ट रूप से समझाएं कि आप इस परिकल्पना का परीक्षण कैसे करेंगे कि निवेश ब्याज-लोचदार है या नहीं। शून्य और वैकल्पिक परिकल्पनाएँ लिखिए।

(2+2+2+2)

ख) मान लीजिए कि वर्ष में कुल निजी खपत व्यय (अरब रुपये में मापा जाता है) (C) वर्ष टी में सकल राष्ट्रीय उत्पाद (GNP) (अरब रुपये में मापा जाता है) और राष्ट्रीय रक्षा व्यय (D) टी वर्ष में (अरब रुपये में मापा जाता है) पर निर्भर है।

$$C_t = \beta_1 + \beta_2 GNP_t + \beta_3 D_t + u_t$$

(i) मान लीजिए कि यह माना जाता है कि $\sigma_t^2 = \sigma^2\sqrt{(GNP_t)}$, प्रतिगमन में संदिग्ध समस्या की प्रकृति क्या है। ऐसी समस्या के स्रोत क्या हैं?

(ii) समस्या का पता लगाने के लिए सुझाए गए परीक्षण के चरणों की रूपरेखा तैयार कीजिये।

(iii) समाश्रयण में प्रतिपादित समस्या को ठीक करने के लिए समाश्रयण को किस प्रकार बदला जा सकता है? (2+2+3)

6. a) A drilling Company tests two drill bits by sinking wells to a maximum of 112 feet and recording the number of hours the procedure took. The first bit was used in 12 cases, resulting in a mean time of 27.3 hours and standard deviation 8.7 hours. Ten wells were dug with the second bit, resulting in a mean time of 31.7 hours and standard deviation 8.3 hours.

(i) Test the $H_0: \mu_1 = \mu_2$ versus $H_A: \mu_1 \neq \mu_2$ using a 10% level of significance.

(ii) What will the conclusion be if it was given that drilling times for both bits had equal variances? (4+2)

b) Consider the following estimated equation:

$$Wage_i = \beta_0 + \beta_1 IQ_i + \beta_2 D + \beta_3 (D * IQ_i) + u_t$$

where Wage is hourly wage rate and IQ is intelligent quotient of 935 individuals. D is dummy variable for gender and it takes value =1, if the individual is male, else it is zero.

	Coefficient	Std error	
constant	357.8567	84.78941	
IQ	3.728518	0.849174	R-squared= 0.4583
D_i	149.1039	139.6018	
D_i*IQ_i	3.412121	1.350971	

(i) Obtain the estimated equation separately for males and females.
(ii) Keeping IQ constant, do you think Males receive statistically significantly higher hourly wage rate than females.
(iii) Test whether the marginal effect of IQ is affected by individual's gender.
(iv) Calculate adjusted R^2.
(v) How will the regression change if the dummy variable D takes value = 1, if the individual is female, else it is zero. (2+2+2+2+1)

6. क) एक ड्रिलिंग कंपनी कुओं को अधिकतम 112 फीट तक डुबो कर दो ड्रिल बिट्स का परीक्षण करती है और प्रक्रिया में लगने वाले घंटों की संख्या को रिकॉर्ड करती है। पहली बिट का उपयोग 12 मामलों में किया गया था, जिसके परिणामस्वरूप औसत समय 27.3 घंटे और मानक विचलन 8.7 घंटे था। दस कुओं को दूसरे बिट के साथ खोदा गया, जिसके परिणामस्वरूप औसत समय 31.7 घंटे और मानक विचलन 8.3 घंटे रहा।

(i) $H_0: \mu_1 = \mu_2$ बनाम $H_A: \mu_1 \neq \mu_2$ का 10% स्तर के महत्व का उपयोग करके परीक्षण कीजिये।

(i) निष्कर्ष क्या होगा यदि यह दिया गया था कि दोनों बिट्स के लिए ड्रिलिंग समय में समान भिन्नताएं थीं? (4+2)

(ख) निम्नलिखित अनुमानित समीकरण पर विचार कीजिये:

$$Wage_i = \beta_0 + \beta_1 IQ_i + \beta_2 D + \beta_3 (D * IQ_i) + u_i$$

जहां वेतन प्रति घंटा मजदूरी दर है और आईक्यू 935 व्यक्तियों का बुद्धिमान भागफल है। डी लिंग के लिए डमी चर है और यह मान = 1 लेता है, यदि व्यक्ति पुरुष है, अन्यथा य: शून्य है।

	Coefficient	Std error	R-squared= 0.4583

constant	357.8567	84.78941	
IQ	3.728518	0.849174	
D_i	149.1039	139.6018	
D_i*IQ$_i$	3.412121	1.350971	

(i) पुरुषों और महिलाओं के लिए अलग-अलग अनुमानित समीकरण प्राप्त कीजिये।

(ii) IQ को स्थिर रखते हुए, क्या आपको लगता है कि पुरुषों को महिलाओं की तुलना में सांख्यिकीय रूप से काफी अधिक प्रति घंटा मजदूरी दर प्राप्त होती है?

(iii) परीक्षण कीजिये कि क्या IQ का सीमांत प्रभाव व्यक्ति के लिंग से प्रभावित होता है?

(iv) समायोजित R^2 की गणना कीजिये।

(v) प्रतिगमन कैसे बदलेगा, यदि डम्मी चर D मान = 1 लेता है, यदि व्यक्ति महिला है, अन्यथा यह शून्य है। (2+2+2+2+1)

7. (a) The In order to test for structural stability of saving function in India for a pre-reform and post-reform period, we have data of savings and GDP from 1980-81 to 2001-2002.

(i) Considering the year 1980-81 to 1990-91, as the pre-reform period and 1991-1992 to 2001-2002, the post-reform, explain the steps involved in conducting the Chow test for structural stability. Cleary state the null and alternative hypotheses.

(ii) Is there an alternative way to test for structural stability? Explain the steps involved in it.

(iii) Which approach is considered to be better and why? (3+3+2)

(b) Consider the results of the following equation in table given below:

$$C_t = \alpha + \beta_1 D_t + \beta_2 P_t + \beta_3 C_{t-1} + u_t$$

(Data on all variables is available from Q1, 1985 to Q2, 1994)

Variable	Coefficient	Std error	
C (consumption)	-0.488	0.575	D-W statistics=1.727
D (Disposal Income)	0.411	0.170	R-squared= .758
P(Price)	-0.12	0.086	
C (-1)	0.818	0.104	

(i) Apply Durbin's h-test of autocorrelation to test the presence of serial correlation at 5% level of significance. Clearly state the null and alternative test.

(ii) Consider/Reason out the applicability of Durbin-Watson test in this case. (5+2)

7. (क) सुधार पूर्व और सुधार के बाद की अवधि के लिए भारत में बचत समारोह की संरचनात्मक स्थिरता के परीक्षण के लिए, हमारे पास 1980-81 से 2001-2002 तक बचत और सकल घरेलू उत्पाद का डेटा है।

(i) वर्ष 1980-81 से 1990-91 को पूर्व-सुधार अवधि और 1991-1992 से 2001-2002 तक, सुधार के बाद की अवधि को ध्यान में रखते हुए, संरचनात्मक स्थिरता के लिए चाउ परीक्षण आयोजित करने में शामिल चरणों की व्याख्या कीजिये। स्पष्ट रूप से अशक्त और वैकल्पिक परिकल्पनाओं का वर्णन कीजिये।

(ii) क्या संरचनात्मक स्थिरता के परीक्षण का कोई वैकल्पिक तरीका है? समझाइये

(iii) कौन सा दृष्टिकोण बेहतर माना जाता है और क्यों? (3+3+2)

(ख) नीचे दी गई तालिका में निम्नलिखित समीकरण के परिणामों पर विचार कीजिये:

$$C_t = \alpha + \beta_1 D_t + \beta_2 P_t + \beta_3 C_{t-1} + u_t$$

(सभी चरों पर डेटा Q1, 1985 से Q2, 1994 तक उपलब्ध है)

Variable	Coefficient	Std error	
C (consumption)	-0.488	0.575	D-W statistics=1.727
D (Disposal Income)	0.411	0.170	R-squared= .758
P(Price)	-0.12	0.086	
C (-1)	0.818	0.104	

(i) 5% के महत्व के स्तर पर सीरियल सहसंबंध की उपस्थिति का परीक्षण करने के लिए ऑटोसहसंबंध के डर्बिन-एच परीक्षण को लागू कीजिये। शून्य और वैकल्पिक परीक्षण स्पष्ट रूप से बताएं।

(ii) इस मामले में डर्बिन-वाटसन परीक्षण की प्रयोज्यता पर विचार कीजिये /कारण कीजिये।

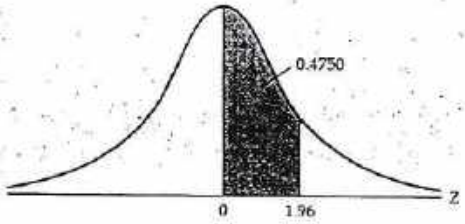
(5+2)

TABLE E-1*a* AREAS UNDER THE STANDARDIZED NORMAL DISTRIBUTION

Example

$\Pr(0 \le Z \le 1.96) = 0.4750$

$\Pr(Z \ge 1.96) = 0.5 - 0.4750 = 0.025$

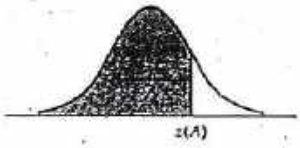


Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4454	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

Note: This table gives the area in the right-hand tail of the distribution (i.e., $Z \ge 0$). But since the normal distribution is symmetrical about $Z = 0$, the area in the left-hand tail is the same as the area in the corresponding right-hand tail. For example, $P(-1.96 \le Z \le 0) = 0.4750$. Therefore, $P(-1.96 \le Z \le 1.96) = 2(0.4750) = 0.95$.

TABLE E-1*b* CUMULATIVE PROBABILITIES OF THE STANDARD NORMAL DISTRIBUTION

Entry is area A under the standard normal curve from $-\infty$ to $Z(A)$



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Selected Percentiles

Cumulative probability A:	.90	.95	.975	.98	.99	.995	.999
$Z(A)$:	1.282	1.645	1.960	2.054	2.326	2.576	3.090

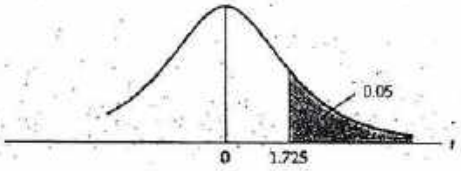
TABLE E-2 PERCENTAGE POINTS OF THE *t* DISTRIBUTION

Example

$\Pr(t > 2.086) = 0.025$

$\Pr(t > 1.725) = 0.05$ for d.f. = 20

$\Pr(|t| > 1.725) = 0.10$



Pr / d.f.	0.25 0.50	0.10 0.20	0.05 0.10	0.025 0.05	0.01 0.02	0.005 0.010	0.001 0.002
1	1.000	3.078	6.314	12.706	31.821	63.657	318.31
2	0.816	1.886	2.920	4.303	6.965	9.925	22.327
3	0.765	1.638	2.353	3.182	4.541	5.841	10.214
4	0.741	1.533	2.132	2.776	3.747	4.604	7.173
5	0.727	1.476	2.015	2.571	3.365	4.032	5.893
6	0.718	1.440	1.943	2.447	3.143	3.707	5.208
7	0.711	1.415	1.895	2.365	2.998	3.499	4.785
8	0.706	1.397	1.860	2.306	2.896	3.355	4.501
9	0.703	1.383	1.833	2.262	2.821	3.250	4.297
10	0.700	1.372	1.812	2.228	2.764	3.169	4.144
11	0.697	1.363	1.796	2.201	2.718	3.106	4.025
12	0.695	1.356	1.782	2.179	2.681	3.055	3.930
13	0.694	1.350	1.771	2.160	2.650	3.012	3.852
14	0.692	1.345	1.761	2.145	2.624	2.977	3.787
15	0.691	1.341	1.753	2.131	2.602	2.947	3.733
16	0.690	1.337	1.746	2.120	2.583	2.921	3.686
17	0.689	1.333	1.740	2.110	2.567	2.898	3.646
18	0.688	1.330	1.734	2.101	2.552	2.878	3.610
19	0.688	1.328	1.729	2.093	2.539	2.861	3.579
20	0.687	1.325	1.725	2.086	2.528	2.845	3.552
21	0.686	1.323	1.721	2.080	2.518	2.831	3.527
22	0.686	1.321	1.717	2.074	2.508	2.819	3.505
23	0.685	1.319	1.714	2.069	2.500	2.807	3.485
24	0.685	1.318	1.711	2.064	2.492	2.797	3.467
25	0.684	1.316	1.708	2.060	2.485	2.787	3.450
26	0.684	1.315	1.706	2.056	2.479	2.779	3.435
27	0.684	1.314	1.703	2.052	2.473	2.771	3.421
28	0.683	1.313	1.701	2.048	2.467	2.763	3.408
29	0.683	1.311	1.699	2.045	2.462	2.756	3.396
30	0.683	1.310	1.697	2.042	2.457	2.750	3.385
40	0.681	1.303	1.684	2.021	2.423	2.704	3.307
60	0.679	1.296	1.671	2.000	2.390	2.660	3.232
120	0.677	1.289	1.658	1.980	2.358	2.617	3.160
∞	0.674	1.282	1.645	1.960	2.326	2.576	3.090

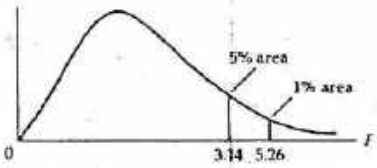
Note: The smaller probability shown at the head of each column is the area in one tail; the larger probability is the area in both tails.

Source: From E. S. Pearson and H. O. Hartley, eds., *Biometrika Tables for Statisticians*, vol. 1, 3rd ed., Table 12, Cambridge University Press, New York, 1966. Reproduced by permission of the editors and trustees of *Biometrika*.

TABLE E-3 UPPER PERCENTAGE POINTS OF THE F DISTRIBUTION

Example

$\Pr(F > 1.59) = 0.25$
$\Pr(F > 2.42) = 0.10$ for d.f. $N_1 = 10$
$\Pr(F > 3.14) = 0.05$ and $N_2 = 9$
$\Pr(F > 5.26) = 0.01$



d.f. for denominator N_2		d.f. for numerator N_1											
	Pr	1	2	3	4	5	6	7	8	9	10	11	12
	.25	5.83	7.50	8.20	8.58	8.82	8.98	9.10	9.19	9.26	9.32	9.36	9.41
1	.10	39.90	49.50	53.60	55.80	57.20	58.20	58.90	59.40	59.90	60.20	60.50	60.70
	.05	161.00	200.00	216.00	225.00	230.00	234.00	237.00	239.00	241.00	242.00	243.00	244.00
	.25	2.57	3.00	3.15	3.23	3.28	3.31	3.34	3.35	3.37	3.38	3.39	3.39
2	.10	8.53	9.00	9.16	9.24	9.29	9.33	9.35	9.37	9.38	9.39	9.40	9.41
	.05	18.50	19.00	19.20	19.20	19.30	19.30	19.40	19.40	19.40	19.40	19.40	19.40
	.01	98.50	99.00	99.20	99.20	99.30	99.30	99.40	99.40	99.40	99.40	99.40	99.40
	.25	2.02	2.28	2.36	2.39	2.41	2.42	2.43	2.44	2.44	2.44	2.45	2.45
3	.10	5.54	5.46	5.39	5.34	5.31	5.28	5.27	5.25	5.24	5.23	5.22	5.22
	.05	10.10	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.76	8.74
	.01	34.10	30.80	29.50	28.70	28.20	27.90	27.70	27.50	27.30	27.20	27.10	27.10
	.25	1.81	2.00	2.05	2.06	2.07	2.08	2.08	2.08	2.08	2.08	2.08	2.08
4	.10	4.54	4.32	4.19	4.11	4.05	4.01	3.98	3.95	3.94	3.92	3.91	3.90
	.05	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.94	5.91
	.01	21.20	18.00	16.70	16.00	15.50	15.20	15.00	14.80	14.70	14.50	14.40	14.40
	.25	1.69	1.85	1.88	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89
5	.10	4.06	3.78	3.62	3.52	3.45	3.40	3.37	3.34	3.32	3.30	3.28	3.27
	.05	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.71	4.68
	.01	16.30	13.30	12.10	11.40	11.00	10.70	10.50	10.30	10.20	10.10	9.96	9.89
	.25	1.62	1.76	1.78	1.79	1.79	1.78	1.78	1.78	1.77	1.77	1.77	1.77
6	.10	3.78	3.46	3.29	3.18	3.11	3.05	3.01	2.98	2.96	2.94	2.92	2.90
	.05	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.03	4.00
	.01	13.70	10.90	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.79	7.72
	.25	1.57	1.70	1.72	1.72	1.71	1.71	1.70	1.70	1.69	1.69	1.69	1.68
7	.10	3.59	3.26	3.07	2.96	2.88	2.83	2.78	2.75	2.72	2.70	2.68	2.67
	.05	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.60	3.57
	.01	12.20	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.54	6.47
	.25	1.54	1.66	1.67	1.66	1.66	1.65	1.64	1.64	1.63	1.63	1.63	1.62
8	.10	3.46	3.11	2.92	2.81	2.73	2.67	2.62	2.59	2.56	2.54	2.52	2.50
	.05	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.31	3.28
	.01	11.30	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.73	5.67
	.25	1.51	1.62	1.63	1.63	1.62	1.61	1.60	1.60	1.59	1.59	1.58	1.58
9	.10	3.36	3.01	2.81	2.69	2.61	2.55	2.51	2.47	2.44	2.42	2.40	2.38
	.05	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.10	3.07
	.01	10.60	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.18	5.11

Source: From E. S. Pearson and H. O. Hartley, eds., *Biometrika Tables for Statisticians*, vol. 1, 3rd ed., Table 18, Cambridge University Press, New York, 1966. Reproduced by permission of the editors and trustees of *Biometrika*.

d.f. for numerator N_1													d.f. for denominator N_2
15	20	24	30	40	50	60	100	120	200	500	∞	Pr	
9.49	9.58	9.63	9.67	9.71	9.74	9.76	9.78	9.80	9.82	9.84	9.85	.25	
61.20	61.70	62.00	62.30	62.50	62.70	62.80	63.00	63.10	63.20	63.30	63.30	.10	1
246.00	248.00	249.00	250.00	251.00	252.00	252.00	253.00	253.00	254.00	254.00	254.00	.05	
3.41	3.43	3.43	3.44	3.45	3.45	3.46	3.47	3.47	3.48	3.48	3.48	.25	
9.42	9.44	9.45	9.46	9.47	9.47	9.47	9.48	9.48	9.49	9.49	9.49	.10	2
19.40	19.40	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50	19.50	.05	
99.40	99.40	99.50	99.50	99.50	99.50	99.50	99.50	99.50	99.50	99.50	99.50	.01	
2.46	2.46	2.46	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	.25	
5.20	5.18	5.18	5.17	5.16	5.15	5.15	5.14	5.14	5.14	5.14	5.13	.10	3
8.70	8.66	8.64	8.62	8.59	8.58	8.57	8.55	8.55	8.54	8.53	8.53	.05	
26.90	26.70	26.60	26.50	26.40	26.40	26.30	26.20	26.20	26.20	26.10	26.10	.01	
2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	.25	
3.87	3.84	3.83	3.82	3.80	3.80	3.79	3.78	3.78	3.77	3.76	3.76	.10	4
5.86	5.80	5.77	5.75	5.72	5.70	5.69	5.66	5.66	5.65	5.64	5.63	.05	
14.20	14.00	13.90	13.80	13.70	13.70	13.70	13.60	13.60	13.50	13.50	13.50	.01	
1.89	1.88	1.88	1.88	1.88	1.88	1.87	1.87	1.87	1.87	1.87	1.87	.25	
3.24	3.21	3.19	3.17	3.16	3.15	3.14	3.13	3.12	3.12	3.11	3.10	.10	5
4.62	4.56	4.53	4.50	4.46	4.44	4.43	4.41	4.40	4.39	4.37	4.36	.05	
9.72	9.55	9.47	9.38	9.29	9.24	9.20	9.13	9.11	9.08	9.04	9.02	.01	
1.76	1.76	1.75	1.75	1.75	1.75	1.74	1.74	1.74	1.74	1.74	1.74	.25	
2.87	2.84	2.82	2.80	2.78	2.77	2.76	2.75	2.74	2.73	2.73	2.72	.10	6
3.94	3.87	3.84	3.81	3.77	3.75	3.74	3.71	3.70	3.69	3.68	3.67	.05	
7.56	7.40	7.31	7.23	7.14	7.09	7.06	6.99	6.97	6.93	6.90	6.88	.01	
1.68	1.67	1.67	1.66	1.66	1.66	1.65	1.65	1.65	1.65	1.65	1.65	.25	
2.63	2.59	2.58	2.56	2.54	2.52	2.51	2.50	2.49	2.48	2.48	2.47	.10	7
3.51	3.44	3.41	3.38	3.34	3.32	3.30	3.27	3.27	3.25	3.24	3.23	.05	
6.31	6.16	6.07	5.99	5.91	5.86	5.82	5.75	5.74	5.70	5.67	5.65	.01	
1.62	1.61	1.60	1.60	1.59	1.59	1.59	1.58	1.58	1.58	1.58	1.58	.25	
2.46	2.42	2.40	2.38	2.36	2.35	2.34	2.32	2.32	2.31	2.30	2.29	.10	8
3.22	3.15	3.12	3.08	3.04	2.02	3.01	2.97	2.97	2.95	2.94	2.93	.05	
5.52	5.36	5.28	5.20	5.12	5.07	5.03	4.96	4.95	4.91	4.88	4.86	.01	
1.57	1.56	1.56	1.55	1.55	1.54	1.54	1.53	1.53	1.53	1.53	1.53	.25	
2.34	2.30	2.28	2.25	2.23	2.22	2.21	2.19	2.18	2.17	2.17	2.16	.10	9
3.01	2.94	2.90	2.86	2.83	2.80	2.79	2.76	2.75	2.73	2.72	2.71	.05	
4.96	4.81	4.73	4.65	4.57	4.52	4.48	4.42	4.40	4.36	4.33	4.31	.01	

TABLE E-3 UPPER PERCENTAGE POINTS OF THE F DISTRIBUTION (CONTINUED)

d.f. for denominator N_2		d.f. for numerator N_1											
	Pr	1	2	3	4	5	6	7	8	9	10	11	12
10	.25	1.49	1.60	1.60	1.59	1.59	1.58	1.57	1.56	1.56	1.55	1.55	1.54
	.10	3.29	2.92	2.73	2.61	2.52	2.46	2.41	2.38	2.35	2.32	2.30	2.28
	.05	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.94	2.91
	.01	10.00	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.77	4.71
11	.25	1.47	1.58	1.58	1.57	1.56	1.55	1.54	1.53	1.53	1.52	1.52	1.51
	.10	3.23	2.86	2.66	2.54	2.45	2.39	2.34	2.30	2.27	2.25	2.23	2.21
	.05	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.82	2.79
	.01	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.46	4.40
12	.25	1.46	1.56	1.56	1.55	1.54	1.53	1.52	1.51	1.51	1.50	1.50	1.49
	.10	3.18	2.81	2.61	2.48	2.39	2.33	2.28	2.24	2.21	2.19	2.17	2.15
	.05	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.72	2.69
	.01	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.22	4.16
13	.25	1.45	1.55	1.55	1.53	1.52	1.51	1.50	1.49	1.49	1.48	1.47	1.47
	.10	3.14	2.76	2.56	2.43	2.35	2.28	2.23	2.20	2.16	2.14	2.12	2.10
	.05	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.63	2.60
	.01	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	4.02	3.96
14	.25	1.44	1.53	1.53	1.52	1.51	1.50	1.49	1.48	1.47	1.46	1.46	1.45
	.10	3.10	2.73	2.52	2.39	2.31	2.24	2.19	2.15	2.12	2.10	2.08	2.05
	.05	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.57	2.53
	.01	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.86	3.80
15	.25	1.43	1.52	1.52	1.51	1.49	1.48	1.47	1.48	1.46	1.45	1.44	1.44
	.10	3.07	2.70	2.49	2.36	2.27	2.21	2.16	2.12	2.09	2.06	2.04	2.02
	.05	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.51	2.48
	.01	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.73	3.67
16	.25	1.42	1.51	1.51	1.50	1.48	1.47	1.46	1.45	1.44	1.44	1.44	1.43
	.10	3.05	2.67	2.46	2.33	2.24	2.18	2.13	2.09	2.06	2.03	2.01	1.99
	.05	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.46	2.42
	.01	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.62	3.55
17	.25	1.42	1.51	1.50	1.49	1.47	1.46	1.45	1.44	1.43	1.43	1.42	1.41
	.10	3.03	2.64	2.44	2.31	2.22	2.15	2.10	2.06	2.03	2.00	1.98	1.96
	.05	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.41	2.38
	.01	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.52	3.46
18	.25	1.41	1.50	1.49	1.48	1.46	1.45	1.44	1.43	1.42	1.42	1.41	1.40
	.10	3.01	2.62	2.42	2.29	2.20	2.13	2.08	2.04	2.00	1.98	1.96	1.93
	.05	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.37	2.34
	.01	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.43	3.37
19	.25	1.41	1.49	1.49	1.47	1.46	1.44	1.43	1.42	1.41	1.41	1.40	1.40
	.10	2.99	2.61	2.40	2.27	2.18	2.11	2.06	2.02	1.98	1.96	1.94	1.91
	.05	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.34	2.31
	.01	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.36	3.30
20	.25	1.40	1.49	1.48	1.46	1.45	1.44	1.43	1.42	1.41	1.40	1.39	1.39
	.10	2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96	1.94	1.92	1.89
	.05	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.31	2.28
	.01	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.29	3.23

d.f. for numerator N_1													d.f. for denominator N_2
15	20	24	30	40	50	60	100	120	200	500	∞	Pr	
1.53	1.52	1.52	1.51	1.51	1.50	1.50	1.49	1.49	1.49	1.48	1.48	.25	
2.24	2.20	2.18	2.16	2.13	2.12	2.11	2.09	2.08	2.07	2.06	2.06	.10	10
2.85	2.77	2.74	2.70	2.66	2.64	2.62	2.59	2.58	2.56	2.55	2.54	.05	
4.56	4.41	4.33	4.25	4.17	4.12	4.08	4.01	4.00	3.96	3.93	3.91	.01	
1.50	1.49	1.49	1.48	1.47	1.47	1.47	1.46	1.46	1.46	1.45	1.45	.25	
2.17	2.12	2.10	2.08	2.05	2.04	2.03	2.00	2.00	1.99	1.98	1.97	.10	11
2.72	2.65	2.61	2.57	2.53	2.51	2.49	2.46	2.45	2.43	2.42	2.40	.05	
4.25	4.10	4.02	3.94	3.86	3.81	3.78	3.71	3.69	3.66	3.62	3.60	.01	
1.48	1.47	1.46	1.45	1.45	1.44	1.44	1.43	1.43	1.43	1.42	1.42	.25	
2.10	2.06	2.04	2.01	1.99	1.97	1.96	1.94	1.93	1.92	1.91	1.90	.10	12
2.62	2.54	2.51	2.47	2.43	2.40	2.38	2.35	2.34	2.32	2.31	2.30	.05	
4.01	3.86	3.78	3.70	3.62	3.57	3.54	3.47	3.45	3.41	3.38	3.36	.01	
1.46	1.45	1.44	1.43	1.42	1.42	1.42	1.41	1.41	1.40	1.40	1.40	.25	
2.05	2.01	1.98	1.96	1.93	1.92	1.90	1.88	1.88	1.86	1.85	1.85	.10	13
2.53	2.46	2.42	2.38	2.34	2.31	2.30	2.26	2.25	2.23	2.22	2.21	.05	
3.82	3.66	3.59	3.51	3.43	3.38	3.34	3.27	3.25	3.22	3.19	3.17	.01	
1.44	1.43	1.42	1.41	1.41	1.40	1.40	1.39	1.39	1.39	1.38	1.38	.25	
2.01	1.96	1.94	1.91	1.89	1.87	1.86	1.83	1.83	1.82	1.80	1.80	.10	14
2.46	2.39	2.35	2.31	2.27	2.24	2.22	2.19	2.18	2.16	2.14	2.13	.05	
3.66	3.51	3.43	3.35	3.27	3.22	3.18	3.11	3.09	3.06	3.03	3.00	.01	
1.43	1.41	1.41	1.40	1.39	1.39	1.38	1.38	1.37	1.37	1.36	1.36	.25	
1.97	1.92	1.90	1.87	1.85	1.83	1.82	1.79	1.79	1.77	1.76	1.76	.10	15
2.40	2.33	2.29	2.25	2.20	2.18	2.16	2.12	2.11	2.10	2.08	2.07	.05	
3.52	3.37	3.29	3.21	3.13	3.08	3.05	2.98	2.96	2.92	2.89	2.87	.01	
1.41	1.40	1.39	1.38	1.37	1.37	1.36	1.36	1.35	1.35	1.34	1.34	.25	
1.94	1.89	1.87	1.84	1.81	1.79	1.78	1.76	1.75	1.74	1.73	1.72	.10	16
2.35	2.28	2.24	2.19	2.15	2.12	2.11	2.07	2.06	2.04	2.02	2.01	.05	
3.41	3.26	3.18	3.10	3.02	2.97	2.93	2.86	2.84	2.81	2.78	2.75	.01	
1.40	1.39	1.38	1.37	1.36	1.35	1.35	1.34	1.34	1.34	1.33	1.33	.25	
1.91	1.86	1.84	1.81	1.78	1.76	1.75	1.73	1.72	1.71	1.69	1.69	.10	17
2.31	2.23	2.19	2.15	2.10	2.08	2.06	2.02	2.01	1.99	1.97	1.96	.05	
3.31	3.16	3.08	3.00	2.92	2.87	2.83	2.76	2.75	2.71	2.68	2.65	.01	
1.39	1.38	1.37	1.36	1.35	1.34	1.34	1.33	1.33	1.32	1.32	1.32	.25	
1.89	1.84	1.81	1.78	1.75	1.74	1.72	1.70	1.69	1.68	1.67	1.66	.10	18
2.27	2.19	2.15	2.11	2.06	2.04	2.02	1.98	1.97	1.95	1.93	1.92	.05	
3.23	3.08	3.00	2.92	2.84	2.78	2.75	2.68	2.66	2.62	2.59	2.57	.01	
1.38	1.37	1.36	1.35	1.34	1.33	1.33	1.32	1.32	1.31	1.31	1.30	.25	
1.86	1.81	1.79	1.76	1.73	1.71	1.70	1.67	1.67	1.65	1.64	1.63	.10	19
2.23	2.16	2.11	2.07	2.03	2.00	1.98	1.94	1.93	1.91	1.89	1.88	.05	
3.15	3.00	2.92	2.84	2.76	2.71	2.67	2.60	2.58	2.55	2.51	2.49	.01	
1.37	1.36	1.35	1.34	1.33	1.33	1.32	1.31	1.31	1.30	1.30	1.29	.25	
1.84	1.79	1.77	1.74	1.71	1.69	1.68	1.65	1.64	1.63	1.62	1.61	.10	20
2.20	2.12	2.08	2.04	1.99	1.97	1.95	1.91	1.90	1.88	1.86	1.84	.05	
3.09	2.94	2.86	2.78	2.69	2.64	2.61	2.54	2.52	2.48	2.44	2.42	.01	

TABLE E-3 UPPER PERCENTAGE POINTS OF THE F DISTRIBUTION (CONTINUED)

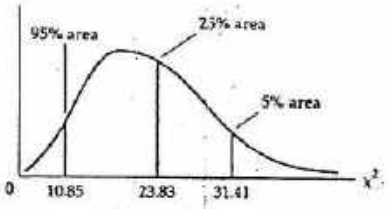
d.f. for denominator N_2	Pr	d.f. for numerator N_1											
		1	2	3	4	5	6	7	8	9	10	11	12
	.25	1.40	1.48	1.47	1.45	1.44	1.42	1.41	1.40	1.39	1.39	1.38	1.37
22	.10	2.95	2.56	2.35	2.22	2.13	2.06	2.01	1.97	1.93	1.90	1.88	1.86
	.05	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.26	2.23
	.01	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.18	3.12
	.25	1.39	1.47	1.46	1.44	1.43	1.41	1.40	1.39	1.38	1.38	1.37	1.36
24	.10	2.93	2.54	2.33	2.19	2.10	2.04	1.98	1.94	1.91	1.88	1.85	1.83
	.05	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.21	2.18
	.01	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.09	3.03
	.25	1.38	1.46	1.45	1.44	1.42	1.41	1.39	1.38	1.37	1.37	1.36	1.35
26	.10	2.91	2.52	2.31	2.17	2.08	2.01	1.96	1.92	1.88	1.86	1.84	1.81
	.05	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.18	2.15
	.01	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09	3.02	2.96
	.25	1.38	1.46	1.45	1.43	1.41	1.40	1.39	1.38	1.37	1.36	1.35	1.34
28	.10	2.89	2.50	2.29	2.16	2.06	2.00	1.94	1.90	1.87	1.84	1.81	1.79
	.05	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.15	2.12
	.01	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03	2.96	2.90
	.25	1.38	1.45	1.44	1.42	1.41	1.39	1.38	1.37	1.36	1.35	1.35	1.34
30	.10	2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85	1.82	1.79	1.77
	.05	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.13	2.09
	.01	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.91	2.84
	.25	1.36	1.44	1.42	1.40	1.39	1.37	1.36	1.35	1.34	1.33	1.32	1.31
40	.10	2.84	2.44	2.23	2.09	2.00	1.93	1.87	1.83	1.79	1.76	1.73	1.71
	.05	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.04	2.00
	.01	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.73	2.66
	.25	1.35	1.42	1.41	1.38	1.37	1.35	1.33	1.32	1.31	1.30	1.29	1.29
60	.10	2.79	2.39	2.18	2.04	1.95	1.87	1.82	1.77	1.74	1.71	1.68	1.66
	.05	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.95	1.92
	.01	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.56	2.50
	.25	1.34	1.40	1.39	1.37	1.35	1.33	1.31	1.30	1.29	1.28	1.27	1.26
120	.10	2.75	2.35	2.13	1.99	1.90	1.82	1.77	1.72	1.68	1.65	1.62	1.60
	.05	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	1.91	1.87	1.83
	.01	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.40	2.34
	.25	1.33	1.39	1.38	1.36	1.34	1.32	1.31	1.29	1.28	1.27	1.26	1.25
200	.10	2.73	2.33	2.11	1.97	1.88	1.80	1.75	1.70	1.66	1.63	1.60	1.57
	.05	3.89	3.04	2.65	2.42	2.26	2.14	2.06	1.98	1.93	1.88	1.84	1.80
	.01	6.76	4.71	3.88	3.41	3.11	2.89	2.73	2.60	2.50	2.41	2.34	2.27
	.25	1.32	1.39	1.37	1.35	1.33	1.31	1.29	1.28	1.27	1.25	1.24	1.24
∞	.10	2.71	2.30	2.08	1.94	1.85	1.77	1.72	1.67	1.63	1.60	1.57	1.55
	.05	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.79	1.75
	.01	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.25	2.18

d.f. for numerator N_1													d.f. for denominator N_2
15	20	24	30	40	50	60	100	120	200	500	∞	Pr	
1.36	1.34	1.33	1.32	1.31	1.31	1.30	1.30	1.30	1.29	1.29	1.28	.25	
1.81	1.76	1.73	1.70	1.67	1.65	1.64	1.61	1.60	1.59	1.58	1.57	.10	22
2.15	2.07	2.03	1.98	1.94	1.91	1.89	1.85	1.84	1.82	1.80	1.78	.05	
2.98	2.83	2.75	2.67	2.58	2.53	2.50	2.42	2.40	2.36	2.33	2.31	.01	
1.35	1.33	1.32	1.31	1.30	1.29	1.29	1.28	1.28	1.27	1.27	1.26	.25	
1.78	1.73	1.70	1.67	1.64	1.62	1.61	1.58	1.57	1.56	1.54	1.53	.10	24
2.11	2.03	1.98	1.94	1.89	1.86	1.84	1.80	1.79	1.77	1.75	1.73	.05	
2.89	2.74	2.66	2.58	2.49	2.44	2.40	2.33	2.31	2.27	2.24	2.21	.01	
1.34	1.32	1.31	1.30	1.29	1.28	1.28	1.26	1.26	1.26	1.25	1.25	.25	
1.76	1.71	1.68	1.65	1.61	1.59	1.58	1.55	1.54	1.53	1.51	1.50	.10	26
2.07	1.99	1.95	1.90	1.85	1.82	1.80	1.76	1.75	1.73	1.71	1.69	.05	
2.81	2.66	2.58	2.50	2.42	2.36	2.33	2.25	2.23	2.19	2.16	2.13	.01	
1.33	1.31	1.30	1.29	1.28	1.27	1.27	1.26	1.25	1.25	1.24	1.24	.25	
1.74	1.69	1.66	1.63	1.59	1.57	1.56	1.53	1.52	1.50	1.49	1.48	.10	28
2.04	1.96	1.91	1.87	1.82	1.79	1.77	1.73	1.71	1.69	1.67	1.65	.05	
2.75	2.60	2.52	2.44	2.35	2.30	2.26	2.19	2.17	2.13	2.09	2.06	.01	
1.32	1.30	1.29	1.28	1.27	1.26	1.26	1.25	1.24	1.24	1.23	1.23	.25	
1.72	1.67	1.64	1.61	1.57	1.55	1.54	1.51	1.50	1.48	1.47	1.46	.10	30
2.01	1.93	1.89	1.84	1.79	1.76	1.74	1.70	1.68	1.66	1.64	1.62	.05	
2.70	2.55	2.47	2.39	2.30	2.25	2.21	2.13	2.11	2.07	2.03	2.01	.01	
1.30	1.28	1.26	1.25	1.24	1.23	1.22	1.21	1.21	1.20	1.19	1.19	.25	
1.66	1.61	1.57	1.54	1.51	1.48	1.47	1.43	1.42	1.41	1.39	1.38	.10	40
1.92	1.84	1.79	1.74	1.69	1.66	1.64	1.59	1.58	1.55	1.53	1.51	.05	
2.52	2.37	2.29	2.20	2.11	2.06	2.02	1.94	1.92	1.87	1.83	1.80	.01	
1.27	1.25	1.24	1.22	1.21	1.20	1.19	1.17	1.17	1.16	1.15	1.15	.25	
1.60	1.54	1.51	1.48	1.44	1.41	1.40	1.36	1.35	1.33	1.31	1.29	.10	60
1.84	1.75	1.70	1.65	1.59	1.56	1.53	1.48	1.47	1.44	1.41	1.39	.05	
2.35	2.20	2.12	2.03	1.94	1.88	1.84	1.75	1.73	1.68	1.63	1.60	.01	
1.24	1.22	1.21	1.19	1.18	1.17	1.16	1.14	1.13	1.12	1.11	1.10	.25	
1.55	1.48	1.45	1.41	1.37	1.34	1.32	1.27	1.26	1.24	1.21	1.19	.10	120
1.75	1.66	1.61	1.55	1.50	1.46	1.43	1.37	1.35	1.32	1.28	1.25	.05	
2.19	2.03	1.95	1.86	1.76	1.70	1.66	1.56	1.53	1.48	1.42	1.38	.01	
1.23	1.21	1.20	1.18	1.16	1.14	1.12	1.11	1.10	1.09	1.08	1.06	.25	
1.52	1.46	1.42	1.38	1.34	1.31	1.28	1.24	1.22	1.20	1.17	1.14	.10	200
1.72	1.62	1.57	1.52	1.46	1.41	1.39	1.32	1.29	1.26	1.22	1.19	.05	
2.13	1.97	1.89	1.79	1.69	1.63	1.58	1.48	1.44	1.39	1.33	1.28	.01	
1.22	1.19	1.18	1.16	1.14	1.13	1.12	1.09	1.08	1.07	1.04	1.00	.25	
1.49	1.42	1.38	1.34	1.30	1.26	1.24	1.18	1.17	1.13	1.08	1.00	.10	∞
1.67	1.57	1.52	1.46	1.39	1.35	1.32	1.24	1.22	1.17	1.11	1.00	.05	
2.04	1.88	1.79	1.70	1.59	1.52	1.47	1.36	1.32	1.25	1.15	1.00	.01	

TABLE E-4 UPPER PERCENTAGE POINTS OF THE χ^2 DISTRIBUTION

Example

$Pr(\chi^2 > 10.85) = 0.95$
$Pr(\chi^2 > 23.83) = 0.25$ for d.f. = 20
$Pr(\chi^2 > 31.41) = 0.05$



Degrees of Freedom \ Pr	.995	.990	.975	.950	.900
1	392704×10^{-10}	157088×10^{-9}	982069×10^{-9}	393214×10^{-8}	.0158
2	.0100	.0201	.0506	.1026	.2107
3	.0717	.1148	.2158	.3518	.5844
4	.2070	.2971	.4844	.7107	1.0636
5	.4117	.5543	.8312	1.1455	1.6103
6	.6757	.8721	1.2373	1.6354	2.2041
7	.9893	1.2390	1.6899	2.1674	2.8331
8	1.3444	1.6465	2.1797	2.7326	3.4895
9	1.7349	2.0879	2.7004	3.3251	4.1682
10	2.1559	2.5582	3.2470	3.9403	4.8652
11	2.6032	3.0535	3.8158	4.5748	5.5778
12	3.0738	3.5706	4.4038	5.2260	6.3038
13	3.5650	4.1069	5.0087	5.8919	7.0415
14	4.0747	4.6604	5.6287	6.5706	7.7895
15	4.6009	5.2294	6.2621	7.2609	8.5468
16	5.1422	5.8122	6.9077	7.9616	9.3122
17	5.6972	6.4078	7.5642	8.6718	10.0852
18	6.2648	7.0149	8.2308	9.3905	10.8649
19	6.8440	7.6327	8.9066	10.1170	11.6509
20	7.4339	8.2604	9.5908	10.8508	12.4426
21	8.0337	8.8972	10.2829	11.5913	13.2396
22	8.6427	9.5425	10.9823	12.3380	14.0415
23	9.2604	10.1957	11.6885	13.0905	14.8479
24	9.8862	10.8564	12.4011	13.8484	15.6587
25	10.5197	11.5240	13.1197	14.6114	16.4734
26	11.1603	12.1981	13.8439	15.3791	17.2919
27	11.8076	12.8786	14.5733	16.1513	18.1138
28	12.4613	13.5648	15.3079	16.9279	18.9392
29	13.1211	14.2565	16.0471	17.7083	19.7677
30	13.7867	14.9535	16.7908	18.4926	20.5992
40	20.7065	22.1643	24.4331	26.5093	29.0505
50	27.9907	29.7067	32.3574	34.7642	37.6886
60	35.5346	37.4848	40.4817	43.1879	46.4589
70	43.2752	45.4418	48.7576	51.7393	55.3290
80	51.1720	53.5400	57.1532	60.3915	64.2778
90	59.1963	61.7541	65.6466	69.1260	73.2912
100*	67.3276	70.0648	74.2219	77.9295	82.3581

*For d.f. greater than 100 the expression $\sqrt{2\chi^2} - \sqrt{(2k-1)} = Z$ follows the standardized normal distribution, where k represents the degrees of freedom.

.750	.500	.250	.100	.050	.025	.010	.005
.1015	.4549	1.3233	2.7055	3.8415	5.0239	6.6349	7.8794
.5754	1.3863	2.7726	4.6052	5.9915	7.3778	9.2103	10.5966
1.2125	2.3660	4.1084	6.2514	7.8147	9.3484	11.3449	12.8381
1.9226	3.3567	5.3853	7.7794	9.4877	11.1433	13.2767	14.8602
2.6746	4.3515	6.6257	9.2364	11.0705	12.8325	15.0863	16.7496
3.4546	5.3481	7.8408	10.6446	12.5916	14.4494	16.8119	18.5476
4.2549	6.3458	9.0372	12.0170	14.0671	16.0128	18.4753	20.2777
5.0706	7.3441	10.2188	13.3616	15.5073	17.5346	20.0902	21.9550
5.8988	8.3428	11.3887	14.6837	16.9190	19.0228	21.6660	23.5893
6.7372	9.3418	12.5489	15.9871	18.3070	20.4831	23.2093	25.1882
7.5841	10.3410	13.7007	17.2750	19.6751	21.9200	24.7250	26.7569
8.4384	11.3403	14.8454	18.5494	21.0261	23.3367	26.2170	28.2995
9.2991	12.3398	15.9839	19.8119	22.3621	24.7356	27.6883	29.8194
10.1653	13.3393	17.1170	21.0642	23.6848	26.1190	29.1413	31.3193
11.0365	14.3389	18.2451	22.3072	24.9958	27.4884	30.5779	32.8013
11.9122	15.3385	19.3688	23.5418	26.2962	28.8454	31.9999	34.2672
12.7919	16.3381	20.4887	24.7690	27.5871	30.1910	33.4087	35.7185
13.6753	17.3379	21.6049	25.9894	28.8693	31.5264	34.8053	37.1564
14.5620	18.3376	22.7178	27.2036	30.1435	32.8523	36.1908	38.5822
15.4518	19.3374	23.8277	28.4120	31.4104	34.1696	37.5662	39.9968
16.3444	20.3372	24.9348	29.6151	32.6705	35.4789	38.9321	41.4010
17.2396	21.3370	26.0393	30.8133	33.9244	36.7807	40.2894	42.7956
18.1373	22.3369	27.1413	32.0069	35.1725	38.0757	41.6384	44.1813
19.0372	23.3367	28.2412	33.1963	36.4151	39.3641	42.9798	45.5585
19.9393	24.3366	29.3389	34.3816	37.6525	40.6465	44.3141	46.9278
20.8434	25.3364	30.4345	35.5631	38.8852	41.9232	45.6417	48.2899
21.7494	26.3363	31.5284	36.7412	40.1133	43.1944	46.9630	49.6449
22.6572	27.3363	32.6205	37.9159	41.3372	44.4607	48.2782	50.9933
23.5666	28.3362	33.7109	39.0875	42.5569	45.7222	49.5879	52.3356
24.4776	29.3360	34.7998	40.2560	43.7729	46.9792	50.8922	53.6720
33.6603	39.3354	45.6160	51.8050	55.7585	59.3417	63.6907	66.7659
42.9421	49.3349	56.3336	63.1671	67.5048	71.4202	76.1539	79.4900
52.2938	59.3347	66.9814	74.3970	79.0819	83.2976	88.3794	91.9517
61.6983	69.3344	77.5766	85.5271	90.5312	95.0231	100.425	104.215
71.1445	79.3343	88.1303	96.5782	101.879	106.629	112.329	116.321
80.6247	89.3342	98.6499	107.565	113.145	118.136	124.116	128.299
90.1332	99.3341	109.141	118.498	124.342	129.561	135.807	140.169

Source: Abridged from E. S. Pearson and H. O. Hartley, eds., *Biometrika Tables for Statisticians*, vol. 1, 3rd ed., Table 8, Cambridge University Press, New York, 1966. Reproduced by permission of the editors and trustees of *Biometrika*.

TABLE E-5a DURBIN-WATSON d STATISTIC: SIGNIFICANCE POINTS OF d_L AND d_U AT 0.05 LEVEL OF SIGNIFICANCE

	$k' = 1$		$k' = 2$		$k' = 3$		$k' = 4$		$k' = 5$		$k' = 6$		$k' = 7$		$k' = 8$		$k' = 9$		$k' = 10$	
n	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U
6	0.610	1.400	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	0.700	1.356	0.467	1.896	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	0.763	1.332	0.559	1.777	0.368	2.287	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	0.824	1.320	0.629	1.699	0.455	2.128	0.296	2.588	—	—	—	—	—	—	—	—	—	—	—	—
10	0.879	1.320	0.697	1.641	0.525	2.016	0.376	2.414	0.243	2.822	—	—	—	—	—	—	—	—	—	—
11	0.927	1.324	0.658	1.604	0.595	1.928	0.444	2.283	0.316	2.645	0.203	3.005	—	—	—	—	—	—	—	—
12	0.971	1.331	0.812	1.579	0.658	1.864	0.512	2.177	0.379	2.506	0.268	2.832	0.171	3.149	—	—	—	—	—	—
13	1.010	1.340	0.861	1.562	0.715	1.816	0.574	2.094	0.445	2.390	0.328	2.692	0.230	2.985	0.147	3.266	—	—	—	—
14	1.045	1.350	0.905	1.551	0.767	1.779	0.632	2.030	0.505	2.296	0.389	2.572	0.286	2.848	0.200	3.111	0.127	3.360	—	—
15	1.077	1.361	0.946	1.543	0.814	1.750	0.685	1.977	0.562	2.220	0.447	2.472	0.343	2.727	0.251	2.979	0.175	3.216	0.111	3.438
16	1.106	1.371	0.982	1.539	0.857	1.728	0.734	1.935	0.615	2.157	0.502	2.388	0.398	2.624	0.304	2.860	0.222	3.090	0.155	3.304
17	1.133	1.381	1.015	1.536	0.897	1.710	0.779	1.900	0.664	2.104	0.554	2.318	0.451	2.537	0.356	2.757	0.272	2.975	0.198	3.184
18	1.158	1.391	1.046	1.535	0.933	1.696	0.820	1.872	0.710	2.060	0.603	2.257	0.502	2.461	0.407	2.667	0.321	2.873	0.244	3.073
19	1.180	1.401	1.074	1.536	0.967	1.685	0.859	1.848	0.752	2.023	0.649	2.206	0.549	2.396	0.456	2.589	0.369	2.783	0.290	2.974
20	1.201	1.411	1.100	1.537	0.998	1.676	0.894	1.828	0.792	1.991	0.692	2.162	0.595	2.339	0.502	2.521	0.416	2.704	0.336	2.885
21	1.221	1.420	1.125	1.538	1.026	1.669	0.927	1.812	0.829	1.964	0.732	2.124	0.637	2.290	0.547	2.460	0.461	2.633	0.380	2.806
22	1.239	1.429	1.147	1.541	1.053	1.664	0.958	1.797	0.863	1.940	0.769	2.090	0.677	2.246	0.588	2.407	0.504	2.571	0.424	2.734
23	1.257	1.437	1.168	1.543	1.078	1.660	0.986	1.785	0.895	1.920	0.804	2.061	0.715	2.208	0.628	2.360	0.545	2.514	0.465	2.670
24	1.273	1.446	1.188	1.546	1.101	1.656	1.013	1.775	0.925	1.902	0.837	2.035	0.751	2.174	0.668	2.318	0.584	2.464	0.506	2.613
25	1.288	1.454	1.206	1.550	1.123	1.654	1.038	1.767	0.953	1.886	0.868	2.012	0.784	2.144	0.702	2.280	0.621	2.419	0.544	2.560
26	1.302	1.461	1.224	1.553	1.143	1.652	1.062	1.759	0.979	1.873	0.897	1.992	0.816	2.117	0.735	2.246	0.657	2.379	0.581	2.513
27	1.316	1.469	1.240	1.556	1.162	1.651	1.084	1.753	1.004	1.861	0.925	1.974	0.845	2.093	0.767	2.215	0.691	2.342	0.616	2.470
28	1.328	1.475	1.255	1.560	1.181	1.650	1.104	1.747	1.028	1.850	0.951	1.958	0.874	2.071	0.798	2.188	0.723	2.309	0.650	2.431
29	1.341	1.483	1.270	1.563	1.198	1.650	1.124	1.743	1.050	1.841	0.975	1.944	0.900	2.052	0.826	2.164	0.753	2.278	0.682	2.396
30	1.352	1.489	1.284	1.567	1.214	1.650	1.143	1.739	1.071	1.833	0.998	1.931	0.926	2.034	0.854	2.141	0.782	2.251	0.712	2.363
31	1.363	1.496	1.297	1.570	1.229	1.650	1.160	1.735	1.090	1.825	1.020	1.920	0.950	2.018	0.879	2.120	0.810	2.226	0.741	2.333
32	1.373	1.502	1.309	1.574	1.244	1.650	1.177	1.732	1.109	1.819	1.041	1.909	0.972	2.004	0.904	2.102	0.836	2.203	0.769	2.306
33	1.383	1.508	1.321	1.577	1.258	1.651	1.193	1.730	1.127	1.813	1.061	1.900	0.994	1.991	0.927	2.085	0.861	2.181	0.795	2.281
34	1.393	1.514	1.333	1.580	1.271	1.652	1.208	1.728	1.144	1.808	1.080	1.891	1.015	1.979	0.950	2.069	0.885	2.162	0.821	2.257
35	1.402	1.519	1.343	1.584	1.283	1.653	1.222	1.726	1.160	1.803	1.097	1.884	1.034	1.967	0.971	2.054	0.908	2.144	0.845	2.236
36	1.411	1.525	1.354	1.587	1.295	1.654	1.238	1.724	1.175	1.799	1.114	1.877	1.053	1.957	0.991	2.041	0.930	2.127	0.868	2.216
37	1.419	1.530	1.364	1.590	1.307	1.655	1.249	1.723	1.190	1.795	1.131	1.870	1.071	1.948	1.011	2.029	0.951	2.112	0.891	2.198
38	1.427	1.535	1.373	1.594	1.318	1.656	1.261	1.722	1.204	1.792	1.146	1.864	1.088	1.939	1.029	2.017	0.970	2.098	0.912	2.180
39	1.435	1.540	1.382	1.597	1.328	1.658	1.273	1.722	1.218	1.789	1.161	1.859	1.104	1.932	1.047	2.007	0.990	2.085	0.932	2.164
40	1.442	1.544	1.391	1.600	1.338	1.659	1.285	1.721	1.230	1.786	1.175	1.854	1.120	1.924	1.064	1.997	1.008	2.072	0.952	2.149
45	1.475	1.566	1.430	1.615	1.383	1.666	1.336	1.720	1.287	1.776	1.238	1.835	1.189	1.895	1.139	1.958	1.089	2.022	1.038	2.088
50	1.503	1.585	1.462	1.628	1.421	1.674	1.378	1.721	1.335	1.771	1.291	1.822	1.246	1.875	1.201	1.930	1.156	1.986	1.110	2.044
55	1.528	1.601	1.490	1.641	1.452	1.681	1.414	1.724	1.374	1.768	1.334	1.814	1.294	1.861	1.253	1.909	1.212	1.959	1.170	2.010
60	1.549	1.616	1.514	1.652	1.480	1.689	1.444	1.727	1.408	1.767	1.372	1.808	1.335	1.850	1.298	1.894	1.260	1.939	1.222	1.984
65	1.567	1.629	1.536	1.662	1.503	1.696	1.471	1.731	1.438	1.767	1.404	1.805	1.370	1.843	1.336	1.882	1.301	1.923	1.266	1.964
70	1.583	1.641	1.554	1.672	1.525	1.703	1.494	1.735	1.464	1.768	1.433	1.802	1.401	1.837	1.369	1.873	1.337	1.910	1.305	1.948
75	1.598	1.652	1.571	1.680	1.543	1.709	1.515	1.739	1.487	1.770	1.458	1.801	1.428	1.834	1.399	1.867	1.369	1.901	1.339	1.935
80	1.611	1.662	1.586	1.688	1.560	1.715	1.534	1.743	1.507	1.772	1.480	1.801	1.453	1.831	1.425	1.861	1.397	1.893	1.369	1.925
85	1.624	1.671	1.600	1.696	1.575	1.721	1.550	1.747	1.525	1.774	1.500	1.801	1.474	1.829	1.446	1.857	1.422	1.886	1.396	1.916
90	1.635	1.679	1.612	1.703	1.589	1.726	1.566	1.751	1.542	1.778	1.518	1.801	1.494	1.827	1.469	1.854	1.445	1.881	1.420	1.909
95	1.645	1.687	1.623	1.709	1.602	1.732	1.579	1.755	1.557	1.778	1.536	1.802	1.512	1.827	1.489	1.852	1.465	1.877	1.442	1.903
100	1.654	1.694	1.634	1.715	1.613	1.736	1.592	1.758	1.571	1.780	1.550	1.803	1.528	1.826	1.506	1.850	1.484	1.874	1.462	1.898
150	1.720	1.746	1.706	1.760	1.693	1.774	1.679	1.788	1.665	1.802	1.651	1.817	1.637	1.832	1.622	1.847	1.608	1.862	1.594	1.877
200	1.758	1.778	1.748	1.789	1.738	1.799	1.729	1.810	1.718	1.820	1.707	1.831	1.697	1.841	1.686	1.852	1.675	1.863	1.665	1.874

	$k' = 11$		$k' = 12$		$k' = 13$		$k' = 14$		$k' = 15$		$k' = 16$		$k' = 17$		$k' = 18$		$k' = 19$		$k' = 20$	
n	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U
16	0.098	3.503	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	0.138	3.378	0.087	3.557	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	0.177	3.265	0.123	3.441	0.078	3.603	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	0.220	3.159	0.160	3.335	0.111	3.496	0.079	3.642	—	—	—	—	—	—	—	—	—	—	—	—
20	0.263	3.063	0.200	3.234	0.145	3.395	0.100	3.542	0.063	3.676	—	—	—	—	—	—	—	—	—	—
21	0.307	2.978	0.240	3.141	0.182	3.300	0.132	3.448	0.091	3.583	0.058	3.705	—	—	—	—	—	—	—	—
22	0.349	2.897	0.281	3.057	0.220	3.211	0.166	3.358	0.120	3.495	0.083	3.619	0.052	3.731	—	—	—	—	—	—
23	0.391	2.826	0.322	2.979	0.259	3.128	0.202	3.272	0.153	3.409	0.110	3.535	0.076	3.650	0.048	3.753	—	—	—	—
24	0.431	2.761	0.362	2.908	0.297	3.053	0.239	3.193	0.186	3.327	0.141	3.454	0.101	3.572	0.070	3.678	0.044	3.773	—	—
25	0.470	2.702	0.400	2.844	0.335	2.983	0.275	3.119	0.221	3.251	0.172	3.376	0.130	3.494	0.094	3.604	0.065	3.702	0.041	3.790
26	0.508	2.649	0.438	2.784	0.373	2.919	0.312	3.051	0.256	3.179	0.205	3.303	0.160	3.420	0.120	3.531	0.087	3.632	0.060	3.724
27	0.544	2.600	0.475	2.730	0.409	2.859	0.348	2.987	0.291	3.112	0.238	3.233	0.191	3.349	0.149	3.460	0.112	3.563	0.081	3.658
28	0.578	2.555	0.510	2.680	0.445	2.805	0.383	2.928	0.325	3.050	0.271	3.168	0.222	3.283	0.178	3.392	0.138	3.495	0.104	3.592
29	0.612	2.515	0.544	2.634	0.479	2.755	0.418	2.874	0.358	2.992	0.305	3.107	0.254	3.219	0.208	3.327	0.166	3.431	0.129	3.528
30	0.643	2.477	0.577	2.592	0.512	2.706	0.451	2.823	0.392	2.937	0.337	3.050	0.286	3.160	0.238	3.266	0.195	3.368	0.158	3.465
31	0.674	2.443	0.608	2.553	0.545	2.665	0.484	2.776	0.425	2.887	0.370	2.996	0.317	3.103	0.269	3.208	0.224	3.309	0.183	3.406
32	0.703	2.411	0.638	2.517	0.576	2.625	0.515	2.733	0.457	2.840	0.401	2.948	0.349	3.050	0.299	3.153	0.253	3.252	0.211	3.348
33	0.731	2.382	0.668	2.484	0.606	2.588	0.546	2.692	0.488	2.796	0.432	2.899	0.379	3.000	0.329	3.100	0.283	3.198	0.239	3.293
34	0.758	2.355	0.695	2.454	0.634	2.554	0.575	2.654	0.518	2.754	0.462	2.854	0.409	2.954	0.359	3.051	0.312	3.147	0.267	3.240
35	0.783	2.330	0.722	2.425	0.662	2.521	0.604	2.619	0.547	2.716	0.492	2.813	0.439	2.910	0.388	3.005	0.340	3.099	0.295	3.190
36	0.808	2.306	0.748	2.398	0.689	2.492	0.631	2.586	0.575	2.680	0.520	2.774	0.467	2.868	0.417	2.961	0.369	3.053	0.323	3.142
37	0.831	2.285	0.772	2.374	0.714	2.464	0.657	2.555	0.602	2.646	0.548	2.738	0.495	2.829	0.445	2.920	0.397	3.009	0.351	3.097
38	0.854	2.265	0.796	2.351	0.739	2.438	0.683	2.526	0.628	2.614	0.575	2.703	0.522	2.792	0.472	2.880	0.424	2.968	0.378	3.054
39	0.875	2.246	0.819	2.329	0.763	2.413	0.707	2.499	0.653	2.585	0.600	2.671	0.549	2.757	0.499	2.843	0.451	2.929	0.404	3.013
40	0.896	2.228	0.840	2.309	0.785	2.391	0.731	2.473	0.678	2.557	0.626	2.641	0.575	2.724	0.525	2.808	0.477	2.892	0.430	2.974
45	0.986	2.156	0.938	2.225	0.887	2.296	0.838	2.367	0.788	2.439	0.740	2.512	0.692	2.586	0.644	2.659	0.598	2.733	0.553	2.807
50	1.064	2.103	1.019	2.163	0.973	2.225	0.927	2.287	0.882	2.350	0.836	2.414	0.792	2.479	0.747	2.544	0.703	2.610	0.660	2.675
55	1.129	2.062	1.087	2.116	1.045	2.170	1.003	2.225	0.961	2.281	0.919	2.338	0.877	2.396	0.836	2.454	0.795	2.512	0.754	2.571
60	1.184	2.031	1.145	2.079	1.106	2.127	1.068	2.177	1.029	2.227	0.990	2.278	0.951	2.330	0.913	2.382	0.874	2.434	0.836	2.487
65	1.231	2.006	1.195	2.049	1.160	2.093	1.124	2.138	1.088	2.183	1.052	2.229	1.016	2.276	0.980	2.323	0.944	2.371	0.908	2.419
70	1.272	1.986	1.239	2.026	1.206	2.066	1.172	2.106	1.139	2.148	1.105	2.189	1.072	2.232	1.038	2.275	1.005	2.318	0.971	2.362
75	1.308	1.970	1.277	2.006	1.247	2.043	1.215	2.080	1.184	2.118	1.153	2.156	1.121	2.195	1.090	2.235	1.058	2.275	1.027	2.315
80	1.340	1.957	1.311	1.991	1.283	2.024	1.253	2.059	1.224	2.093	1.196	2.129	1.165	2.165	1.136	2.201	1.106	2.238	1.075	2.275
85	1.369	1.948	1.342	1.977	1.315	2.009	1.287	2.040	1.260	2.073	1.232	2.105	1.205	2.139	1.177	2.172	1.149	2.206	1.121	2.241
90	1.395	1.937	1.369	1.968	1.344	1.995	1.318	2.025	1.292	2.055	1.266	2.085	1.240	2.116	1.213	2.148	1.187	2.179	1.160	2.211
95	1.418	1.929	1.394	1.956	1.370	1.984	1.345	2.012	1.321	2.040	1.296	2.068	1.271	2.097	1.247	2.126	1.222	2.158	1.197	2.186
100	1.439	1.923	1.416	1.948	1.393	1.974	1.371	2.000	1.347	2.026	1.324	2.053	1.301	2.080	1.277	2.108	1.253	2.135	1.229	2.164
150	1.579	1.892	1.564	1.908	1.550	1.924	1.535	1.940	1.519	1.956	1.504	1.972	1.489	1.989	1.474	2.006	1.458	2.023	1.443	2.040
200	1.654	1.885	1.643	1.896	1.632	1.908	1.621	1.919	1.610	1.931	1.599	1.943	1.588	1.955	1.576	1.967	1.565	1.979	1.554	1.991

Note: n = number of observations, k' = number of explanatory variables excluding the constant term.

Source: This table is an extension of the original Durbin-Watson table and is reproduced from N. E. Savin and K. J. White, "The Durbin-Watson Test for Serial Correlation with Extreme Small Samples or Many Regressors," *Econometrica*, vol. 45, November 1977, pp. 1989–96 and as corrected by R. W. Farebrother, *Econometrica*, vol. 48, September 1980, p. 1554. Reprinted by permission of the Econometric Society.

Example E.1.

If $n = 40$ and $k' = 4$, $d_L = 1.285$ and $d_U = 1.721$. If a computed d value is less than 1.285, there is evidence of positive first-order serial correlation; if it is greater than 1.721, there is no evidence of positive first-order serial correlation; but if d lies between the lower and the upper limit, there is inconclusive evidence regarding the presence or absence of positive first-order serial correlation.

TABLE E-5*b* DURBIN-WATSON d STATISTIC: SIGNIFICANCE POINTS OF d_L AND d_U AT 0.01 LEVEL OF SIGNIFICANCE

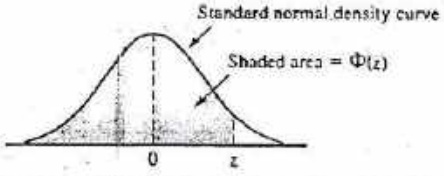
	$k' = 1$		$k' = 2$		$k' = 3$		$k' = 4$		$k' = 5$		$k' = 6$		$k' = 7$		$k' = 8$		$k' = 9$		$k' = 10$	
n	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U
6	0.390	1.142	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	0.435	1.036	0.294	1.676	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	0.497	1.003	0.345	1.489	0.229	2.102	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	0.554	0.998	0.408	1.389	0.279	1.875	0.183	2.433	—	—	—	—	—	—	—	—	—	—	—	—
10	0.604	1.001	0.466	1.333	0.340	1.733	0.230	2.193	0.150	2.690	—	—	—	—	—	—	—	—	—	—
11	0.653	1.010	0.519	1.297	0.396	1.640	0.286	2.030	0.193	2.453	0.124	2.892	—	—	—	—	—	—	—	—
12	0.697	1.023	0.569	1.274	0.449	1.575	0.339	1.913	0.244	2.280	0.164	2.665	0.105	3.053	—	—	—	—	—	—
13	0.738	1.038	0.616	1.261	0.499	1.526	0.391	1.826	0.294	2.150	0.211	2.490	0.140	2.838	0.090	3.182	—	—	—	—
14	0.776	1.054	0.660	1.254	0.547	1.490	0.441	1.757	0.343	2.049	0.257	2.354	0.183	2.667	0.122	2.981	0.078	3.287	—	—
15	0.811	1.070	0.700	1.252	0.591	1.464	0.488	1.704	0.391	1.967	0.303	2.244	0.226	2.530	0.161	2.817	0.107	3.101	0.068	3.374
16	0.844	1.086	0.737	1.252	0.633	1.446	0.532	1.663	0.437	1.900	0.349	2.153	0.269	2.416	0.200	2.681	0.142	2.944	0.094	3.201
17	0.874	1.102	0.772	1.255	0.672	1.432	0.574	1.630	0.480	1.847	0.393	2.078	0.313	2.319	0.241	2.566	0.179	2.811	0.127	3.053
18	0.902	1.118	0.805	1.259	0.708	1.422	0.613	1.604	0.522	1.803	0.435	2.015	0.355	2.238	0.282	2.467	0.216	2.697	0.160	2.925
19	0.928	1.132	0.835	1.265	0.742	1.415	0.650	1.584	0.561	1.767	0.476	1.963	0.396	2.169	0.322	2.381	0.255	2.597	0.196	2.813
20	0.952	1.147	0.863	1.271	0.773	1.411	0.685	1.567	0.598	1.737	0.515	1.918	0.436	2.110	0.362	2.308	0.294	2.510	0.232	2.714
21	0.975	1.161	0.890	1.277	0.803	1.408	0.718	1.554	0.633	1.712	0.552	1.881	0.474	2.059	0.400	2.244	0.331	2.434	0.268	2.625
22	0.997	1.174	0.914	1.284	0.831	1.407	0.748	1.543	0.667	1.691	0.587	1.849	0.510	2.015	0.437	2.188	0.368	2.367	0.304	2.548
23	1.018	1.187	0.938	1.291	0.858	1.407	0.777	1.534	0.698	1.673	0.620	1.821	0.545	1.977	0.473	2.140	0.404	2.308	0.340	2.479
24	1.037	1.199	0.960	1.298	0.882	1.407	0.805	1.528	0.728	1.658	0.652	1.797	0.578	1.944	0.507	2.097	0.439	2.255	0.375	2.417
25	1.056	1.211	0.981	1.305	0.906	1.409	0.831	1.523	0.756	1.645	0.682	1.776	0.610	1.915	0.540	2.059	0.473	2.209	0.409	2.362
26	1.072	1.222	1.001	1.312	0.928	1.411	0.855	1.518	0.783	1.635	0.711	1.759	0.640	1.889	0.572	2.026	0.505	2.168	0.441	2.313
27	1.089	1.233	1.019	1.319	0.949	1.413	0.878	1.515	0.808	1.626	0.738	1.743	0.669	1.867	0.602	1.997	0.536	2.131	0.473	2.269
28	1.104	1.244	1.037	1.325	0.969	1.415	0.900	1.513	0.832	1.618	0.764	1.729	0.696	1.847	0.630	1.970	0.566	2.098	0.504	2.229
29	1.119	1.254	1.054	1.332	0.988	1.418	0.921	1.512	0.855	1.611	0.788	1.718	0.723	1.830	0.658	1.947	0.595	2.068	0.533	2.190
30	1.133	1.263	1.070	1.339	1.006	1.421	0.941	1.511	0.877	1.606	0.812	1.707	0.748	1.814	0.684	1.925	0.622	2.041	0.562	2.160
31	1.147	1.273	1.085	1.345	1.023	1.425	0.960	1.510	0.897	1.601	0.834	1.698	0.772	1.800	0.710	1.906	0.649	2.017	0.589	2.131
32	1.160	1.282	1.100	1.352	1.040	1.428	0.979	1.510	0.917	1.597	0.856	1.690	0.794	1.788	0.734	1.889	0.674	1.995	0.615	2.104
33	1.172	1.291	1.114	1.358	1.055	1.432	0.996	1.510	0.936	1.594	0.876	1.683	0.816	1.776	0.757	1.874	0.698	1.975	0.641	2.080
34	1.184	1.299	1.128	1.364	1.070	1.435	1.012	1.511	0.954	1.591	0.896	1.677	0.837	1.766	0.779	1.860	0.722	1.957	0.665	2.057
35	1.195	1.307	1.140	1.370	1.085	1.439	1.028	1.512	0.971	1.589	0.914	1.671	0.857	1.757	0.800	1.847	0.744	1.940	0.689	2.037
36	1.206	1.315	1.153	1.376	1.098	1.442	1.043	1.513	0.988	1.588	0.932	1.666	0.877	1.749	0.821	1.836	0.766	1.925	0.711	2.018
37	1.217	1.323	1.165	1.382	1.112	1.446	1.058	1.514	1.004	1.586	0.950	1.662	0.895	1.742	0.841	1.825	0.787	1.911	0.733	2.001
38	1.227	1.330	1.176	1.388	1.124	1.449	1.072	1.515	1.019	1.585	0.966	1.658	0.913	1.735	0.860	1.816	0.807	1.899	0.754	1.985
39	1.237	1.337	1.187	1.393	1.137	1.453	1.085	1.517	1.034	1.584	0.982	1.655	0.930	1.729	0.878	1.807	0.826	1.887	0.774	1.970
40	1.246	1.344	1.198	1.398	1.148	1.457	1.098	1.518	1.048	1.584	0.997	1.652	0.946	1.724	0.895	1.799	0.844	1.876	0.749	1.956
45	1.288	1.376	1.245	1.423	1.201	1.474	1.156	1.528	1.111	1.584	1.065	1.643	1.019	1.704	0.974	1.768	0.927	1.834	0.881	1.902
50	1.324	1.403	1.285	1.446	1.245	1.491	1.205	1.538	1.164	1.587	1.123	1.639	1.081	1.692	1.039	1.748	0.997	1.806	0.955	1.864
55	1.356	1.427	1.320	1.466	1.284	1.506	1.247	1.548	1.209	1.592	1.172	1.638	1.134	1.685	1.095	1.734	1.057	1.785	1.018	1.837
60	1.383	1.449	1.350	1.484	1.317	1.520	1.283	1.558	1.249	1.598	1.214	1.639	1.179	1.682	1.144	1.726	1.108	1.771	1.072	1.817
65	1.407	1.468	1.377	1.500	1.346	1.534	1.315	1.568	1.283	1.604	1.251	1.642	1.218	1.680	1.186	1.720	1.153	1.761	1.120	1.802
70	1.429	1.485	1.400	1.515	1.372	1.546	1.343	1.578	1.313	1.611	1.283	1.645	1.253	1.680	1.223	1.716	1.192	1.754	1.162	1.792
75	1.448	1.501	1.422	1.529	1.396	1.557	1.368	1.587	1.340	1.617	1.313	1.649	1.284	1.682	1.256	1.714	1.227	1.748	1.199	1.783
80	1.466	1.515	1.441	1.541	1.416	1.568	1.390	1.595	1.364	1.624	1.338	1.652	1.312	1.683	1.285	1.714	1.259	1.745	1.232	1.777
85	1.482	1.528	1.458	1.553	1.435	1.578	1.411	1.603	1.386	1.630	1.362	1.657	1.337	1.685	1.312	1.714	1.287	1.743	1.262	1.773
90	1.496	1.540	1.474	1.563	1.452	1.587	1.429	1.611	1.406	1.636	1.383	1.661	1.360	1.687	1.336	1.714	1.312	1.741	1.288	1.769
95	1.510	1.552	1.489	1.573	1.468	1.596	1.446	1.618	1.425	1.642	1.403	1.666	1.381	1.690	1.358	1.715	1.336	1.741	1.313	1.767
100	1.522	1.562	1.503	1.583	1.482	1.604	1.462	1.625	1.441	1.647	1.421	1.670	1.400	1.693	1.378	1.717	1.357	1.741	1.335	1.765
150	1.611	1.637	1.598	1.651	1.584	1.665	1.571	1.679	1.557	1.693	1.543	1.708	1.530	1.722	1.515	1.737	1.501	1.752	1.486	1.767
200	1.664	1.684	1.653	1.693	1.643	1.704	1.633	1.715	1.623	1.725	1.613	1.735	1.603	1.746	1.592	1.757	1.582	1.768	1.571	1.779

	$k' = 11$		$k' = 12$		$k' = 13$		$k' = 14$		$k' = 15$		$k' = 16$		$k' = 17$		$k' = 18$		$k' = 19$		$k' = 20$	
n	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U
16	0.060	3.446	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	0.084	3.286	0.053	3.506	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	0.113	3.146	0.075	3.358	0.047	3.357	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	0.145	3.023	0.102	3.227	0.067	3.420	0.043	3.601	—	—	—	—	—	—	—	—	—	—	—	—
20	0.178	2.914	0.131	3.109	0.092	3.297	0.061	3.474	0.038	3.639	—	—	—	—	—	—	—	—	—	—
21	0.212	2.817	0.162	3.004	0.119	3.185	0.084	3.358	0.055	3.521	0.035	3.671	—	—	—	—	—	—	—	—
22	0.246	2.729	0.194	2.909	0.148	3.084	0.109	3.252	0.077	3.412	0.050	3.562	0.032	3.700	—	—	—	—	—	—
23	0.281	2.651	0.227	2.822	0.178	2.991	0.136	3.155	0.100	3.311	0.070	3.459	0.046	3.597	0.029	3.725	—	—	—	—
24	0.315	2.580	0.260	2.744	0.209	2.906	0.165	3.065	0.125	3.218	0.092	3.363	0.065	3.501	0.043	3.629	0.027	3.747	—	—
25	0.348	2.517	0.292	2.674	0.240	2.829	0.194	2.982	0.152	3.131	0.116	3.274	0.085	3.410	0.060	3.538	0.039	3.657	0.025	3.766
26	0.381	2.460	0.324	2.610	0.272	2.758	0.224	2.906	0.180	3.050	0.141	3.191	0.107	3.325	0.079	3.452	0.055	3.572	0.036	3.682
27	0.413	2.409	0.356	2.552	0.303	2.694	0.253	2.836	0.208	2.978	0.167	3.113	0.131	3.245	0.100	3.371	0.073	3.490	0.051	3.602
28	0.444	2.363	0.387	2.499	0.333	2.635	0.283	2.772	0.232	2.907	0.194	3.040	0.156	3.169	0.122	3.294	0.093	3.412	0.068	3.524
29	0.474	2.321	0.417	2.451	0.363	2.582	0.313	2.713	0.266	2.843	0.222	2.972	0.182	3.098	0.148	3.220	0.114	3.338	0.087	3.450
30	0.503	2.283	0.447	2.407	0.393	2.533	0.342	2.659	0.294	2.785	0.249	2.909	0.208	3.032	0.171	3.152	0.137	3.267	0.107	3.379
31	0.531	2.248	0.475	2.367	0.422	2.487	0.371	2.609	0.322	2.730	0.277	2.851	0.234	2.970	0.196	3.087	0.160	3.201	0.128	3.311
32	0.558	2.216	0.503	2.330	0.450	2.446	0.399	2.563	0.350	2.680	0.304	2.797	0.261	2.912	0.221	3.026	0.184	3.137	0.151	3.246
33	0.585	2.187	0.530	2.296	0.477	2.408	0.426	2.520	0.377	2.633	0.331	2.746	0.287	2.858	0.246	2.969	0.209	3.078	0.174	3.184
34	0.610	2.160	0.556	2.266	0.503	2.373	0.452	2.481	0.404	2.590	0.357	2.699	0.313	2.808	0.272	2.915	0.233	3.022	0.197	3.126
35	0.634	2.136	0.581	2.237	0.529	2.340	0.478	2.444	0.430	2.550	0.383	2.655	0.339	2.761	0.297	2.865	0.257	2.969	0.221	3.071
36	0.658	2.113	0.605	2.210	0.554	2.310	0.504	2.410	0.455	2.512	0.409	2.614	0.364	2.717	0.322	2.818	0.282	2.919	0.244	3.019
37	0.680	2.092	0.628	2.186	0.578	2.282	0.528	2.379	0.480	2.477	0.434	2.576	0.389	2.675	0.347	2.774	0.306	2.872	0.268	2.969
38	0.702	2.073	0.651	2.164	0.601	2.256	0.552	2.350	0.504	2.445	0.458	2.540	0.414	2.637	0.371	2.733	0.330	2.828	0.291	2.923
39	0.723	2.055	0.673	2.143	0.623	2.232	0.575	2.323	0.528	2.414	0.482	2.507	0.438	2.600	0.395	2.694	0.354	2.787	0.315	2.879
40	0.744	2.039	0.694	2.123	0.645	2.210	0.597	2.297	0.551	2.386	0.505	2.476	0.461	2.566	0.418	2.657	0.377	2.748	0.338	2.838
45	0.835	1.972	0.790	2.044	0.744	2.118	0.700	2.193	0.655	2.269	0.612	2.346	0.570	2.424	0.528	2.503	0.488	2.582	0.448	2.661
50	0.913	1.925	0.871	1.987	0.829	2.051	0.787	2.116	0.746	2.182	0.705	2.250	0.665	2.318	0.625	2.387	0.586	2.456	0.548	2.526
55	0.979	1.891	0.940	1.945	0.902	2.002	0.863	2.059	0.825	2.117	0.786	2.176	0.748	2.237	0.711	2.298	0.674	2.359	0.637	2.421
60	1.037	1.865	1.001	1.914	0.965	1.964	0.929	2.015	0.893	2.067	0.857	2.120	0.822	2.173	0.786	2.227	0.751	2.283	0.716	2.338
65	1.087	1.845	1.053	1.889	1.020	1.934	0.966	1.980	0.953	2.027	0.919	2.075	0.886	2.123	0.852	2.172	0.819	2.221	0.786	2.272
70	1.131	1.831	1.099	1.870	1.068	1.911	1.037	1.953	1.005	1.995	0.974	2.038	0.943	2.082	0.911	2.127	0.880	2.172	0.849	2.217
75	1.170	1.819	1.141	1.856	1.111	1.893	1.082	1.931	1.052	1.970	1.023	2.009	0.993	2.049	0.964	2.090	0.934	2.131	0.905	2.172
80	1.205	1.810	1.177	1.844	1.150	1.878	1.122	1.913	1.094	1.949	1.066	1.984	1.036	2.022	1.011	2.059	0.983	2.097	0.955	2.135
85	1.236	1.803	1.210	1.834	1.184	1.866	1.158	1.898	1.132	1.931	1.106	1.965	1.080	1.999	1.053	2.033	1.027	2.068	1.000	2.104
90	1.264	1.798	1.240	1.827	1.215	1.856	1.191	1.886	1.166	1.917	1.141	1.948	1.116	1.979	1.091	2.012	1.066	2.044	1.041	2.077
95	1.290	1.793	1.267	1.821	1.244	1.846	1.221	1.875	1.197	1.905	1.174	1.934	1.150	1.963	1.126	1.993	1.102	2.023	1.079	2.054
100	1.314	1.790	1.292	1.816	1.270	1.841	1.248	1.868	1.225	1.895	1.203	1.922	1.181	1.949	1.158	1.977	1.136	2.006	1.113	2.034
150	1.473	1.785	1.458	1.799	1.444	1.814	1.429	1.830	1.414	1.847	1.400	1.863	1.385	1.880	1.370	1.897	1.355	1.913	1.340	1.931
200	1.561	1.791	1.550	1.801	1.539	1.813	1.528	1.824	1.518	1.836	1.507	1.847	1.496	1.860	1.484	1.871	1.474	1.883	1.462	1.896

Note: n = number of observations, k' = number of explanatory variables excluding the constant term.
Source: Savin and White, op. cit., by permission of Econometric Society.

Table A.3 Standard Normal Curve Areas

$\Phi(z) = P(Z \le z)$



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0017	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0038
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0352	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0722	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3482
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

(continued)

Table A.3 Standard Normal Curve Areas *(cont.)*

$\Phi(z) = P(Z \le z)$

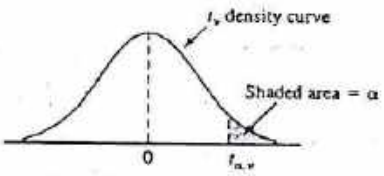
z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9278	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Table A.4 The Incomplete Gamma Function

$$F(x;\alpha) = \int_0^x \frac{1}{\Gamma(\alpha)} y^{\alpha-1} e^{-y}\, dy$$

x \ α	1	2	3	4	5	6	7	8	9	10
1	.632	.264	.080	.019	.004	.001	.000	.000	.000	.000
2	.865	.594	.323	.143	.053	.017	.005	.001	.000	.000
3	.950	.801	.577	.353	.185	.084	.034	.012	.004	.001
4	.982	.908	.762	.567	.371	.215	.111	.051	.021	.008
5	.993	.960	.875	.735	.560	.384	.238	.133	.068	.032
6	.998	.983	.938	.849	.715	.554	.394	.256	.153	.084
7	.999	.993	.970	.918	.827	.699	.550	.401	.271	.170
8	1.000	.997	.986	.958	.900	.809	.687	.547	.407	.283
9		.999	.994	.979	.945	.884	.793	.676	.544	.413
10		1.000	.997	.990	.971	.933	.870	.780	.667	.542
11			.999	.995	.985	.962	.921	.857	.768	.659
12			1.000	.998	.992	.980	.954	.911	.845	.758
13				.999	.996	.989	.974	.946	.900	.834
14				1.000	.998	.994	.986	.968	.938	.891
15					.999	.997	.992	.982	.963	.930

Table A.5 Critical Values for t Distributions

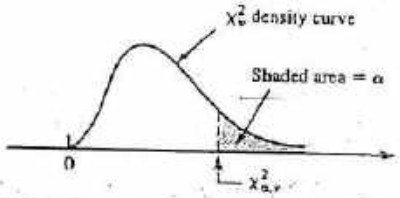


	α						
ν	.10	.05	.025	.01	.005	.001	.0005
1	3.078	6.314	12.706	31.821	63.657	318.31	636.62
2	1.886	2.920	4.303	6.965	9.925	22.326	31.598
3	1.638	2.353	3.182	4.541	5.841	10.213	12.924
4	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	1.319	1.714	2.069	2.500	2.807	3.485	3.767
24	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	1.310	1.697	2.042	2.457	2.750	3.385	3.646
32	1.309	1.694	2.037	2.449	2.738	3.365	3.622
34	1.307	1.691	2.032	2.441	2.728	3.348	3.601
36	1.306	1.688	2.028	2.434	2.719	3.333	3.582
38	1.304	1.686	2.024	2.429	2.712	3.319	3.566
40	1.303	1.684	2.021	2.423	2.704	3.307	3.551
50	1.299	1.676	2.009	2.403	2.678	3.262	3.496
60	1.296	1.671	2.000	2.390	2.660	3.232	3.460
120	1.289	1.658	1.980	2.358	2.617	3.160	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.090	3.291

Table A.6 Tolerance Critical Values for Normal Population Distributions

	Two-Sided Intervals						One-Sided Intervals					
Confidence Level	95%			99%			95%			99%		
% of Population Captured	≥ 90%	≥ 95%	≥ 99%	≥ 90%	≥ 95%	≥ 99%	≥ 90%	≥ 95%	≥ 99%	≥ 90%	≥ 95%	≥ 99%
2	32.019	37.674	48.430	160.193	188.491	242.300	20.581	26.260	37.094	103.029	131.426	185.617
3	8.380	9.916	12.861	18.930	22.401	29.055	6.156	7.656	10.553	13.995	17.370	23.896
4	5.369	6.370	8.299	9.398	11.150	14.527	4.162	5.144	7.042	7.380	9.083	12.387
5	4.275	5.079	6.634	6.612	7.855	10.260	3.407	4.203	5.741	5.362	6.578	8.939
6	3.712	4.414	5.775	5.337	6.345	8.301	3.006	3.708	5.062	4.411	5.406	7.335
7	3.369	4.007	5.248	4.613	5.488	7.187	2.756	3.400	4.642	3.859	4.728	6.412
8	3.136	3.732	4.891	4.147	4.936	6.468	2.582	3.187	4.354	3.497	4.285	5.812
9	2.967	3.532	4.631	3.822	4.550	5.966	2.454	3.031	4.143	3.241	3.972	5.389
10	2.839	3.379	4.433	3.582	4.265	5.594	2.355	2.911	3.981	3.048	3.738	5.074
11	2.737	3.259	4.277	3.397	4.045	5.308	2.275	2.815	3.852	2.898	3.556	4.829
12	2.655	3.162	4.150	3.250	3.870	5.079	2.210	2.736	3.747	2.777	3.410	4.633
13	2.587	3.081	4.044	3.130	3.727	4.893	2.155	2.671	3.659	2.677	3.290	4.472
14	2.529	3.012	3.955	3.029	3.608	4.737	2.109	2.615	3.585	2.593	3.189	4.337
15	2.480	2.954	3.878	2.945	3.507	4.605	2.068	2.566	3.520	2.522	3.102	4.222
16	2.437	2.903	3.812	2.872	3.421	4.492	2.033	2.524	3.464	2.460	3.028	4.123
Sample Size n 17	2.400	2.858	3.754	2.808	3.345	4.393	2.002	2.486	3.414	2.405	2.963	4.037
18	2.366	2.819	3.702	2.753	3.279	4.307	1.974	2.453	3.370	2.357	2.905	3.960
19	2.337	2.784	3.656	2.703	3.221	4.230	1.949	2.423	3.331	2.314	2.854	3.892
20	2.310	2.752	3.615	2.659	3.168	4.161	1.926	2.396	3.295	2.276	2.808	3.832
25	2.208	2.631	3.457	2.494	2.972	3.904	1.838	2.292	3.158	2.129	2.633	3.601
30	2.140	2.549	3.350	2.385	2.841	3.733	1.777	2.220	3.064	2.030	2.516	3.447
35	2.090	2.490	3.272	2.306	2.748	3.611	1.732	2.167	2.995	1.957	2.430	3.334
40	2.052	2.445	3.213	2.247	2.677	3.518	1.697	2.126	2.941	1.902	2.364	3.249
45	2.021	2.408	3.165	2.200	2.621	3.444	1.669	2.092	2.898	1.857	2.312	3.180
50	1.996	2.379	3.126	2.162	2.576	3.385	1.646	2.065	2.863	1.821	2.269	3.125
60	1.958	2.333	3.066	2.103	2.506	3.293	1.609	2.022	2.807	1.764	2.202	3.038
70	1.929	2.299	3.021	2.060	2.454	3.225	1.581	1.990	2.765	1.722	2.153	2.974
80	1.907	2.272	2.986	2.026	2.414	3.173	1.559	1.965	2.733	1.688	2.114	2.924
90	1.889	2.251	2.958	1.999	2.382	3.130	1.542	1.944	2.706	1.661	2.082	2.883
100	1.874	2.233	2.934	1.977	2.355	3.096	1.527	1.927	2.684	1.639	2.056	2.850
150	1.825	2.175	2.859	1.905	2.270	2.983	1.478	1.870	2.611	1.566	1.971	2.741
200	1.798	2.143	2.816	1.865	2.222	2.921	1.450	1.837	2.570	1.524	1.923	2.679
250	1.780	2.121	2.788	1.839	2.191	2.880	1.431	1.815	2.542	1.496	1.891	2.638
300	1.767	2.106	2.767	1.820	2.169	2.850	1.417	1.800	2.522	1.476	1.868	2.608
∞	1.645	1.960	2.576	1.645	1.960	2.576	1.282	1.645	2.326	1.282	1.645	2.326

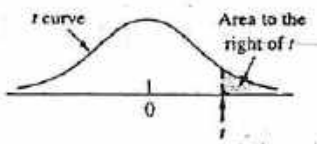
Table A.7 Critical Values for Chi-Squared Distributions



	α									
ν	.995	.99	.975	.95	.90	.10	.05	.025	.01	.005
1	0.000	0.000	0.001	0.004	0.016	2.706	3.843	5.025	6.637	7.882
2	0.010	0.020	0.051	0.103	0.211	4.605	5.992	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.344	12.837
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.070	12.832	15.085	16.748
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.440	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.012	18.475	20.276
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.534	20.090	21.954
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.022	21.665	23.587
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.724	26.755
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.300
13	3.565	4.107	5.009	5.892	7.041	19.812	22.362	24.735	27.687	29.817
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.600	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.577	32.799
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.407	7.564	8.682	10.085	24.769	27.587	30.190	33.408	35.716
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.843	7.632	8.906	10.117	11.651	27.203	30.143	32.852	36.190	38.580
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.033	8.897	10.283	11.591	13.240	29.615	32.670	35.478	38.930	41.399
22	8.643	9.542	10.982	12.338	14.042	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.688	13.090	14.848	32.007	35.172	38.075	41.637	44.179
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.558
25	10.519	11.523	13.120	14.611	16.473	34.381	37.652	40.646	44.313	46.925
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.807	12.878	14.573	16.151	18.114	36.741	40.113	43.194	46.962	49.642
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.120	14.256	16.147	17.708	19.768	39.087	42.557	45.772	49.586	52.333
30	13.787	14.954	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
31	14.457	15.655	17.538	19.280	21.433	41.422	44.985	48.231	52.190	55.000
32	15.134	16.362	18.291	20.072	22.271	42.585	46.194	49.480	53.486	56.328
33	15.814	17.073	19.046	20.866	23.110	43.745	47.400	50.724	54.774	57.646
34	16.501	17.789	19.806	21.664	23.952	44.903	48.602	51.966	56.061	58.964
35	17.191	18.508	20.569	22.465	24.796	46.059	49.802	53.203	57.340	60.272
36	17.887	19.233	21.336	23.269	25.643	47.212	50.998	54.437	58.619	61.581
37	18.584	19.960	22.105	24.075	26.492	48.363	52.192	55.667	59.891	62.880
38	19.289	20.691	22.878	24.884	27.343	49.513	53.384	56.896	61.162	64.181
39	19.994	21.425	23.654	25.695	28.196	50.660	54.572	58.119	62.426	65.473
40	20.706	22.164	24.433	26.509	29.050	51.805	55.758	59.342	63.691	66.766

For $\nu > 40$, $\chi^2_{\alpha,\nu} \approx \nu\left(1 - \frac{2}{9\nu} + z_\alpha\sqrt{\frac{2}{9\nu}}\right)^3$

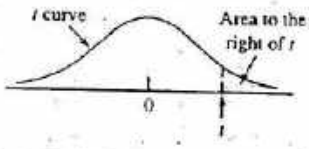
Table A.8 t Curve Tail Areas



t \ ν	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0.0	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500
0.1	.468	.465	.463	.463	.462	.462	.462	.461	.461	.461	.461	.461	.461	.461	.461	.461	.461	.461
0.2	.437	.430	.427	.426	.425	.424	.424	.423	.423	.423	.423	.422	.422	.422	.422	.422	.422	.422
0.3	.407	.396	.392	.390	.388	.387	.386	.386	.386	.385	.385	.385	.384	.384	.384	.384	.384	.384
0.4	.379	.364	.358	.355	.353	.352	.351	.350	.349	.349	.348	.348	.348	.347	.347	.347	.347	.347
0.5	.352	.333	.326	.322	.319	.317	.316	.315	.315	.314	.313	.313	.313	.312	.312	.312	.312	.312
0.6	.328	.305	.295	.290	.287	.285	.284	.283	.282	.281	.280	.280	.279	.279	.279	.278	.278	.278
0.7	.306	.278	.267	.261	.258	.255	.253	.252	.251	.250	.249	.249	.248	.247	.247	.247	.247	.246
0.8	.285	.254	.241	.234	.230	.227	.225	.223	.222	.221	.220	.220	.219	.218	.218	.218	.217	.217
0.9	.267	.232	.217	.210	.205	.201	.199	.197	.196	.195	.194	.193	.192	.191	.191	.191	.190	.190
1.0	.250	.211	.196	.187	.182	.178	.175	.173	.172	.170	.169	.169	.168	.167	.167	.166	.166	.165
1.1	.235	.193	.176	.167	.162	.157	.154	.152	.150	.149	.147	.146	.146	.144	.144	.144	.143	.143
1.2	.221	.177	.158	.148	.142	.138	.135	.132	.130	.129	.128	.127	.126	.124	.124	.124	.123	.123
1.3	.209	.162	.142	.132	.125	.121	.117	.115	.113	.111	.110	.109	.108	.107	.107	.106	.105	.105
1.4	.197	.148	.128	.117	.110	.106	.102	.100	.098	.096	.095	.093	.092	.091	.091	.090	.090	.089
1.5	.187	.136	.115	.104	.097	.092	.089	.086	.084	.082	.081	.080	.079	.077	.077	.077	.076	.075
1.6	.178	.125	.104	.092	.085	.080	.077	.074	.072	.070	.069	.068	.067	.065	.065	.065	.064	.064
1.7	.169	.116	.094	.082	.075	.070	.065	.064	.062	.060	.059	.057	.056	.055	.055	.054	.054	.053
1.8	.161	.107	.085	.073	.066	.061	.057	.055	.053	.051	.050	.049	.048	.046	.046	.045	.045	.044
1.9	.154	.099	.077	.065	.058	.053	.050	.047	.045	.043	.042	.041	.040	.038	.038	.038	.037	.037
2.0	.148	.092	.070	.058	.051	.046	.043	.040	.038	.037	.035	.034	.033	.032	.032	.031	.031	.030
2.1	.141	.085	.063	.052	.045	.040	.037	.034	.033	.031	.030	.029	.028	.027	.027	.026	.025	.025
2.2	.136	.079	.058	.046	.040	.035	.032	.029	.028	.026	.025	.024	.023	.022	.022	.021	.021	.021
2.3	.131	.074	.052	.041	.035	.031	.027	.025	.023	.022	.021	.020	.019	.018	.018	.018	.017	.017
2.4	.126	.069	.048	.037	.031	.027	.024	.022	.020	.019	.018	.017	.016	.015	.015	.014	.014	.014
2.5	.121	.065	.044	.033	.027	.023	.020	.018	.017	.016	.015	.014	.013	.012	.012	.012	.011	.011
2.6	.117	.061	.040	.030	.024	.020	.018	.016	.014	.013	.012	.012	.011	.010	.010	.010	.009	.009
2.7	.113	.057	.037	.027	.021	.018	.015	.014	.012	.011	.010	.010	.009	.008	.008	.008	.008	.007
2.8	.109	.054	.034	.024	.019	.016	.013	.012	.010	.009	.009	.008	.008	.007	.007	.006	.006	.006
2.9	.106	.051	.031	.022	.017	.014	.011	.010	.009	.008	.007	.007	.006	.005	.005	.005	.005	.005
3.0	.102	.048	.029	.020	.015	.012	.010	.009	.007	.007	.006	.006	.005	.004	.004	.004	.004	.004
3.1	.099	.045	.027	.018	.013	.011	.009	.007	.006	.006	.005	.005	.004	.004	.004	.003	.003	.003
3.2	.096	.043	.025	.016	.012	.009	.008	.006	.005	.005	.004	.004	.003	.003	.003	.003	.003	.002
3.3	.094	.040	.023	.015	.011	.008	.007	.005	.005	.004	.004	.003	.003	.002	.002	.002	.002	.002
3.4	.091	.038	.021	.014	.010	.007	.006	.005	.004	.003	.003	.003	.002	.002	.002	.002	.002	.002
3.5	.089	.036	.020	.012	.009	.006	.005	.004	.003	.003	.002	.002	.002	.002	.002	.001	.001	.001
3.6	.086	.035	.018	.011	.008	.006	.004	.004	.003	.002	.002	.002	.002	.001	.001	.001	.001	.001
3.7	.084	.033	.017	.010	.007	.005	.004	.003	.002	.002	.002	.002	.001	.001	.001	.001	.001	.001
3.8	.082	.031	.016	.010	.006	.004	.003	.003	.002	.002	.001	.001	.001	.001	.001	.001	.001	.001
3.9	.080	.030	.015	.009	.006	.004	.003	.002	.002	.001	.001	.001	.001	.001	.001	.001	.001	.001
4.0	.078	.029	.014	.008	.005	.004	.003	.002	.002	.001	.001	.001	.001	.001	.001	.001	.000	.000

(continued)

Table A.8 *t* Curve Tail Areas *(cont.)*



t \ ν	19	20	21	22	23	24	25	26	27	28	29	30	35	40	60	120	∞ (= z)
0.0	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500
0.1	.461	.461	.461	.461	.461	.461	.461	.461	.461	.461	.461	.461	.460	.460	.460	.460	.460
0.2	.422	.422	.422	.422	.422	.422	.422	.422	.421	.421	.421	.421	.421	.421	.421	.421	.421
0.3	.384	.384	.384	.383	.383	.383	.383	.383	.383	.383	.383	.383	.383	.383	.383	.382	.382
0.4	.347	.347	.347	.347	.346	.346	.346	.346	.346	.346	.346	.346	.346	.346	.345	.345	.345
0.5	.311	.311	.311	.311	.311	.311	.311	.311	.311	.310	.310	.310	.310	.310	.309	.309	.309
0.6	.278	.278	.278	.277	.277	.277	.277	.277	.277	.277	.277	.277	.276	.276	.275	.275	.274
0.7	.246	.246	.246	.246	.245	.245	.245	.245	.245	.245	.245	.245	.244	.244	.243	.243	.242
0.8	.217	.217	.216	.216	.216	.216	.216	.215	.215	.215	.215	.215	.215	.214	.213	.213	.212
0.9	.190	.189	.189	.189	.189	.189	.188	.188	.188	.188	.188	.188	.187	.187	.186	.185	.184
1.0	.165	.165	.164	.164	.164	.164	.163	.163	.163	.163	.163	.163	.162	.162	.161	.160	.159
1.1	.143	.142	.142	.142	.141	.141	.141	.141	.141	.140	.140	.140	.139	.139	.138	.137	.136
1.2	.122	.122	.122	.121	.121	.121	.121	.120	.120	.120	.120	.120	.119	.119	.117	.116	.115
1.3	.105	.104	.104	.104	.103	.103	.103	.103	.102	.102	.102	.102	.101	.101	.099	.098	.097
1.4	.089	.089	.088	.088	.087	.087	.087	.087	.086	.086	.086	.086	.085	.085	.083	.082	.081
1.5	.075	.075	.074	.074	.074	.073	.073	.073	.073	.072	.072	.072	.071	.071	.069	.068	.067
1.6	.063	.063	.062	.062	.062	.061	.061	.061	.061	.060	.060	.060	.059	.059	.057	.056	.055
1.7	.053	.052	.052	.052	.051	.051	.051	.051	.050	.050	.050	.050	.049	.048	.047	.046	.045
1.8	.044	.043	.043	.043	.042	.042	.042	.042	.042	.041	.041	.041	.040	.040	.038	.037	.036
1.9	.036	.036	.036	.035	.035	.035	.035	.034	.034	.034	.034	.034	.033	.032	.031	.030	.029
2.0	.030	.030	.029	.029	.029	.028	.028	.028	.028	.028	.027	.027	.027	.026	.025	.024	.023
2.1	.025	.024	.024	.024	.023	.023	.023	.023	.023	.022	.022	.022	.022	.021	.020	.019	.018
2.2	.020	.020	.020	.019	.019	.019	.019	.018	.018	.018	.018	.018	.017	.017	.016	.015	.014
2.3	.016	.016	.016	.016	.015	.015	.015	.015	.015	.015	.014	.014	.014	.013	.012	.012	.011
2.4	.013	.013	.013	.013	.012	.012	.012	.012	.012	.012	.012	.011	.011	.011	.010	.009	.008
2.5	.011	.011	.010	.010	.010	.010	.010	.010	.009	.009	.009	.009	.009	.008	.008	.007	.006
2.6	.009	.009	.008	.008	.008	.008	.008	.008	.007	.007	.007	.007	.007	.007	.006	.005	.005
2.7	.007	.007	.007	.007	.006	.006	.006	.006	.006	.006	.006	.006	.005	.005	.004	.004	.003
2.8	.006	.006	.005	.005	.005	.005	.005	.005	.005	.005	.005	.004	.004	.004	.003	.003	.003
2.9	.005	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.003	.003	.003	.003	.002	.002
3.0	.004	.004	.003	.003	.003	.003	.003	.003	.003	.003	.003	.003	.002	.002	.002	.002	.001
3.1	.003	.003	.003	.003	.003	.002	.002	.002	.002	.002	.002	.002	.002	.002	.001	.001	.001
3.2	.002	.002	.002	.002	.002	.002	.002	.002	.002	.002	.002	.002	.001	.001	.001	.001	.001
3.3	.002	.002	.002	.002	.002	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.000
3.4	.002	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.000	.000	.000
3.5	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.000	.000	.000
3.6	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.000	.000	.000	.000	.000
3.7	.001	.001	.001	.001	.001	.001	.001	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000
3.8	.001	.001	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3.9	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
4.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Table A.9 Critical Values for *F* Distributions

ν_2 = denominator df	α	ν_1 = numerator df: 1	2	3	4	5	6	7	8	9
1	.100	39.86	49.50	53.59	55.83	57.24	58.20	58.91	59.44	59.86
	.050	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54
	.010	4052.20	4999.50	5403.40	5624.60	5763.60	5859.00	5928.40	5981.10	6022.50
	.001	405,284	500,000	540,379	562,500	576,405	585,937	592,873	598,144	602,284
2	.100	8.53	9.00	9.16	9.24	9.29	9.33	9.35	9.37	9.38
	.050	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
	.010	98.50	99.00	99.17	99.25	99.30	99.33	99.36	99.37	99.39
	.001	998.50	999.00	999.17	999.25	999.30	999.33	999.36	999.37	999.39
3	.100	5.54	5.46	5.39	5.34	5.31	5.28	5.27	5.25	5.24
	.050	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
	.010	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.35
	.001	167.03	148.50	141.11	137.10	134.58	132.85	131.58	130.62	129.86
4	.100	4.54	4.32	4.19	4.11	4.05	4.01	3.98	3.95	3.94
	.050	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
	.010	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66
	.001	74.14	61.25	56.18	53.44	51.71	50.53	49.66	49.00	48.47
5	.100	4.06	3.78	3.62	3.52	3.45	3.40	3.37	3.34	3.32
	.050	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77
	.010	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16
	.001	47.18	37.12	33.20	31.09	29.75	28.83	28.16	27.65	27.24
6	.100	3.78	3.46	3.29	3.18	3.11	3.05	3.01	2.98	2.96
	.050	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
	.010	13.75	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98
	.001	35.51	27.00	23.70	21.92	20.80	20.03	19.46	19.03	18.69
7	.100	3.59	3.26	3.07	2.96	2.88	2.83	2.78	2.75	2.72
	.050	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
	.010	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72
	.001	29.25	21.69	18.77	17.20	16.21	15.52	15.02	14.63	14.33
8	.100	3.46	3.11	2.92	2.81	2.73	2.67	2.62	2.59	2.56
	.050	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
	.010	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91
	.001	25.41	18.49	15.83	14.39	13.48	12.86	12.40	12.05	11.77
9	.100	3.36	3.01	2.81	2.69	2.61	2.55	2.51	2.47	2.44
	.050	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18
	.010	10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35
	.001	22.86	16.39	13.90	12.56	11.71	11.13	10.70	10.37	10.11
10	.100	3.29	2.92	2.73	2.61	2.52	2.46	2.41	2.38	2.35
	.050	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02
	.010	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94
	.001	21.04	14.91	12.55	11.28	10.48	9.93	9.52	9.20	8.96
11	.100	3.23	2.86	2.66	2.54	2.45	2.39	2.34	2.30	2.27
	.050	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90
	.010	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63
	.001	19.69	13.81	11.56	10.35	9.58	9.05	8.66	8.35	8.12
12	.100	3.18	2.81	2.61	2.48	2.39	2.33	2.28	2.24	2.21
	.050	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80
	.010	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39
	.001	18.64	12.97	10.80	9.63	8.89	8.38	8.00	7.71	7.48

(continued)

Table A.9 Critical Values for *F* Distributions *(cont.)*

ν_1 = numerator df										
10	**12**	**15**	**20**	**25**	**30**	**40**	**50**	**60**	**120**	**1000**
60.19	60.71	61.22	61.74	62.05	62.26	62.53	62.69	62.79	63.06	63.30
241.88	243.91	245.95	248.01	249.26	250.10	251.14	251.77	252.20	253.25	254.19
6055.80	6106.30	6157.30	6208.70	6239.80	6260.60	6286.80	6302.50	6313.00	6339.40	6362.70
605,621	610,668	615,764	620,908	624,017	626,099	628,712	630,285	631,337	633,972	636,301
9.39	9.41	9.42	9.44	9.45	9.46	9.47	9.47	9.47	9.48	9.49
19.40	19.41	19.43	19.45	19.46	19.46	19.47	19.48	19.48	19.49	19.49
99.40	99.42	99.43	99.45	99.46	99.47	99.47	99.48	99.48	99.49	99.50
999.40	999.42	999.43	999.45	999.46	999.47	999.47	999.48	999.48	999.49	999.50
5.23	5.22	5.20	5.18	5.17	5.17	5.16	5.15	5.15	5.14	5.13
8.79	8.74	8.70	8.66	8.63	8.62	8.59	8.58	8.57	8.55	8.53
27.23	27.05	26.87	26.69	26.58	26.50	26.41	26.35	26.32	26.22	26.14
129.25	128.32	127.37	126.42	125.84	125.45	124.96	124.66	124.47	123.97	123.53
3.92	3.90	3.87	3.84	3.83	3.82	3.80	3.80	3.79	3.78	3.76
5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.70	5.69	5.66	5.63
14.55	14.37	14.20	14.02	13.91	13.84	13.75	13.69	13.65	13.56	13.47
48.05	47.41	46.76	46.10	45.70	45.43	45.09	44.88	44.75	44.40	44.09
3.30	3.27	3.24	3.21	3.19	3.17	3.16	3.15	3.14	3.12	3.11
4.74	4.68	4.62	4.56	4.52	4.50	4.46	4.44	4.43	4.40	4.37
10.05	9.89	9.72	9.55	9.45	9.38	9.29	9.24	9.20	9.11	9.03
26.92	26.42	25.91	25.39	25.08	24.87	24.60	24.44	24.33	24.06	23.82
2.94	2.90	2.87	2.84	2.81	2.80	2.78	2.77	2.76	2.74	2.72
4.06	4.00	3.94	3.87	3.83	3.81	3.77	3.75	3.74	3.70	3.67
7.87	7.72	7.56	7.40	7.30	7.23	7.14	7.09	7.06	6.97	6.89
18.41	17.99	17.56	17.12	16.85	16.67	16.44	16.31	16.21	15.98	15.77
2.70	2.67	2.63	2.59	2.57	2.56	2.54	2.52	2.51	2.49	2.47
3.64	3.57	3.51	3.44	3.40	3.38	3.34	3.32	3.30	3.27	3.23
6.62	6.47	6.31	6.16	6.06	5.99	5.91	5.86	5.82	5.74	5.66
14.08	13.71	13.32	12.93	12.69	12.53	12.33	12.20	12.12	11.91	11.72
2.54	2.50	2.46	2.42	2.40	2.38	2.36	2.35	2.34	2.32	2.30
3.35	3.28	3.22	3.15	3.11	3.08	3.04	3.02	3.01	2.97	2.93
5.81	5.67	5.52	5.36	5.26	5.20	5.12	5.07	5.03	4.95	4.87
11.54	11.19	10.84	10.48	10.26	10.11	9.92	9.80	9.73	9.53	9.36
2.42	2.38	2.34	2.30	2.27	2.25	2.23	2.22	2.21	2.18	2.16
3.14	3.07	3.01	2.94	2.89	2.86	2.83	2.80	2.79	2.75	2.71
5.26	5.11	4.96	4.81	4.71	4.65	4.57	4.52	4.48	4.40	4.32
9.89	9.57	9.24	8.90	8.69	8.55	8.37	8.26	8.19	8.00	7.84
2.32	2.28	2.24	2.20	2.17	2.16	2.13	2.12	2.11	2.08	2.06
2.98	2.91	2.85	2.77	2.73	2.70	2.66	2.64	2.62	2.58	2.54
4.85	4.71	4.56	4.41	4.31	4.25	4.17	4.12	4.08	4.00	3.92
8.75	8.45	8.13	7.80	7.60	7.47	7.30	7.19	7.12	6.94	6.78
2.25	2.21	2.17	2.12	2.10	2.08	2.05	2.04	2.03	2.00	1.98
2.85	2.79	2.72	2.65	2.60	2.57	2.53	2.51	2.49	2.45	2.41
4.54	4.40	4.25	4.10	4.01	3.94	3.86	3.81	3.78	3.69	3.61
7.92	7.63	7.32	7.01	6.81	6.68	6.52	6.42	6.35	6.18	6.02
2.19	2.15	2.10	2.06	2.03	2.01	1.99	1.97	1.96	1.93	1.91
2.75	2.69	2.62	2.54	2.50	2.47	2.43	2.40	2.38	2.34	2.30
4.30	4.16	4.01	3.86	3.76	3.70	3.62	3.57	3.54	3.45	3.37
7.29	7.00	6.71	6.40	6.22	6.09	5.93	5.83	5.76	5.59	5.44

(continued)

Table A.9 Critical Values for *F* Distributions (*cont.*)

ν_2 = denominator df	α	ν_1 = numerator df: 1	2	3	4	5	6	7	8	9
13	.100	3.14	2.76	2.56	2.43	2.35	2.28	2.23	2.20	2.16
	.050	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71
	.010	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19
	.001	17.82	12.31	10.21	9.07	8.35	7.86	7.49	7.21	6.98
14	.100	3.10	2.73	2.52	2.39	2.31	2.24	2.19	2.15	2.12
	.050	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65
	.010	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03
	.001	17.14	11.78	9.73	8.62	7.92	7.44	7.08	6.80	6.58
15	.100	3.07	2.70	2.49	2.36	2.27	2.21	2.16	2.12	2.09
	.050	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59
	.010	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89
	.001	16.59	11.34	9.34	8.25	7.57	7.09	6.74	6.47	6.26
16	.100	3.05	2.67	2.46	2.33	2.24	2.18	2.13	2.09	2.06
	.050	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54
	.010	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78
	.001	16.12	10.97	9.01	7.94	7.27	6.80	6.46	6.19	5.98
17	.100	3.03	2.64	2.44	2.31	2.22	2.15	2.10	2.06	2.03
	.050	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49
	.010	8.40	6.11	5.19	4.67	4.34	4.10	3.93	3.79	3.68
	.001	15.72	10.66	8.73	7.68	7.02	6.56	6.22	5.96	5.75
18	.100	3.01	2.62	2.42	2.29	2.20	2.13	2.08	2.04	2.00
	.050	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46
	.010	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60
	.001	15.38	10.39	8.49	7.46	6.81	6.35	6.02	5.76	5.56
19	.100	2.99	2.61	2.40	2.27	2.18	2.11	2.06	2.02	1.98
	.050	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42
	.010	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52
	.001	15.08	10.16	8.28	7.27	6.62	6.18	5.85	5.59	5.39
20	.100	2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96
	.050	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39
	.010	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46
	.001	14.82	9.95	8.10	7.10	6.46	6.02	5.69	5.44	5.24
21	.100	2.96	2.57	2.36	2.23	2.14	2.08	2.02	1.98	1.95
	.050	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37
	.010	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40
	.001	14.59	9.77	7.94	6.95	6.32	5.88	5.56	5.31	5.11
22	.100	2.95	2.56	2.35	2.22	2.13	2.06	2.01	1.97	1.93
	.050	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34
	.010	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35
	.001	14.38	9.61	7.80	6.81	6.19	5.76	5.44	5.19	4.99
23	.100	2.94	2.55	2.34	2.21	2.11	2.05	1.99	1.95	1.92
	.050	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32
	.010	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30
	.001	14.20	9.47	7.67	6.70	6.08	5.65	5.33	5.09	4.89
24	.100	2.93	2.54	2.33	2.19	2.10	2.04	1.98	1.94	1.91
	.050	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30
	.010	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26
	.001	14.03	9.34	7.55	6.59	5.98	5.55	5.23	4.99	4.80

(*continued*)

Table A.9 Critical Values for F Distributions *(cont.)*

ν_1 = numerator df										
10	12	15	20	25	30	40	50	60	120	1000
2.14	2.10	2.05	2.01	1.98	1.96	1.93	1.92	1.90	1.88	1.85
2.67	2.60	2.53	2.46	2.41	2.38	2.34	2.31	2.30	2.25	2.21
4.10	3.96	3.82	3.66	3.57	3.51	3.43	3.38	3.34	3.25	3.18
6.80	6.52	6.23	5.93	5.75	5.63	5.47	5.37	5.30	5.14	4.99
2.10	2.05	2.01	1.96	1.93	1.91	1.89	1.87	1.86	1.83	1.80
2.60	2.53	2.46	2.39	2.34	2.31	2.27	2.24	2.22	2.18	2.14
3.94	3.80	3.66	3.51	3.41	3.35	3.27	3.22	3.18	3.09	3.02
6.40	6.13	5.85	5.56	5.38	5.25	5.10	5.00	4.94	4.77	4.62
2.06	2.02	1.97	1.92	1.89	1.87	1.85	1.83	1.82	1.79	1.76
2.54	2.48	2.40	2.33	2.28	2.25	2.20	2.18	2.16	2.11	2.07
3.80	3.67	3.52	3.37	3.28	3.21	3.13	3.08	3.05	2.96	2.88
6.08	5.81	5.54	5.25	5.07	4.95	4.80	4.70	4.64	4.47	4.33
2.03	1.99	1.94	1.89	1.86	1.84	1.81	1.79	1.78	1.75	1.72
2.49	2.42	2.35	2.28	2.23	2.19	2.15	2.12	2.11	2.06	2.02
3.69	3.55	3.41	3.26	3.16	3.10	3.02	2.97	2.93	2.84	2.76
5.81	5.55	5.27	4.99	4.82	4.70	4.54	4.45	4.39	4.23	4.08
2.00	1.96	1.91	1.86	1.83	1.81	1.78	1.76	1.75	1.72	1.69
2.45	2.38	2.31	2.23	2.18	2.15	2.10	2.08	2.06	2.01	1.97
3.59	3.46	3.31	3.16	3.07	3.00	2.92	2.87	2.83	2.75	2.66
5.58	5.32	5.05	4.78	4.60	4.48	4.33	4.24	4.18	4.02	3.87
1.98	1.93	1.89	1.84	1.80	1.78	1.75	1.74	1.72	1.69	1.66
2.41	2.34	2.27	2.19	2.14	2.11	2.06	2.04	2.02	1.97	1.92
3.51	3.37	3.23	3.08	2.98	2.92	2.84	2.78	2.75	2.66	2.58
5.39	5.13	4.87	4.59	4.42	4.30	4.15	4.06	4.00	3.84	3.69
1.96	1.91	1.86	1.81	1.78	1.76	1.73	1.71	1.70	1.67	1.64
2.38	2.31	2.23	2.16	2.11	2.07	2.03	2.00	1.98	1.93	1.88
3.43	3.30	3.15	3.00	2.91	2.84	2.76	2.71	2.67	2.58	2.50
5.32	4.97	4.70	4.43	4.26	4.14	3.99	3.90	3.84	3.68	3.53
1.94	1.89	1.84	1.79	1.76	1.74	1.71	1.69	1.68	1.64	1.61
2.35	2.28	2.20	2.12	2.07	2.04	1.99	1.97	1.95	1.90	1.85
3.37	3.23	3.09	2.94	2.84	2.78	2.69	2.64	2.61	2.52	2.43
5.08	4.82	4.56	4.29	4.12	4.00	3.86	3.77	3.70	3.54	3.40
1.92	1.87	1.83	1.78	1.74	1.72	1.69	1.67	1.66	1.62	1.59
2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.94	1.92	1.87	1.82
3.31	3.17	3.03	2.88	2.79	2.72	2.64	2.58	2.55	2.46	2.37
4.95	4.70	4.44	4.17	4.00	3.88	3.74	3.64	3.58	3.42	3.28
1.90	1.86	1.81	1.76	1.73	1.70	1.67	1.65	1.64	1.60	1.57
2.30	2.23	2.15	2.07	2.02	1.98	1.94	1.91	1.89	1.84	1.79
3.26	3.12	2.98	2.83	2.73	2.67	2.58	2.53	2.50	2.40	2.32
4.83	4.58	4.33	4.06	3.89	3.78	3.63	3.54	3.48	3.32	3.17
1.89	1.84	1.80	1.74	1.71	1.69	1.66	1.64	1.62	1.59	1.55
2.27	2.20	2.13	2.05	2.00	1.96	1.91	1.88	1.86	1.81	1.76
3.21	3.07	2.93	2.78	2.69	2.62	2.54	2.48	2.45	2.35	2.27
4.73	4.48	4.23	3.96	3.79	3.68	3.53	3.44	3.38	3.22	3.08
1.88	1.83	1.78	1.73	1.70	1.67	1.64	1.62	1.61	1.57	1.54
2.25	2.18	2.11	2.03	1.97	1.94	1.89	1.86	1.84	1.79	1.74
3.17	3.03	2.89	2.74	2.64	2.58	2.49	2.44	2.40	2.31	2.22
4.64	4.39	4.14	3.87	3.71	3.59	3.45	3.36	3.29	3.14	2.99

(continued)

Table A.9 Critical Values for *F* Distributions (*cont.*)

		ν_1 = numerator df								
	α	1	2	3	4	5	6	7	8	9
25	.100	2.92	2.53	2.32	2.18	2.09	2.02	1.97	1.93	1.89
	.050	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28
	.010	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22
	.001	13.88	9.22	7.45	6.49	5.89	5.46	5.15	4.91	4.71
26	.100	2.91	2.52	2.31	2.17	2.08	2.01	1.96	1.92	1.88
	.050	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27
	.010	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18
	.001	13.74	9.12	7.36	6.41	5.80	5.38	5.07	4.83	4.64
27	.100	2.90	2.51	2.30	2.17	2.07	2.00	1.95	1.91	1.87
	.050	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25
	.010	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.26	3.15
	.001	13.61	9.02	7.27	6.33	5.73	5.31	5.00	4.76	4.57
28	.100	2.89	2.50	2.29	2.16	2.06	2.00	1.94	1.90	1.87
	.050	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24
	.010	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12
	.001	13.50	8.93	7.19	6.25	5.66	5.24	4.93	4.69	4.50
29	.100	2.89	2.50	2.28	2.15	2.06	1.99	1.93	1.89	1.86
	.050	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22
	.010	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.09
	.001	13.39	8.85	7.12	6.19	5.59	5.18	4.87	4.64	4.45
30	.100	2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85
	.050	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21
	.010	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07
	.001	13.29	8.77	7.05	6.12	5.53	5.12	4.82	4.58	4.39
40	.100	2.84	2.44	2.23	2.09	2.00	1.93	1.87	1.83	1.79
	.050	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12
	.010	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89
	.001	12.61	8.25	6.59	5.70	5.13	4.73	4.44	4.21	4.02
50	.100	2.81	2.41	2.20	2.06	1.97	1.90	1.84	1.80	1.76
	.050	4.03	3.18	2.79	2.56	2.40	2.29	2.20	2.13	2.07
	.010	7.17	5.06	4.20	3.72	3.41	3.19	3.02	2.89	2.78
	.001	12.22	7.96	6.34	5.46	4.90	4.51	4.22	4.00	3.82
60	.100	2.79	2.39	2.18	2.04	1.95	1.87	1.82	1.77	1.74
	.050	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04
	.010	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72
	.001	11.97	7.77	6.17	5.31	4.76	4.37	4.09	3.86	3.69
100	.100	2.76	2.36	2.14	2.00	1.91	1.83	1.78	1.73	1.69
	.050	3.94	3.09	2.70	2.46	2.31	2.19	2.10	2.03	1.97
	.010	6.90	4.82	3.98	3.51	3.21	2.99	2.82	2.69	2.59
	.001	11.50	7.41	5.86	5.02	4.48	4.11	3.83	3.61	3.44
200	.100	2.73	2.33	2.11	1.97	1.88	1.80	1.75	1.70	1.66
	.050	3.89	3.04	2.65	2.42	2.26	2.14	2.06	1.98	1.93
	.010	6.76	4.71	3.88	3.41	3.11	2.89	2.73	2.60	2.50
	.001	11.15	7.15	5.63	4.81	4.29	3.92	3.65	3.43	3.26
1000	.100	2.71	2.31	2.09	1.95	1.85	1.78	1.72	1.68	1.64
	.050	3.85	3.00	2.61	2.38	2.22	2.11	2.02	1.95	1.89
	.010	6.66	4.63	3.80	3.34	3.04	2.82	2.66	2.53	2.43
	.001	10.89	6.96	5.46	4.65	4.14	3.78	3.51	3.30	3.13

ν_2 = denominator df

(continued)

Table A.9 Critical Values for *F* Distributions *(cont.)*

ν_1 = numerator df										
10	12	15	20	25	30	40	50	60	120	1000
1.87	1.82	1.77	1.72	1.68	1.66	1.63	1.61	1.59	1.56	1.52
2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.84	1.82	1.77	1.72
3.13	2.99	2.85	2.70	2.60	2.54	2.45	2.40	2.36	2.27	2.18
4.56	4.31	4.06	3.79	3.63	3.52	3.37	3.28	3.22	3.06	2.91
1.86	1.81	1.76	1.71	1.67	1.65	1.61	1.59	1.58	1.54	1.51
2.22	2.15	2.07	1.99	1.94	1.90	1.85	1.82	1.80	1.75	1.70
3.09	2.96	2.81	2.66	2.57	2.50	2.42	2.36	2.33	2.23	2.14
4.48	4.24	3.99	3.72	3.56	3.44	3.30	3.21	3.15	2.99	2.84
1.85	1.80	1.75	1.70	1.66	1.64	1.60	1.58	1.57	1.53	1.50
2.20	2.13	2.06	1.97	1.92	1.88	1.84	1.81	1.79	1.73	1.68
3.06	2.93	2.78	2.63	2.54	2.47	2.38	2.33	2.29	2.20	2.11
4.41	4.17	3.92	3.66	3.49	3.38	3.23	3.14	3.08	2.92	2.78
1.84	1.79	1.74	1.69	1.65	1.63	1.59	1.57	1.56	1.52	1.48
2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.79	1.77	1.71	1.66
3.03	2.90	2.75	2.60	2.51	2.44	2.35	2.30	2.26	2.17	2.08
4.35	4.11	3.86	3.60	3.43	3.32	3.18	3.09	3.02	2.86	2.72
1.83	1.78	1.73	1.68	1.64	1.62	1.58	1.56	1.55	1.51	1.47
2.18	2.10	2.03	1.94	1.89	1.85	1.81	1.77	1.75	1.70	1.65
3.00	2.87	2.73	2.57	2.48	2.41	2.33	2.27	2.23	2.14	2.05
4.29	4.05	3.80	3.54	3.38	3.27	3.12	3.03	2.97	2.81	2.66
1.82	1.77	1.72	1.67	1.63	1.61	1.57	1.55	1.54	1.50	1.46
2.16	2.09	2.01	1.93	1.88	1.84	1.79	1.76	1.74	1.68	1.63
2.98	2.84	2.70	2.55	2.45	2.39	2.30	2.25	2.21	2.11	2.02
4.24	4.00	3.75	3.49	3.33	3.22	3.07	2.98	2.92	2.76	2.61
1.76	1.71	1.66	1.61	1.57	1.54	1.51	1.48	1.47	1.42	1.38
2.08	2.00	1.92	1.84	1.78	1.74	1.69	1.66	1.64	1.58	1.52
2.80	2.66	2.52	2.37	2.27	2.20	2.11	2.06	2.02	1.92	1.82
3.87	3.64	3.40	3.14	2.98	2.87	2.73	2.64	2.57	2.41	2.25
1.73	1.68	1.62	1.57	1.53	1.50	1.46	1.44	1.42	1.38	1.33
2.03	1.95	1.87	1.78	1.73	1.69	1.63	1.60	1.58	1.51	1.45
2.70	2.56	2.42	2.27	2.17	2.10	2.01	1.95	1.91	1.80	1.70
3.67	3.44	3.20	2.95	2.79	2.68	2.53	2.44	2.38	2.21	2.05
1.71	1.66	1.60	1.54	1.50	1.48	1.44	1.41	1.40	1.35	1.30
1.99	1.92	1.84	1.75	1.69	1.65	1.59	1.56	1.53	1.47	1.40
2.63	2.50	2.35	2.20	2.10	2.03	1.94	1.88	1.84	1.73	1.62
3.54	3.32	3.08	2.83	2.67	2.55	2.41	2.32	2.25	2.08	1.92
1.66	1.61	1.56	1.49	1.45	1.42	1.38	1.35	1.34	1.28	1.22
1.93	1.85	1.77	1.68	1.62	1.57	1.52	1.48	1.45	1.38	1.30
2.50	2.37	2.22	2.07	1.97	1.89	1.80	1.74	1.69	1.57	1.45
3.30	3.07	2.84	2.59	2.43	2.32	2.17	2.08	2.01	1.83	1.64
1.63	1.58	1.52	1.46	1.41	1.38	1.34	1.31	1.29	1.23	1.16
1.88	1.80	1.72	1.62	1.56	1.52	1.46	1.41	1.39	1.30	1.21
2.41	2.27	2.13	1.97	1.87	1.79	1.69	1.63	1.58	1.45	1.30
3.12	2.90	2.67	2.42	2.26	2.15	2.00	1.90	1.83	1.64	1.43
1.61	1.55	1.49	1.43	1.38	1.35	1.30	1.27	1.25	1.18	1.08
1.84	1.76	1.68	1.58	1.52	1.47	1.41	1.36	1.33	1.24	1.11
2.34	2.20	2.06	1.90	1.79	1.72	1.61	1.54	1.50	1.35	1.16
2.99	2.77	2.54	2.30	2.14	2.02	1.87	1.77	1.69	1.49	1.22