

單選題(共100題, 每題1分, 共100分)

- 1) Economics is best defined as the study of how people
 - A) attain wealth.
 - B) use their infinite resources.
 - C) choose abundance over scarcity.
 - D) make choices to cope with scarcity.

- 2) A monopolistically competitive firm has _____ power to set the price of its product because _____.
 - A) no; there are no barriers to entry
 - B) no; of product differentiation
 - C) some; there are barriers to entry
 - D) some; of product differentiation

- 3) An externality can be a
 - A) benefit but not a cost.
 - B) cost or a benefit.
 - C) cost but not a benefit.
 - D) marginal cost but not a total cost.

- 4) The use of government purchases and taxes to manipulate the economy is known as
 - A) anti-stabilization policy.
 - B) balancing the budget.
 - C) federal expenditure.
 - D) fiscal policy.

- 5) Consider the market for hot dogs. If the government imposes a tax on hot dogs,
 - A) the marginal cost and marginal benefit of hot dogs will decrease.
 - B) deadweight loss will be minimized.
 - C) there will be a gain of producer surplus.
 - D) there will be a loss of consumer surplus.

- 6) The marginal revenue curve for a single-price monopoly
 - A) lies above its demand curve.
 - B) is horizontal.
 - C) lies below its demand curve.
 - D) coincides with its demand curve.

- 7) Advertising by firms in monopolistic competition
 - A) can persuade customers that product differentiation exists.
 - B) provides consumers with no useful information.
 - C) wastes resources because the entry of rivals forces firms to be price takers.
 - D) does not occur.

- 8) Monetarists contend that
 - A) increases in money growth increase investment.
 - B) exports decrease as a result of an increase in money growth.
 - C) wages are "sticky" the entire time that the economy is in a recession.
 - D) the Keynesian multiplier is too small.

- 9) If taxes exactly equaled government expenditures in a year the
 - A) federal government debt would decrease.
 - B) budget deficit would be zero.
 - C) budget deficit would not change.
 - D) federal government debt would be zero.

- 10) A price _____ makes it illegal to pay a lower price than the specified level. One example is
 - A) floor; the minimum wage.
 - B) ceiling; rent control.
 - C) ceiling; the minimum wage.
 - D) floor; rent control.

- 11) All of the following are a current account transaction EXCEPT
 - A) importing services.
 - B) importing goods.
 - C) investing abroad.
 - D) exporting goods.
- 12) A large part of the principal-agent problem stems from the desire of
 - A) principals to avoid working.
 - B) agents to work hard.
 - C) principals to work hard.
 - D) agents to avoid working.
- 13) On-the-job-training is an example of
 - A) investment in human capital.
 - B) investment in physical capital.
 - C) technological change.
 - D) increasing labor force participation.
- 14) An example of a variable resource in the short run is
 - A) capital equipment.
 - B) land.
 - C) an employee.
 - D) a building.
- 15) Net investment during a year equals
 - A) the change in investment spending and the change in government expenditures on infrastructure.
 - B) the change in capital stock over the year.
 - C) exports minus imports.
 - D) the change in inventories over the year.
- 16) An increase in the value of a domestic currency in terms of other currencies is known as
 - A) an appreciation.
 - B) a depreciation.
 - C) a term not given in the above answers.
 - D) a flexible exchange rate.
- 17) In perfect competition, an individual firm
 - A) has a price elasticity of supply equal to infinity.
 - B) faces unitary elasticity of demand.
 - C) faces infinitely elastic demand.
 - D) has a price elasticity of supply equal to one.
- 18) Income earned by owners of capital is classified as
 - A) commission payments.
 - B) rent payments.
 - C) wages and salaries.
 - D) interest payments.
- 19) The consumption function shifts upward when
 - A) saving increases.
 - B) disposable income increases.
 - C) the population decreases.
 - D) wealth increases.
- 20) Monetarists would try to control inflation by
 - A) letting the quantity of money vary with needs.
 - B) increasing tax rates.
 - C) a constant rate of growth of the quantity of money.
 - D) decreasing government purchases.
- 21) The tools at the disposal of the Fed for changing the quantity of money do NOT include
 - A) changing discount rates.
 - B) open market operations.
 - C) changing the required reserve ratio.
 - D) increasing the number of commercial banks.

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- 22) In computing GDP, it is essential to
- include government tax revenues.
 - include government transfer payments.
 - avoid double counting.
 - count all intermediate products directly as they are produced.
- 23) Comparative advantage implies that a country will
- export those goods in which the country has a comparative advantage.
 - find it difficult to conclude free trade agreements with other nations.
 - import those goods in which the country has a comparative advantage.
 - export goods produced by domestic industries with low wages relative to its trading partners.
- 24) Measured wealth is a less accurate indicator of economic inequality than is measured income because measured wealth excludes
- owner-occupied housing.
 - human capital.
 - depreciation.
 - financial assets.
- 25) Perfect competition is an industry with
- a few firms producing goods that differ somewhat in quality.
 - a few firms producing identical goods.
 - many firms producing identical goods.
 - many firms producing goods that differ somewhat.
- 26) The Keynesian explanation of the business cycle rests on several concepts, including
- shocks to the rate of technological change.
 - sticky money wage rates.
 - the desire of politicians to be re-elected.
 - unstable monetary policy by the Fed.
- 27) Any production point outside the production possibilities frontier
- is unattainable.
 - is attainable only if prices rise.
 - is attainable only if prices fall.
 - is associated with unused resources.
- 28) If the marginal revenue product of labor exceeds the wage rate, a firm in a competitive labor market will
- pay a higher wage.
 - employ more labor.
 - pay a lower wage.
 - employ less labor.
- 29) If the Fed responds to an increase in aggregate demand by increasing the quantity of money,
- there may be continued inflation.
 - wages will fall to reduce the unemployment.
 - nothing happens because aggregate demand had already increased.
 - output will begin to decrease more rapidly than otherwise.
- 30) In order to promote long-term economic growth via investment in new technologies, the government can
- raise interest rates.
 - provide tax incentives for research and development activities.
 - use discretionary fiscal policy.
 - increase the quantity of money.

- 31) The variables that determine a household's budget line are
 A) its preferences and income. B) prices and income.
 C) its preferences and prices. D) None of the above are correct.
- 32) What is measured on the vertical axis of a diagram showing the aggregate supply curve?
 A) the interest rate B) real national income
 C) nominal income D) the price level
- 33) Which of the following statements can be used to describe efficiency?
 I. Efficiently using resources means that producers make the highest profits possible.
 II. Using resources efficiently means that we cannot produce more of one good without producing less of another good that has a higher value.
 III. Resource use is efficient when we produce goods and services that people value most highly.
 A) I and II B) I only C) I, II and III D) II and III
- 34) A shift in the aggregate expenditure curve as a result of an increase in the price level results in a
 A) rightward shift in the aggregate demand curve.
 B) movement down along the aggregate demand curve.
 C) leftward shift in the aggregate demand curve.
 D) movement up along the aggregate demand curve.
- 35) The opportunity cost of any action is
 A) the time required but not the monetary cost. B) all the possible alternatives forgone.
 C) the monetary cost but not the time required. D) the highest-valued alternative forgone.
- 36) Gina is eating two slices of pizza. Which of the following statements is true?
 A) Gina's marginal benefit from the second slice of pizza equals the maximum she is willing to pay for the second slice.
 B) Gina must have some consumer surplus from the second slice of pizza.
 C) Gina's marginal benefit from the second slice of pizza is equal to the sum of the benefit from the first slice plus the benefit from the second slice.
 D) Gina can not have any consumer surplus from the second slice of pizza.
- 37) If the Fed wants to increase the quantity of money, it can
 A) sell government securities in the open market. B) instruct banks to print more money.
 C) raise the required reserve ratio. D) buy government securities on the open market.
- 38) If the quantity of labor supplied equals the quantity of labor demanded,
 A) the economy has an above the full-employment equilibrium.
 B) the economy is operating on the long-run aggregate supply curve.
 C) the income effect equals the opportunity cost effect.
 D) the real wage equals the money wage.
- 39) If the marginal social cost of pollution equals the marginal external cost of pollution, then the marginal private cost of pollution
 A) equals the marginal private benefit. B) equals the marginal social cost.
 C) equals the marginal social benefit. D) is zero.

- 40) Firms in monopolistic competition always will
- A) produce at the minimum average total cost.
 - B) earn an economic profit.
 - C) set their price above their marginal cost.
 - D) set their price equal to their marginal cost.
- 41) Suppose the data show that an unanticipated change in tax rates caused a recent recession. These data support which model of the business cycle?
- A) new Keynesian
 - B) new classical
 - C) real business cycle
 - D) Both answers A and B are correct.
- 42) Let MU_a and MU_b stand for the marginal utilities of apples and bagels. Let P_a and P_b stand for their prices. The general necessary condition for consumer equilibrium is
- A) $MU_a / MU_b = P_b / P_a$.
 - B) $MU_a = MU_b$ and $P_a = P_b$.
 - C) $MU_a = MU_b$.
 - D) $MU_a / P_a = MU_b / P_b$.
- 43) Markets allow economic growth to occur by promoting
- A) specialization.
 - B) enforcement of property rights.
 - C) exchange of goods and services.
 - D) Both answers A and C are correct.
- 44) The price elasticity of demand measures
- A) how often the price of a good changes.
 - B) the slope of a budget curve.
 - C) the responsiveness of the quantity demanded to changes in price.
 - D) how sensitive the quantity demanded is to changes in demand.
- 45) Full employment means that
- A) there is no cyclical unemployment.
 - B) there is no structural or frictional unemployment.
 - C) there is no cyclical or frictional unemployment.
 - D) no one is unemployed.
- 46) The term "business cycle" most closely refers to the
- A) fiscal year.
 - B) accounting period used by firms.
 - C) fluctuating profits of firms.
 - D) alternating periods of expansions and recessions.
- 47) Demand is perfectly inelastic when
- A) shifts of the supply curve results in no change in quantity demanded.
 - B) the good in question has perfect substitutes.
 - C) shifts of the supply curve results in no change in the total revenue from sales.
 - D) shifts in the supply curve results in no change in price.
- 48) Investment includes
- A) purchases of stocks and bonds.
 - B) purchases of new assembly lines.
 - C) additions to inventories.
 - D) Both answers B and C are correct.

- 49) The economic profit of a perfectly competitive firm
- is greater than its total revenue.
 - equals its total revenue.
 - is less than its total revenue if its supply curve is inelastic and is greater than its total revenue if its supply curve is elastic.
 - is less than its total revenue.
- 50) Initially in a cost-push inflation
- the price level rises and real GDP decreases.
 - only real GDP changes while the price level remains constant.
 - the price level and real GDP both increase.
 - All of the above answers are correct.
- 51) Diminishing marginal utility is
- an implication of utility theory.
 - a result of the law of demand.
 - a result of the law of supply.
 - an assumption of utility theory.
- 52) Which of the following correctly completes this statement? Gains from trade are
- the same as decreasing costs of production.
 - unrelated to the terms of trade.
 - obtained when a country can consume beyond its production possibilities frontier.
 - All of the above answers are correct.
- 53) Efficiency in the provision of a public good is achieved when its
- marginal benefit equals its marginal cost.
 - average benefit equals its average cost.
 - total benefit equals its total cost.
 - marginal benefit equals zero.
- 54) In a regulated natural monopoly, a marginal cost pricing rule maximizes
- economic profit.
 - total costs.
 - producer surplus.
 - total surplus.
- 55) The demand for a good increases when the price of a substitute _____ and also increases when the price of a complement _____.
- falls; rises
 - rises; falls
 - falls; falls
 - rises; rises
- 56) "When the cost of producing a unit of a good falls because the firm uses specialized resources to produce a range of goods and services" is the definition of
- economic efficiency.
 - economies of scope.
 - economies of scale.
 - technological efficiency.
- 57) When the cost of producing a unit of a good decreases as its output rate increases, there are economies of
- production.
 - size.
 - scale.
 - scope.
- 58) An efficiency wage is a wage
- such that the quantity of labor demanded exceeds the quantity of labor supplied.
 - that reduces unemployment to zero.
 - that is the equilibrium wage only when the economy is producing at its potential GDP.
 - at which there are no discouraged workers.

- 59) By definition, an inferior good is a
- A) good for which demand decreases when its price rises.
 - B) normal substitute good.
 - C) want that is not expressed by demand.
 - D) good for which demand decreases when income increases.
- 60) The _____ the expected profit rate from new capital, the greater is the _____.
- A) greater; investment demand
 - B) lower; capital stock
 - C) lower; investment demand
 - D) None of the above answers is correct
- 61) When disposable income equals consumption expenditure, then
- A) the $MPC = zero$.
 - B) saving is zero.
 - C) the $MPS = zero$.
 - D) None of the above are correct.
- 62) The short-run aggregate supply curve is
- A) negatively sloped.
 - B) horizontal.
 - C) positively sloped.
 - D) vertical.
- 63) The annual return on a stock consists of
- A) the dividends divided by the price of the stock.
 - B) only the dividends paid to stockholders.
 - C) the dividends multiplied by the number of shares outstanding.
 - D) the dividends plus the change in the price of the stock.
- 64) The law of diminishing returns implies that, with the use of capital fixed, as the use of labor rises,
- A) the total product of labor will fall below the marginal product of labor.
 - B) the production process will become technologically inefficient eventually.
 - C) total product will fall eventually.
 - D) the marginal product of labor will fall eventually.
- 65) The quantity of goods and services that an hour of labor earns is defined as the
- A) marginal product of labor.
 - B) money wage rate.
 - C) supply of labor.
 - D) real wage rate.
- 66) The demand for a good is elastic if
- A) a decrease in its price results in a decrease in total revenue.
 - B) an increase in its price results in an increase in total revenue.
 - C) an increase in its price results in a decrease in total revenue.
 - D) the good is a necessity.
- 67) The most important sources of economic growth include all of the following EXCEPT
- A) investment in human capital.
 - B) technological change.
 - C) growth in labor productivity.
 - D) growth in government assistance to industry.
- 68) _____ points out that a rise in the price level decreases the value of real wealth, which then decreases consumption.
- A) The interest rate effect
 - B) The substitution effect
 - C) The open-economy effect
 - D) The wealth effect

- 69) Regulation refers to
 A) the formation of monopolies. B) rules administered by a government agency.
 C) cartelization of a competitive industry. D) the discipline of the marketplace.
- 70) A tax is regressive if the average tax rate
 A) increases as income increases. B) is less than one.
 C) is negative. D) increases as income decreases.
- 71) The aggregate demand curve is shifted rightward by
 A) an increase in tax rates. B) a decrease in government purchases.
 C) an increase in government purchases. D) an increase in the federal budget surplus.
- 72) If Sam is producing at a point on his production possibilities frontier, then he
 A) is not subject to scarcity.
 B) will be unable to gain from trade.
 C) can produce more of one good only by producing less of the other.
 D) cannot produce any more of either good.
- 73) The statement "An increase in the price of gasoline will lead to a decrease in the amount purchased" is
 A) a positive statement. B) a normative statement.
 C) a political statement. D) a scientific statement.
- 74) Higher anticipated inflation
 A) has no effect on investment.
 B) cannot affect tax rates unless the government enacts fiscal policy.
 C) has no effect on nominal interest rates.
 D) lowers the after-tax real interest rates.
- 75) An advantage of the corporate form of organization is that
 A) owners have joint unlimited liability. B) owners have individual unlimited liability.
 C) owners have limited liability. D) creditors have unlimited liability.
- 76) If the real interest rate rises, we would expect
 A) you to earn a higher income. B) you to decrease your expected future income.
 C) you to save more. D) you to save less.
- 77) Indifference curves
 A) are bowed out away from the origin. B) are straight lines with a positive slope.
 C) slope upward to the right. D) are bowed in toward the origin.
- 78) A stock's capital loss is _____
 A) the dividend paid on the stock B) a decrease in its price
 C) an increase in its price D) the retained earnings of the stock
- 79) When we cannot produce more of any good without giving up some other good that we value more highly, we have achieved
 A) equity. B) economic growth.
 C) production. D) allocative efficiency.

- 80) Sam's demand curve for pizza
- A) has one point in common with her marginal benefit curve for pizza.
 - B) is the same as her marginal benefit curve for pizza.
 - C) lies above her marginal benefit curve for pizza.
 - D) lies below her marginal benefit curve for pizza.
- 81) Credit cards are
- A) not a part of money because they are not a means of payment.
 - B) a part of M2 but not a part of M1.
 - C) a part of M1 but not of M2.
 - D) a part of money because they are used to purchase goods and services.
- 82) In the calculation of gross domestic product by the expenditure approach, the "investment" component is
- A) gross investment.
 - B) gross investment minus depreciation.
 - C) gross investment plus depreciation.
 - D) net investment.
- 83) If the demand for its product is inelastic, a monopoly's
- A) marginal revenue is equal to zero.
 - B) marginal revenue is negative.
 - C) total revenue increases when the firm lowers its price.
 - D) total revenue is unchanged when the firm lowers its price.
- 84) As the quantity of a good consumed increases, its marginal utility _____ and its total utility _____.
- A) increases; increases
 - B) decreases; increases
 - C) increases; decreases
 - D) decreases; decreases
- 85) The monetary base consists of
- A) demand deposits and vault cash.
 - B) government securities held by the Fed.
 - C) the quantity of money.
 - D) Federal Reserve notes, coins, and banks' deposits at the Fed.
- 86) An increase in the size of the multiplier can be caused by
- A) an increase in the marginal propensity to import.
 - B) an increase in the MPC.
 - C) an increase in the MPS.
 - D) a decrease in induced expenditures.
- 87) Good A and good B are substitutes in production. The demand for good A increases so that the price of good A rises. The increase in the price of good A shifts the
- A) supply curve of good B rightward.
 - B) demand curve for good B leftward.
 - C) supply curve of good B leftward.
 - D) demand curve for good B rightward.
- 88) The most important goal of the firm is to
- A) maximize its profits.
 - B) minimize its costs.
 - C) maximize its sales volume.
 - D) maximize its revenues.

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- 89) As a unit of account, money is used to
- A) state prices of all goods and services.
 - B) exchange for goods and services.
 - C) pay off future debts.
 - D) hold purchasing power over time.
- 90) Lowering the tariff on good X will
- A) increase the domestic imports of good X.
 - B) increase the domestic price of good X.
 - C) have no effect unless the nation's trading partner lowers its tariff on good X.
 - D) increase domestic employment in industry X.
- 91) Marginal cost is calculated as
- A) the increase in total cost divided by the increase in output.
 - B) total cost divided by output.
 - C) total cost minus total fixed cost.
 - D) the increase in total cost divided by the increase in labor, given the amount of capital.
- 92) When dealing with anything that is measured as a flow, one must
- A) make sure the thing can be measured accurately.
 - B) specify a time period.
 - C) use dollar values.
 - D) specify the point in time one is using.
- 93) Unregulated monopolies
- A) cannot change the market quantity.
 - B) can influence the market quantity and price.
 - C) cannot incorporate.
 - D) take the market price as given.
- 94) At the best affordable point, consumers equate their marginal rates of substitution to
- A) their money income.
 - B) relative quantities.
 - C) their real income.
 - D) relative prices.
- 95) A fall in the price of a good causes producers to reduce the quantity of the good they are willing to produce. This fact illustrates
- A) the law of supply.
 - B) a change in supply.
 - C) the nature of an inferior good.
 - D) the law of demand.
- 96) The difference between actual reserves and required reserves is
- A) net worth.
 - B) borrowings from the Fed.
 - C) illegal reserves.
 - D) excess reserves.
- 97) Nonrivalry is a feature of
- A) excludable goods.
 - B) all nonexcludable goods.
 - C) pure public goods.
 - D) goods but not services.
- 98) When the production possibilities frontier bows outward from the origin,
- A) some of society's resources are unemployed.
 - B) opportunity costs are decreasing.
 - C) opportunity costs are increasing.
 - D) opportunity costs are constant.

- 99) The marginal product of labor is the
- A) change in total product produced by hiring an additional unit of labor.
 - B) total revenue divided by units of labor.
 - C) revenue gained by employing one more unit of labor.
 - D) revenue gained by selling one more unit of output produced by hiring additional units of labor.
- 100) The closer an income Lorenz curve is to the line of equality, the
- A) less equally income is distributed.
 - B) slower income is growing.
 - C) more equally income is distributed.
 - D) faster income is growing.

1. Consider the matrix A and the vector v ,

$$A = \begin{pmatrix} -1 & 1 & 2 \\ -6 & 2 & 6 \\ 0 & 1 & 1 \end{pmatrix} \quad v = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$$

(5%) (a) Show that v is an eigenvector of A and find the corresponding eigenvalue.

(b) Diagonalize A by finding the eigenvalues and corresponding eigenvectors. Write down an invertible matrix P and a diagonal matrix D such that $P^{-1}AP = D$.

Check that $AP = PD$.

(10%) Find P^{-1} .

(c) The system of linear difference equations $x_t = Ax_{t-1}$ for $t \in \mathbb{N}$ is given by

$$\begin{aligned} x_t &= -x_{t-1} + y_{t-1} + 2z_{t-1} \\ y_t &= -6x_{t-1} + 2y_{t-1} + 6z_{t-1} \\ z_t &= y_{t-1} + z_{t-1} \end{aligned} \quad \text{with} \quad \begin{pmatrix} x_0 \\ y_0 \\ z_0 \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix}$$

Solve the system. (Show that $x_t = A^t x_0$ and express A^t in terms of P , P^{-1} and D .)

(20%) Write down expressions for x_t , y_t , z_t .

Find the value of z_5 from your solution.

2. Consider the system of linear equations $Ax = b$, where λ and μ are constants:

$$A = \begin{pmatrix} 1 & 2 & 0 \\ 5 & 1 & \lambda \\ 1 & -1 & 1 \end{pmatrix} \quad x = \begin{pmatrix} x \\ y \\ z \end{pmatrix} \quad b = \begin{pmatrix} 2 \\ 7 \\ \mu \end{pmatrix}$$

(5%) (i) Calculate the determinant of A , $|A|$

(ii) Determine for which values of λ and μ this system has:

- (a) a unique solution
- (b) no solutions
- (c) infinitely many solutions.

In case (a), use Cramer's rule to find the value of z in terms of λ and μ .

In case (c), solve the system using Gaussian elimination and express the solution in vector form, $x = p + tv$.

0%) 3. (a) Find and classify the stationary points of the function:
 $f: \mathbb{R}^2 \rightarrow \mathbb{R}$ defined by

$$f(x, y) = 4x^2y - 9y - 7x^2$$

(10%) Does f have any global extrema?

(b) (i) Find the overall minimum for the joint cost function

$$C(x, y) = 3x^2 + 2xy + 3y^2 - 32x - 32y + 163$$

for a company producing goods x and y .

The production function for the company for the goods x and y is

$$P(x, y) = 100x^{\frac{1}{4}}y^{\frac{1}{4}}$$

Evaluate the production when cost is minimised.

(10%)(ii) Show that when the production must be at least 300, the cost of production is minimised when $(x, y) = (9, 9)$.

(10%)(iii) Given that the production must be at least 100, find the quantities for which the cost of production is minimised.

(c) (i) Sketch a clear map of the contours of the surface

$$z = 3x^2 - 10xy + 3y^2$$

(10%) { in the xy plane, roughly indicating the directions of their gradient vectors.
 (ii) Find, if they exist, the points where the function
 $f(x, y) = 3x^2 - 10xy + 3y^2$ attains its maximum and minimum values subject to the constraints

$$x + y \leq 5, \quad y \geq 0$$

1. Poisson Process: (20%)

The p.d.f. of Poisson distribution is

$$f(x) = \frac{\lambda^x e^{-\lambda}}{x!} \tag{1}$$

Show how this distribution can be *derived* from the binomial distribution. Your answer should comprise of two parts. First, write down the **approximate Poisson process** in terms of binomial distribution. Then, show that the limit of this binomial distribution is Poisson distribution.

(Hint: The following formula may be useful for you.)

$$\lim_{n \rightarrow \infty} \left(1 - \frac{\lambda}{n}\right)^n = e^{-\lambda} \tag{2}$$

2. Simulate a Random Variable: (20%)

If your computer supplies you with only *uniform distribution*, show how to simulate observations sampled from an exponential distribution with a mean of $\theta = 10$. Note that the distribution function of X is

$$F(x) = 1 - e^{-\frac{x}{10}}, \quad 0 \leq x < \infty. \tag{3}$$

3. Normal Distribution (20%)

Prove that

$$\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{(x - \mu)^2}{2\sigma^2}\right] dx = 1 \tag{4}$$

4. Probabilistic Independence (10%)

Let the joint probability density function of X and Y be

$$f(x, y) = \frac{xy^2}{30}, \tag{5}$$

where $x = 1, 2, 3$, and $y = 1, 2$. Show that X and Y are independent.

5. Moment-Generating Function (10%)

Let X_1 and X_2 have independent distribution $b(n_1, p)$ and $b(n_2, p)$. Find the moment-generating function of

$$Y = X_1 + X_2. \tag{6}$$

How is Y distributed?

6. Maximum Likelihood Estimator (10%)

Let

$$f(x; \theta) = \theta x^{\theta-1}, \quad 0 < x < 1, \tag{7}$$

where $\theta \in \Omega = \{\theta : 0 < \theta < \infty\}$. Let X_1, X_2, \dots, X_n denote a random sample of size n from this distribution. Find the *maximum likelihood estimator* of θ .

7. Confidence Interval (10%)

Let $X_1, X_2, X_3, \dots, X_n$ be a random sample from $N(\mu, \sigma^2)$, with known mean μ . Describe how you would construct a confidence interval for the unknown variance σ^2 .

第一部分：

1. 請繪圖說明：

(1)(7%) 飛人喬丹在公牛隊打球時，曾經年薪高達3,000萬美元，為什麼他可以拿到這麼高的薪水？請利用“準租”的概念，繪圖說明你的答案。

(2)(8%) 小華說：「我喜歡吃香蕉，但是我更喜歡吃蘋果，你拿再多的香蕉給我，我也不願意跟你交換一顆蘋果。」請把蘋果放在橫軸，香蕉放在縱軸，繪出小華對於蘋果與香蕉的無異曲線，並指出其效用增加的方向。

2. (20%) 試證明：

(1) 在其他條件不變下，廠商的長期利潤不會小於短期利潤。

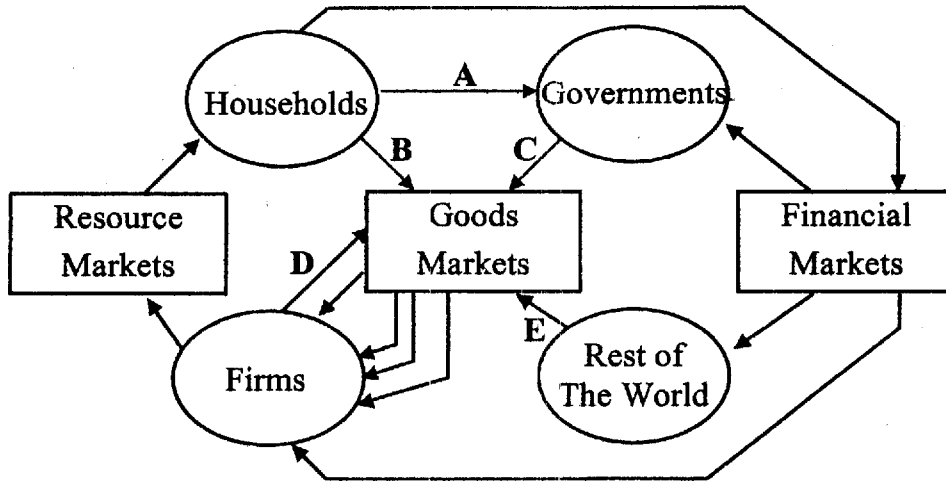
(2) 在其他條件不變下，廠商的長期供給彈性不會小於短期供給彈性。

3. (15%) 自從全民健保實施以來，就一直呈現虧損的狀態，為什麼？為了彌補損失，政府採行健保雙漲政策。請問健保雙漲的效果如何？請問這符合公平與效率的原則嗎？

第二部分：是非簡答題(共四題；第一、二題滿分各為10分，第三、四題滿分各為15分；合計滿分50分)

- 一、假設某一家廠商為獨賣廠商，本來是根據 $MR=MC$ 採取單一訂價來追求最大利潤，現若改採第一級或完全差別取價來增加其利潤，則此訂價行為必將導致社會福利降低。(10分)
- 二、隨著物價水準的上漲，若社會救濟金完全按照消費者物價指數的變動率調整，則領救濟金的低所得家庭會過的比以前還好。(10分)
- 三、教育部助學優惠貸款如果限制只適用於學雜費，不適用於生活費，將導致清寒學生的人力資本投資增加，但當期消費則不受影響，妳(你)同意嗎？(15分)
- 四、當兩家上市公司在同一期間欲透過公開申購來辦現金增資，若它們過去60天的平均價格與未來展望都一樣，則其折價幅度也應一樣。(15分)

- 一、The figure shows the flows of income and expenditure on Lotus Island. During 1997, A was \$15 million, B was \$30 million, C was \$9 million, D was \$18 million, and E was \$3 million. (20%)



- (4%) What is the private savings?
- (4%) Calculate national savings.
- (4%) Where does Lotus Island get the funds to finance its investment?
- (4%) Supposed that GDP is \$40 million below its potential level. It is expected that next-period GNP will be \$20 billion below potential, and that two periods from now it will be back at its potential level. The multiplier for government spending is 5. What policy actions can be taken to put GDP back on target each period?
- (4%) What is the Sacrifice ratio?

二、Please answer the following questions: (30%)

- (12%) In October 1979, the U.S. central bank announced that it would play a less active role in limiting fluctuations in dollar interest rates. After this new policy was put into effect, the dollar's exchange rates against foreign currencies become more volatile. Please analyze the connection between these two events with the aid of diagram where the exchange rate is the price of dollars in terms of New Taiwan dollar (for example, NT 33 per dollar).

2. (18%) The following information has been discovered about the economy of Cape Despair. Subsistence real GDP is \$15 an hour. Whenever real GDP per hour rises above this level, the population grows, and when real GDP per hour of labor falls below this level, the population falls. The productivity curve in Cape Despair is as follows:

Capital per hour of labor (1996 dollars per hour)	Real GDP per hour of labor (1996 dollars per hour)
20	8
40	15
60	21
80	26
100	30
120	33
140	35
160	36

Initially, the population of Cape Despair is constant, and real GDP is at its subsistence level. Then a technological advance shifts the productivity curve upward by \$7 at each level of capital per hour of labor.

- a. (2%) What happens to the population growth rate following the technological advance?
- b. (4%) What happens to real GDP per hour of labor immediately following the technological advance?
- c. (4%) What is the eventual quantity of capital per hour of labor in Cape Despair?
- d. (8%) Please illustrate New Growth Theory with the aid of diagram containing a productivity curve and a target rate of return curve. What is the role of knowledge capital playing in New Growth Theory?

三、請回答下列有關我國財政收支的問題：

1. 請具體敘述目前我國財政收支與政府債務餘額的狀況。(7分)
2. 請問造成我國政府債務餘額不斷攀升的主要因素？(8分)
3. 妳(你)認為政府在面臨高債務餘額時，其支出對經濟體系的影響效果取決於哪些因素？(10分)

二、請回答下列有關通貨緊縮(Deflation)的問題

1. 何謂通貨緊縮(Deflation)？其對經濟主要的負面衝擊為何？(6分)
2. 造成我國近年來呈現通貨緊縮現象的主要因素為何？(6分)
3. 何謂流動性陷阱(Liquidity Trap)？(5分)
4. 一個經濟體系同時存在通貨緊縮與流動性陷阱時，政府可採取那些政策使經濟脫離通貨緊縮的困境？(8分)

(一)

Answer the following questions as clearly and precisely as possible. No partial credit is given to simple answers without proper explanations or justifications. These questions have been proofread carefully to avoid mistakes and typos. However, if you believe there is any important misprint or ambiguity, spell it out explicitly and give your answers accordingly. Good luck!

1 Regression Analysis (10)

Let the true model for y_t be:

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \epsilon_t \quad (1)$$

where ϵ_t is iid with mean 0 and variance σ^2 . but you mistakenly estimate the wrong model:

$$y_t = b_0 + b_1 x_{1t} + u_t \quad (2)$$

Let γ_{12}, γ_{21} be the coefficient of regressing x_{1t} on x_{2t} and x_{2t} on x_{1t} respectively:

$$\begin{aligned} x_{1t} &= c_1 + \gamma_{12} x_{2t} + u_{1t} \\ x_{2t} &= c_2 + \gamma_{21} x_{1t} + u_{2t} \end{aligned}$$

Denote $\hat{\beta}_1, \hat{\beta}_2, \hat{b}_1, \hat{\gamma}_{12}, \hat{\gamma}_{21}$ as the OLS estimates of $\beta_1, \beta_2, b, \gamma_{12}, \gamma_{21}$ respectively. Answer the following questions.

- (3) Under what condition(s), will \hat{b}_1 be equal to $\hat{\beta}_1$?
- (3) How do you determine if \hat{b}_1 will over- or under-estimate β_1 ? Be specific.
- (4) Suppose that your calculator can only perform simple regression. That is, it can only compute regression with only one regressor and constant. Under this constraint, how do you compute $\hat{\beta}_1$, the OLS estimate of β_1 ?

2 Correlation Analysis (10)

Let X, Y, Z are three normal random variables under investigation and you are given n -sample data $(x_i, y_i, z_i), i = 1, \dots, n$.

- (3) How do you test if X, Y are uncorrelated? That is, testing the null hypothesis: $H_0 : \rho_{xy} \equiv \text{corr}(X, Y) = 0$. Specify precisely the test statistics and its distribution under the null hypothesis:
- (4) Suppose you suspect that Z is the common cause for X, Y . How do you find the correlation between X, Y with the effect of Z controlled? In other words, how to compute the partial correlation between X and Y conditional upon Z ? Either give the explicit formula or state precisely the procedure of computing the statistics.
- (3) Give an example that X and Y are correlated but conditional upon Z , X and Y are not correlated. You need to write down the exact model for your answer.

3 On R^2 (10)

Let y be defined as:

$$y_i = \alpha + \beta x_i + u_i, \quad i = 1, \dots, n \quad (3)$$

$\hat{\alpha}, \hat{\beta}$ be the corresponding OLS estimates, and R^2 the *coefficient of multiple determination*, the percent of the variation explained by the regression.

- (3) Write down the formula for R^2 .
- (3) Let $\hat{u}_i = y_i - \hat{\alpha} - \hat{\beta}x_i, i = 1, \dots, n$. What value is the R^2 when you regress y_i against x_i, \hat{u}_i with constant? Prove or explain your answer.
- (2) Let the constant, α , be dropped off the equation:

$$y_i = \gamma x_i + v_i, \quad i = 1, \dots, n \quad (4)$$

Is R^2 in (4) always between 0 and 1? Prove or justify your claim.

- (2) When a new variable Z is added to the regression in (3), the R^2 can never decrease. True or false. Explain your answer.

4 Hypothesis Testing (10)

Let

$$y_i = \alpha + \beta_1 x_{1i} + \beta_2 x_{2i} + \epsilon_i, \quad i = 1, \dots, n$$

where ϵ_i is *iid* normal with mean 0 and variance σ^2 , y, x_1, x_2 denote real money demand, income and interest rate respectively. Logarithmic transformations are applied to money demand and income but not to interest rate.

1. (3) How do you test if money demand model above is valid? Be specific about the test statistics and its distribution.
2. (3) How do you test if the income elasticity of money demand is equal to 1? Be specific about your test statistics and its distribution.
3. (4) For any given sample size, one can always construct the test statistics with proper size, say 5%. Thus, hypothesis testing is not affected by sample size as long as it is greater than number of parameters. True or false. Explain your answer.

5 Estimation and Prediction (10)

Let

$$y_i = \alpha + \beta_1 x_i + \epsilon_i, \quad i = 1, \dots, n$$

where ϵ_i is *iid* normal with mean 0 and variance σ^2 , and $(\hat{\alpha}, \hat{\beta})$ denotes the OLS estimate of (α, β) .

1. (3) What is the confidence interval of predicting y when $x = x_0$?
2. (3) What value should x_0 be to minimize the variance of predicting y ? Explain your answer.
3. (4) Suppose that x_i is a fixed regressor with M, m being upper and lower bounds and you have the power of determining the value of $x_i, i = 1, \dots, n$ (n is even). How do you select $x_i, i = 1, \dots, n$ to maximize the estimation precision of $\hat{\beta}$? In other words, how to choose x_i to minimize the standard deviation of $\hat{\beta}$? Be precise about your answer.

(二)

1. (6%) A machine in a factory must be repaired if it produces more than 10% defectives among the large lot of items it produces in a day. A random sample of 100 items from the day's production contains 15 defectives, and the supervisor says that the machine must be repaired. Does the sample evidence support his decision? Use a test with level .01.
2. (5%) The service times for customers coming through a checkout counter in a retail store are independent random variables with mean 1.5 minutes and variance 1.0. Approximate the probability that 100 customers can be served in less than 2 hours of total service time.
3. (5%) Of the volunteers donating blood in a clinic, 80% have the Rhesus factor present in their blood. If five are randomly selected, what is the probability that at most four have the Rhesus factor?
4. (6%) Let

$$f(y_1, y_2) = \begin{cases} 6y_1y_2^2, & 0 \leq y_1 \leq 1; 0 \leq y_2 \leq 1 \\ 0, & \text{elsewhere} \end{cases}$$

Show that Y_1 and Y_2 are independent.

5. (6%) Two methods for teaching reading were applied to two randomly selected groups of elementary schoolchildren and then compared on the basis of a reading comprehension test given at the end of the learning period. The sample means and variances computed from the test scores are shown in the accompanying table. Do the data present sufficient evidence to indicate a difference in the mean scores for the populations associated with the two teaching methods? What can be said about the attained significance level? What assumptions are required? What would you conclude at the $\alpha = .05$ level of significance?

	Method I	Method II
Number of children in group	11	14
\bar{y}	64	69
s^2	52	71

6. (6%) An experiment to explore the pain thresholds to electrical shocks for males and females resulted in the data summary given in table below. Do the data provide sufficient evidence to indicate a significant difference in the variability of pain thresholds for men and women? Use $\alpha = .10$. What can be said about the p -value.

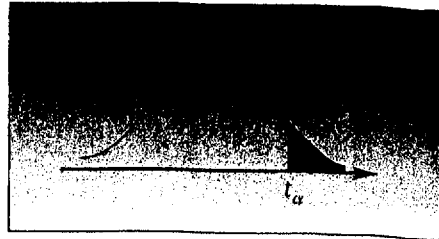
	Males	Females
n	14	10
\bar{y}	16.2	14.9
s^2	12.7	26.4

7. (10%) The Brunner Manufacturing Company operates 24 hours a day, five days a week. The workers rotate shifts each week. Management is interested in whether there is a difference in the number of units produced when the employees work on various shifts. A sample of five workers is selected and their output recorded on each shift. At the .05 significance level, can we conclude there is a difference in the mean production by shift and in the mean production by employee?

Employee	Day	Units Produced	
		Afternoon	Night
Skaff	31	25	35
Lum	33	26	33
Clark	28	24	30
Treece	30	29	28
Morgan	28	26	27

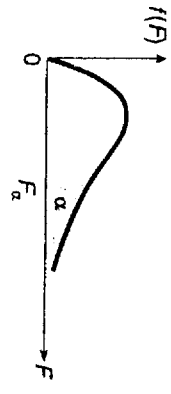
8. (6%) Pierre's Restaurant announced that on Thursday night the menu would consist of unusual gourmet items, such as squid, rabbit, snails from Scotland, and dandelion greens. As part of a large survey, a sample of 81 regular customers was asked whether they preferred the regular menu or the gourmet menu. Forty-three preferred the gourmet menu. Using the sign test and the .02 level, test whether the customers liked the gourmet menu better than the regular menu. Justify your conclusion.

Critical Values of the t Distribution

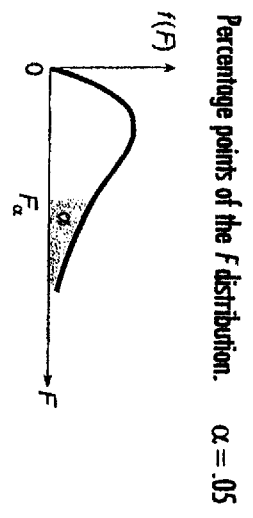


Degrees of Freedom	$t_{.100}$	$t_{.050}$	$t_{.025}$	$t_{.010}$	$t_{.005}$
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
40	1.303	1.684	2.021	2.423	2.704
60	1.296	1.671	2.000	2.390	2.660
120	1.289	1.658	1.980	2.358	2.617
∞	1.282	1.645	1.960	2.326	2.576

Percentage points of the F distribution. $\alpha = .01$



1/2	NUMERATOR DEGREES OF FREEDOM										NUMERATOR DEGREES OF FREEDOM									
	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120		
1	4.052	4.999	5.403	5.625	5.764	5.859	5.928	5.982	6.022	6.056	6.106	6.157	6.209	6.235	6.261	6.287	6.313	6.339	6.366	
2	98.50	99.00	99.17	98.25	98.30	99.33	99.36	99.37	99.39	99.40	99.42	99.43	99.45	99.46	99.47	99.47	99.48	99.49	99.50	
3	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.35	27.23	27.05	26.87	26.69	26.60	26.50	26.41	26.32	26.22	26.13	
4	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.55	14.37	14.20	14.02	13.93	13.84	13.75	13.65	13.56	13.48	
5	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16	10.05	9.89	9.72	9.55	9.47	9.38	9.29	9.20	9.11	9.02	
6	13.75	10.92	9.78	9.15	8.75	8.45	8.26	8.10	7.98	7.87	7.72	7.56	7.40	7.31	7.23	7.14	7.06	6.97	6.88	
7	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.47	6.31	6.16	6.07	5.99	5.91	5.82	5.74	5.65	
8	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.67	5.52	5.36	5.28	5.20	5.12	5.03	4.95	4.86	
9	10.56	8.02	7.00	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.11	4.96	4.81	4.73	4.65	4.57	4.48	4.40	4.31	
10	10.04	7.56	6.57	6.00	5.64	5.39	5.20	5.06	4.94	4.85	4.71	4.56	4.41	4.33	4.25	4.17	4.08	4.00	3.91	
11	9.65	7.21	6.22	5.65	5.32	5.07	4.88	4.74	4.63	4.54	4.40	4.25	4.10	4.02	3.94	3.86	3.78	3.70	3.61	
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.16	4.01	3.86	3.78	3.70	3.62	3.54	3.46	3.38	
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	3.96	3.82	3.66	3.58	3.50	3.42	3.34	3.26	3.18	
14	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.80	3.66	3.51	3.43	3.35	3.27	3.19	3.11	3.03	
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.67	3.52	3.37	3.29	3.21	3.13	3.05	2.97	2.89	
16	8.53	6.23	5.29	4.77	4.44	4.22	4.04	3.90	3.78	3.69	3.55	3.41	3.26	3.18	3.10	3.02	2.94	2.86	2.78	
17	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.46	3.31	3.16	3.08	3.00	2.92	2.84	2.76	2.68	
18	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.37	3.23	3.08	3.00	2.92	2.84	2.75	2.67	2.59	
19	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15	3.00	2.92	2.84	2.76	2.67	2.59	2.51	
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09	2.94	2.86	2.78	2.70	2.61	2.52	2.44	
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.17	3.03	2.88	2.80	2.72	2.64	2.55	2.46	2.38	
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.12	2.98	2.83	2.75	2.67	2.59	2.50	2.42	2.34	
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.07	2.93	2.78	2.70	2.62	2.54	2.45	2.36	2.28	
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.03	2.89	2.74	2.66	2.58	2.50	2.41	2.32	2.24	
25	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22	3.13	2.99	2.85	2.70	2.62	2.54	2.45	2.36	2.27	2.19	
26	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.28	3.18	3.09	2.95	2.81	2.66	2.58	2.50	2.42	2.33	2.24	2.16	
27	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.25	3.15	3.06	2.92	2.78	2.63	2.55	2.47	2.38	2.29	2.20	2.12	
28	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.22	3.12	3.03	2.89	2.75	2.60	2.52	2.44	2.35	2.26	2.17	2.09	
29	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.10	3.00	2.87	2.73	2.58	2.50	2.42	2.33	2.24	2.15	2.07	
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70	2.55	2.47	2.39	2.30	2.21	2.12	2.04	
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.66	2.52	2.37	2.29	2.20	2.11	2.02	1.92	1.84	
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.50	2.35	2.20	2.12	2.03	1.94	1.84	1.73	1.66	
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.34	2.19	2.03	1.95	1.86	1.76	1.66	1.53	1.48	
∞	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.18	2.04	1.88	1.79	1.70	1.59	1.47	1.32	1.00	



$v_1 \backslash v_2$	NUMERATOR DEGREES OF FREEDOM										NUMERATOR DEGREES OF FREEDOM									
	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞	
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5	241.9	243.9	245.9	248.0	249.1	250.1	251.1	252.2	253.3	254.3	
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50	
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53	
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63	
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.36	
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67	
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23	
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93	
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71	
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54	
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.78	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40	
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30	
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.29	2.25	2.21	
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13	
15	4.54	3.68	3.28	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.47	2.40	2.33	2.29	2.25	2.21	2.16	2.12	2.07	
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.20	2.16	2.11	2.07	2.02	
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.44	2.37	2.30	2.23	2.19	2.15	2.11	2.06	2.02	1.97	
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.20	2.16	2.12	2.08	2.03	1.99	1.94	
19	4.38	3.49	3.10	2.87	2.71	2.60	2.52	2.45	2.39	2.34	2.27	2.20	2.13	2.09	2.05	2.01	1.96	1.92	1.87	
20	4.35	3.45	3.06	2.83	2.67	2.56	2.48	2.41	2.36	2.31	2.24	2.17	2.10	2.06	2.02	1.98	1.93	1.89	1.84	
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.11	2.07	2.03	1.99	1.94	1.90	1.85	
22	4.30	3.44	3.04	2.82	2.66	2.55	2.46	2.40	2.34	2.29	2.22	2.15	2.08	2.04	2.00	1.96	1.91	1.87	1.82	
23	4.28	3.42	3.01	2.80	2.64	2.53	2.44	2.38	2.32	2.27	2.20	2.13	2.06	2.02	1.98	1.93	1.89	1.84	1.79	
24	4.26	3.40	2.99	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.04	2.00	1.96	1.91	1.87	1.82	1.77	
25	4.24	3.39	2.98	2.76	2.60	2.49	2.40	2.34	2.28	2.23	2.16	2.09	2.02	1.98	1.94	1.89	1.84	1.79	1.74	
26	4.23	3.37	2.96	2.74	2.59	2.47	2.38	2.32	2.26	2.21	2.14	2.07	1.99	1.95	1.91	1.86	1.81	1.76	1.71	
27	4.21	3.35	2.94	2.73	2.57	2.45	2.36	2.30	2.24	2.19	2.12	2.05	1.97	1.93	1.89	1.84	1.79	1.74	1.69	
28	4.20	3.34	2.93	2.71	2.55	2.43	2.34	2.28	2.22	2.17	2.10	2.03	1.95	1.91	1.87	1.82	1.77	1.72	1.67	
29	4.18	3.33	2.92	2.70	2.54	2.42	2.33	2.27	2.21	2.16	2.09	2.02	1.94	1.90	1.86	1.81	1.76	1.71	1.66	
30	4.17	3.32	2.92	2.69	2.53	2.41	2.32	2.26	2.20	2.15	2.08	2.01	1.93	1.89	1.84	1.79	1.74	1.69	1.64	
40	4.08	3.23	2.84	2.61	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.02	1.94	1.89	1.84	1.79	1.74	1.69	1.62	
60	4.00	3.15	2.76	2.53	2.45	2.34	2.25	2.18	2.12	2.07	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.59	1.51	
120	3.92	3.07	2.68	2.45	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39	
∞	3.84	3.00	2.60	2.37	2.29	2.17	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25	