1. (a) Total sales (S) of a firm selling two products X and Y is given by S=a+bX+cY. Determine sales when 10 units of X and 20 units of Y are sold.

- **Approach:**
  1. **Formulate Equations:** Set up three linear equations using the given sales data for three months to solve for constants a, b, and c.
  2. **Solve using Determinants (Cramer's Rule):** Calculate determinants to find the values of a, b, and c.
  3. **Calculate Sales:** Substitute the derived a, b, and c values into the sales equation with X=10 and Y=20.

OR

1. (a) Mr. Y invested ₹50,000 divided into three investments. Use matrix algebra to find the amount in each.

- **Approach:**
  1. **Define Variables:** Represent the amounts invested in savings, bonds, and business as x, y, and z.
  2. **Formulate System of Equations:** Create three linear equations based on total investment, net income, and the relationship between business and savings investments.
  3. **Solve using Matrix Algebra:** Represent the system as AX=B and calculate X=A−1B.

1. (b) Input-Output Analysis: Given transaction matrix, final demand, and labour inputs.

- **Approach:**
  - **(i) Technology Matrix & Simon-Hawkins:** Calculate the technology matrix (A) and test viability using Simon-Hawkins conditions on the (I−A) matrix.
  - **(ii) Gross Output for New Demand:** Use the Leontief Inverse model: X=(I−A)−1Dnew.
  - **(iii) Feasibility with Labour:** Calculate total labour required for the new output and compare it with the available labour.
  - **(iv) Value Added:** Determine value added for each sector (Total Output - Intermediate Consumption).
  - **(v) Equilibrium Prices:** Use the price equation P′=(I−A′)−1V′ (value added per unit derived from labour cost).

OR

1. (b) Input-Output Analysis: Given transaction matrix.

- **Approach:**
  - **(i) Technology Matrix & Simon-Hawkins:** Similar to 1(b)(i) above.
  - **(ii) New Transaction Matrix for Increased Final Demand:** Calculate new gross outputs using the Leontief Inverse, then construct the new transaction matrix by applying the technology coefficients to the new gross outputs.

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2. (a) EOQ and Inventory Cost: Given annual demand, unit cost, ordering cost, and storage cost.

- **Approach:**
  1. **Calculate EOQ:** Apply the Economic Order Quantity formula.
  2. **Calculate Minimum Total Cost:** Sum the purchasing, ordering, and holding costs at EOQ.
  3. **Evaluate Discount Offer:** Calculate total cost if the order size is 1000 units with the discount and compare it to the minimum total cost.

OR

2. (a) Demand Function: $5q=400-2p$.

- **Approach:**
  - **(i) Elasticity Regions:** Derive the elasticity of demand formula, then find price intervals for elastic, inelastic, and unit elasticity.
  - **(ii) Revenue Function Analysis:** Formulate the total revenue function ($R=pq$), find its derivative, set to zero to maximize revenue, and identify intervals of increase/decrease.

2. (b) Cable Service Operator: Maximize Total Revenue.

- **Approach:**
  1. **Define Variables:** Let 'x' be the number of price decreases.
  2. **Formulate Price and Quantity:** Express price and number of subscribers in terms of 'x'.

3. **Revenue Function:** Create the total revenue function R=P×Q.
4. **Maximize Revenue:** Find the derivative of R with respect to x, set it to zero, and solve for x to determine the optimal decrease in service charge.

OR

2. (b) Engine Cost: Most Economical Speed.

- **Approach:**
  1. **Formulate Fuel Cost:** Establish the proportionality constant 'k' from the given data (Cf=kv2).
  2. **Total Cost per km:** Formulate a total cost function that includes fuel cost and other costs, divided by speed, to get cost per kilometer.
  3. **Minimize Cost:** Differentiate the cost per km function with respect to speed (v), set to zero, and solve for v.

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3. (a) Monopolist selling in two separate markets: Maximize Profit.

- **Approach:**
  1. **Revenue Functions:** Derive total revenue from each market.
  2. **Total Cost:** Express total cost as a function of total quantity.
  3. **Profit Function:** Formulate profit as Total Revenue - Total Cost.
  4. **Maximize Profit:** Find partial derivatives of profit with respect to quantities in each market, set to zero, and solve the system.

OR

3. (a) Production Function Q=AL2/7K2/7.

- **Approach:**
  - **(i) Returns to Scale:** Sum the exponents of L and K.
  - **(ii) Returns to Inputs:** Analyze individual exponents to determine if returns to individual factors are diminishing.
  - **(iii) Total Reward and Exhaustion of Product:** Calculate marginal products (MP_L, MP_K). Total reward is (L×MPL

)+(K×MPK). Compare to Q using Euler's theorem for homogeneous functions.

3. (b) Elasticity of Demand: Find Demand Function.

- **Approach:**
    1. **Differential Equation:** Set up a differential equation using the elasticity formula Ed=(dq/dp)∗(p/q).
    2. **Integration:** Integrate the derived differential equation after partial fraction decomposition.
    3. **Solve for Constant:** Use the given initial condition (q=4 at p=3) to find the integration constant and complete the demand function.

OR

3. (b) Demand and Supply Laws: Find Consumer and Producer Surplus.

- **Approach:**
    1. **Equilibrium:** Solve for equilibrium quantity (x0) and price (P0) by setting demand equal to supply.
    2. **Consumer Surplus (CS):** Calculate ∫0x0Pd(x)dx−P0x0.
    3. **Producer Surplus (PS):** Calculate P0x0−∫0x0Ps(x)dx.

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4. Attempt any three questions.

- **(a) Debt Repayment: Find Final Payment.**
    1. **Principle of Equivalence:** Equate the present value of all debts to the present value of all payments.
    2. **Calculate Present Values:** Discount all future obligations and known payments to the present.
    3. **Solve for Final Payment:** Use the equivalence principle to set up an equation and solve for the unknown final payment.
- **(b) Machine Selection: Preferable Machine (NPV).**
    1. **Calculate NPV:** For each machine, compute the Net Present Value as (PV of Annual Savings) - Initial Cost.
    2. **PV of Annual Savings:** Use the present value of annuity formula.
    3. **Compare:** Choose the machine with the higher NPV.
- **(c) Deferred Annuity: Find Amount of Annuity.**
    1. **Future Value of Annuity:** Use the future value of an ordinary annuity formula, noting that the deferral period

doesn't affect the future value *at the end of the annuity term itself*.

- **(d) Machine Depreciation: Find Years Used.**
    1. **Depreciation Formula:** Use the reducing balance method formula: Salvage Value = Cost $\times(1-\text{rate})^n$.
    2. **Solve for n:** Substitute the given values and solve for 'n' (number of years) using logarithms.

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5. Linear Programming (Simplex Method): Complete and Analyze Simplex Table.

- **Approach:**
    - **(i) Complete and Test Optimality:** Calculate the Z_j and $C_j - Z_j$ rows. For maximization, optimality is achieved when all $C_j - Z_j \le 0$.
    - **(ii) Optimal Product Mix and Profit:** Identify basic variables and their values from the 'Quantity' column to determine the optimal product mix and profit.
    - **(iii) Feasibility:** A solution is feasible if all basic variable values in the 'Quantity' column are non-negative.
    - **(iv) Alternative Solutions:** If any non-basic variable has a $C_j - Z_j = 0$ in the optimal table, an alternative solution exists.
    - **(v) Shadow Prices:** These are the $C_j - Z_j$ values for the slack variables in the optimal table.
    - **(vi) Priority for Expansion:** Prioritize the department with the highest positive shadow price.
    - **(vii) Producing 13 units of x3:** Substitute $x_3 = 13$ into the original constraints and analyze the impact on the other variables and feasibility.
    - **(viii) Price Increase for x3:** This relates to the allowable increase in x_3's objective function coefficient, often derived from its $C_j - Z_j$ value in the optimal tableau.
    - **(ix) Degeneracy:** A solution is degenerate if any basic variable in the 'Quantity' column has a value of zero.